Musical Imagery:
Hearing and Imagining Music

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Musical imagery is defined as the conscious 'inner hearing' of a mental representation of music. In spite of the apparent importance of imagery for musical activity, there is a dearth of empirical knowledge on the subject, due in part to its essentially private and internal nature. Psychological methods of examining the phenomenon are necessarily restricted to indirect research techniques. This thesis explores the intuition that musical imagery is central to musical thought, through an exploration of its occurrence and its character in a variety of musical activities. Three categories of musical imagery are described. First, musical imagery can occur unintentionally – the phenomenon often called 'tune on the brain'. Second, musical imagery may be an involuntary consequence of musical activity. Finally, imagery may be intentional, as in the 'silent' analysis of musical score. The studies reported progress from unintentional to intentional imagery, combining a variety of methods in increasingly specialised musical contexts to investigate the relationship between imagery and perception. The subject is approached through theoretical discussion, a sampling study, experiments, fieldwork, and interviews with expert musicians.

It is argued that musical imagery and perception are separable but mutually dependent cognitive phenomena. The results highlight a shifting relationship between perception and imagery depending upon the contextual factors of image intentionality and musical task. Evidence is provided for the prevalence of 'tune on the brain' episodes in everyday life. The veridicality of imagery for different musical dimensions is also explored, with the experiment finding that timbre is a less stable component of musical imagery than timing and pitch. Musical imagery is described as situated between the subconscious influence of mental representations during the pure perception of music, and the rare occurrence of eidetic imagery.

CONTENTS

Volume 1

Volume 2

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CHAPTER ONE –

AN INTRODUCTION TO MUSICAL IMAGERY

1.1 What is 'Musical Imagery'?

Most investigations into music have focused on the physical occurrence of music, but musical experience may not always be 'real': music is ephemeral, but when it is no longer before the ear, imagery may provide an alternative, purely mental musical awareness. This is the conscious experience of an internal representation of music, or 'inner hearing'. It is the product of the elusive 'mind's ear', and is widespread in its supposed occurrence. Three major categories of musical imagery can be discerned. Firstly, musical imagery can occur unintentionally – the phenomenon often called 'tune on the brain'. Secondly, musical imagery may be an involuntary corollary of musical activity, such as anticipating the next track on an album while listening to music, or working towards an ideal musical sound in performance based on internally 'hearing' how it should sound. Finally, imagery may be deliberate, as in the 'silent' analysis of musical score, or the auralisation of sound in harmony and counterpoint exercises.

'Take out the image from the musical mind and you take out its very essence' (Seashore, 1938: 6). Seashore implies a controversial division of the 'musical mind' from the notion of an implied 'non-musical mind', yet the underlying point is important: musical imagery is fundamental to all musical endeavour. The intangibility of the phenomenon leaves such speculation at least momentarily unchecked. Musical imagery is probably universally experienced but this conjecture is difficult to substantiate, as imagery is a private experience that is difficult to communicate. Consequently, remarkably little is known about the subject. Moreover, while imagery has received a great deal of psychological attention in the field of vision, auditory and musical imagery have faced specific challenges which have halted the progress of knowledge in this area. For instance, the temporal quality of music renders imagery all the more elusive, while imaging a visual object is less concerned with temporality, making the experience apparently more tangible. Furthermore, it will be seen that experimental tasks requiring participants to image music tend to be demanding on participants.

Various definitions of imagery, or 'mental images' have been offered. In the auditory domain, Intons-Peterson (1992: 46) describes it as:

> The introspective persistence of an auditory experience, including one constructed from components drawn from long-term memory, in the absence of direct sensory instigation of that experience.

Musical imagery is a production of the 'mind's inner ear', a pattern of neuronal activation reflecting imaginative processing. It may differ importantly as an experience from the internal processes that channel and interpret any actual incoming sensory information, otherwise known as 'perception'. Imagery can be distinguished from imagination, as imagination encompasses imagery, being 'the faculty or action of producing mental images of what is not present or in one's own experience' (HarperCollins, 1998). The other definition of imagination (from the same source) as 'creative mental ability' presents imagery as a key ingredient in creative thought. Seashore (1938) makes a link between imagery and creation when he speculates that 'Perhaps the most outstanding mark of the musical mind is auditory imagery, the capacity to hear music in recall, in creative work, and to supplement the actual physical sounds in musical hearing' (161).

Hebb (1968) describes the mental image in a basic but nonetheless important manner, as a mental representation that is formed of amalgamated knowledge. The example he furnishes is of the way in which the mind is able to imagine a complete hand in any number of positions, based entirely on a projection of knowledge about hands. Imagery is something more than the memory of a perceptual event. It is intuitively a more sensory phenomenon. Most reported imagery is not experienced as a single modality, but as a cross-modal occurrence. For example, while a musical memory may be closely associated with external events, musical or otherwise, a musical image is often complete with visual, kinaesthetic and spatial sensations that somehow subsist apart from 'reality'. While this difference is subtle, it helps to explain an otherwise elusive feeling about the nature of imaginative experience.

Zatorre, Halpern, Perry, Meyer and Evans (1996: 29) write that imagery experiences 'seem to be more directly linked to the sensory system originally involved in encoding the information' than recollection or recognition. It is certainly true that imagery is seen as veering towards the more elusive creative and emotive attributes of music. Robertson asserts that 'We must accept that memory and a beautifully formed musical imagination are the prime factors in music making' (1996: 20). Again, it is Seashore who emphatically highlights the notion that imagery is the very core of art:

> To a person who is not capable of imagery, there can be no genuine music, because, like the lines in the crayon sketch, the tones by themselves, however accurately heard, furnish at the best a mere skeleton for hearing (Seashore, 1938: 169).

Schneider and Godøy (2001) provide a comprehensive philosophical and psychological history of musical imagery, usefully touching on some of the problematic issues involved with its definition. They explore the role of implicit and explicit, conscious and sub-conscious processes in music. They also tackle the indistinct overlap of musical imagery with perception, arguing that it is difficult to compartmentalise imagery of any sort. Their overview of perspectives on musical imagery points out areas of common interest to researchers such as the neurological basis for the experience, issues of 'functional equivalence', cross-modality, and triggers for musical imagery. Although interest in musical imagery comes from a broad background, very little empirical research has been attempted. This lack of systematic empirical study in musical imagery coupled with the centrality of imagery to musical experience and cognitive processing points to an urgent need for investigation.

It has been mentioned that musical imagery might occur as a 'tune on the brain' memory image and this experience is presumed to occur irrespective of musical training. Musical imagery, however, has particular importance for musicians, functioning in creation, performance, 'auralisation' and recollection and anticipation. For example, composers and orchestrators are presumed to inwardly 'hear' their ideas, and perhaps manipulate the musical image in their mind's ear. Situated between composition and performance is improvisation in which, once more, musical imagery may have a role to play as a performance goal, an ideal sound to be projected. Musicians in the Western classical tradition rely heavily on musical notation. This requires the translation from written symbol to an aural image of the sound being communicated. More generally, discussion about music might rely on a shared ability to translate named music into a musical image of that piece. And finally, listening to music might also involve the imaging of music, either as the recollection of familiar music, or through the active anticipation of music to come.

Because the consequences of imagery for music making are manifold, an array of imagery terminology has arisen to refer to the phenomenon (Brodsky, Henik, Rubinstein and Zorman, 1999). Ward uses the term 'auralize' to refer to inner hearing (Levitin and Cook, 1996). Indeed, this term is widely applied to everyday voluntary use of mental representations. Gordon coined the expression 'audiation', while Walters described musical imagery as 'hearing music that is not before the ear at the moment through recall, prediction, or conception' (see Brodsky *et al.*, 1999: 4). Brodsky *et al.* make a nominal division between inner hearing triggered by notation and other imagery triggers. They say that notation 'auralisation' has been variously described as 'acoustic picture', 'mental score', 'notational audition' and 'silent singing'. Given the apparent importance of musical imagery, musicologists have formulated certain views about the many properties of the phenomenon. These require psychological validation, and empirical methods must be found to study musical imagery.

1.2 Studying Musical Imagery

In addition to the benefits of learning more about imagery for its role in musical activity, it is probable that an exploration of the phenomenon will reveal a great deal regarding cognitive mechanisms of the human mind. Music is a temporal happening, and, assuming that temporality is at least partially represented in musical imagery (as does Halpern, 1992), this has important implications for an understanding of the phenomenon. Godøy makes the thought-provoking claim that as 'musical cognition is based on retrospective images of flux, . . . we are in fact dealing with musical imagery when talking about musical cognition' (1997: 92). In this instance, imagery is extended to mean mental representations of a more general kind than the definition of musical imagery as a conscious 'hearing'. Should the domain of musical cognition view musical imagery as a research priority? This is certainly not the traditional view as issues of actual perception have, until present, taken precedence.

Most of the traditional approaches to imagery research are firmly and exclusively grounded in the study of visual imagery, to the extent that 'imagery' has become synonymous with visual concerns in psychology research. A lot can be learnt from research in this area. For instance, it has already been seen that imagery is frequently associated with the more general field of memory. This is because the term imagery most often refers to experiencing a 'memory image' of an object once perceived. However, imagery is more specialised than memory, as the latter may involve more declarative and abstract knowledge of previous experience, while imagery is essentially a low-level generation of the qualia of previous experience (albeit informed by higher-level cognitive processes). Another useful means of distinguishing the two is to consider that imagery remains an internal occurrence, while memory tasks in psychological investigation are executive. Furthermore, musical imagery is characterised by its autonomous status: musical memory is generally triggered by external events, while musical imagery is commonly associated with the seemingly autonomous 'tune on the brain'. Within the classical understanding of memory, a division is normally made between long-term and short-term, or working memory systems. It seems clear that musical imagery calls upon long-term memory. Evidence from Bartlett and Snelus confirms what most people subjectively believe to be the case, that recollection for music may cover a lifespan (1980), regardless of musical training levels. However, short-term musical memory, or working memory, is responsible for the instantaneous generation, re-integration and creative use of imagery.

It has been suggested that mental imagery is a more complex entity than the mere product of memory. For instance, Collingwood describes the role that imagery and imagination play during musical perception:

> A piece of music is not something audible, but something which may exist solely in the musician's head. To some extent it must exist solely in the musician's head... for his imagination is always supplementing, correcting and expurgating what he actually hears. The music which he actually enjoys as a work of art is thus never sensuously or 'actually' heard at all. It is something imagined. (Collingwood, 1938; cited in Cook, 1990: 36).

While it is possible that perceiving music inevitably involves an element of imaginative interpretation, Collingwood is extreme to claim that music is never 'actually' heard. The theoretical relationship of perception to imagery has been a key concern of most perspectives taken on visual imagery. Indeed, it is hard to conceive of a method of explaining and describing imagery other than by comparing it with perception. Consequently, likening imagery to perception is commonly considered the most effective way to an understanding of the phenomenon.

'If memory and perception are the two key branches of cognitive psychology, the study of imagery stands precisely at their intersection' (Neisser, 1972; cited in Intons-Peterson, 1992: 65). Contemplating imagery as a confluence of memory and perception represents a conceptual foundation from which to investigate the differing levels of clarity possible in imagery. Sometimes an image may be as vivid as real perception (as in hallucinations), while at other times it is no more than an impression. Traditional theories of visual imagery differ greatly with respect to the relationship of imagery to perception. For instance, Finke (1989) writes about imagery as being functionally equivalent to perception in so far as similar physical mechanisms are activated during both processes. Neuropsychological study has also determined many parallels between imagery and perception processes. Shepard (1978) takes the viewpoint that visual images may be defined 'solely in relation to their corresponding external objects'. He worked on the premise that a mental representation can be manipulated once it has reached consciousness, as for example in the mental rotation of objects. However, Pylyshyn (1981) is at odds with this perspective, arguing that conscious mental images are 'merely an epiphenomenal trace of work already accomplished' (Neisser, 1976: 129). As regards the relationship of imagery to perception, Neisser (1976) argued that:

> Imagining is not perceiving, but images are indeed derivations of perceptual activity . . . In particular, they are the anticipatory phases of that activity, schemata that the perceiver has detached from the perceptual cycle for other purposes (Neisser, 1976: 130).

According to this view, being able to image an elephant is a form of perceptual readiness for the subsequent perception of an elephant.

These theories highlight considerable divergence among imagery researchers as regards the closeness of imagery to perception. Such theories are inadequate by their omission of auditory imagery[1]. Nevertheless, some of the principles underlying the work have informed recent efforts to explore musical imagery. Most common is the assumption that imagery and perception in music are functionally equivalent. The few published empirical studies of musical imagery have tended to use perception tasks as a control against which to compare imagery test data (for example, Halpern, Zatorre, Bouffard, Johnson, 2002; Intons-Peterson, 1992). Given the intangibility of musical imagery, this approach represents a practical means of understanding the phenomenon. However, musical imagery research to date is disparate in nature, and often fails to address fundamental questions. These questions are: Is musical imagery a psychological 'reality', and how do musical images behave by comparison with their perceptual counterparts? How common is

[1] Although Finke (1989) is unusual in his mention of work on auditory imagery by Halpern, and Farah & Smith.

musical imagery experience? What role does musical imagery play in everyday life and in musical activity? What effects might an individual's musical background have on their experience of musical imagery? How vivid is the imagery experience for various musical dimensions such as expression, tempo and timing, pitch, timbre, dynamics, and rhythm?

Does the context of imagery's occurrence determine the nature of the relationship of musical imagery to perception? This thesis addresses these questions by consolidating existing theoretical knowledge, and examining musical imagery in a variety of contexts that include controlled experiments.

The musical imagery of another can never be experienced directly. Indirect ways of measuring the phenomenon must suffice. This necessitates the expression of an occurrence which is not normally expressed: musical imagery must be translated into singing, playing, movement, verbal description, or the use of visual and spatial metaphor. Verbal description in particular should be treated with care as vocabulary may either restrict or inflate the account and perhaps also the experience of imagery. While controlled experiments producing quantitative data are amenable to statistical testing, this advantage should be balanced against the loss of detail, individual insight and allowance for the unexpected that are inherent when employing solely quantitative research techniques (Windsor, 1998). Given the advantages and drawbacks of both qualitative and quantitative methods, the approach adopted in this thesis is to triangulate these approaches. This usefully combines the study of conscious and sub-conscious cognitive behaviour, providing reflective and non-reflective forms of data about musical imagery. The research in this thesis combines theory, sampling techniques, experiment, fieldwork and case study interviews. The aim is to build on existing knowledge of musical imagery, by exploring the psychological reality of musicological intuitions, and examining imagery in its various aspects in order to clarify any potential effects from the different occurrences of musical imagery.

The techniques employed in this research require both a degree of introspection and expertise in performing specifically musical tasks. Musicians are therefore most able to participate: they possess the specific vocabulary to describe music, and are used to performing relatively analytical musical tasks. More importantly, musicians are a key population to study for theoretical reasons: they are unique in experiencing musical imagery in its specialised musical forms (connected with composition, conducting, and performance), as well as experiencing the presumably ubiquitous 'tune on the brain'. For this reason, musicians were the focus of this research.

1.2.1 Content of the research

Musical imagery is presumed to occur in a number of contexts that differ in their degree of musical specialisation and in the extent to which imaging is intentional. It might be expected that the focal relationship of imagery to perception be affected by such contextual factors. This thesis presents research relating to a dual progression from unintentional to intentional imagery, and from general to specialised musical activity. The purpose of this organisation is to highlight the relationship of imagery to perception across the three categories of musical imagery outlined at the start of this chapter. These are 1) the unintentional 'tune on the brain', 2) the unintentional corollary of general musical activity, and 3) intentional imaging in specialised music activity such as score reading.

This thesis consists of four empirical components that address the issues outlined above in distinct ways. The first component is a 'real world' study of the prevalence and nature of musical imagery. This addresses the phenomenon of unintentional occurrences of 'tune on the brain' imagery. The second component comprises experiments that examine the relationship between imagery and perception as a context for the discrimination of timing, pitch, and timbre. These experiments gather data of an explicit and implicit kind. The third component explores the sorts of inner hearing training that are on offer in a number of institutions of higher education in the UK. Over the period of one year, fieldwork at these institutions allowed the observation of different aural training teaching methods. The fourth component is the sampling of expert musicians who were interviewed about the role of imagery in their musical and everyday lives. For each of these components, the relationship of imagery to perception was the focus, with a view to determining how different musical circumstances might call on different sorts of mental input.

While each of the studies within the project is underlined by a common theoretical focus, they led to quite different forms of data and different kinds of conclusion. Thus care was needed in organising and presenting the results. Chapter Two presents a literature review, which also includes a theoretical exploration of definitions of imagery, and the role of musical imagery in music listening. Empirical chapters follow, as these arise out of the theoretical issues raised at the beginning of the thesis. The work is organised according to a trajectory of increasingly specialised music activity. Chapter Three begins by asking a previously unanswered but fundamental question, namely 'what is the prevalence of musical imagery in everyday life?' using music students as the target population. A very practical means of sampling everyday experience was adopted for this, namely the use of experience-sampling methods. This part of the research aims to determine the incidence of musical imagery during the day for a group of music students, and the nature of such imagery in its relationship to perceived music.

Chapter Four describes two experiments designed to compare timing and pitch discrimination following imagery and perception contexts. By isolating the musical dimensions of timing and pitch, more is learned about the possibilities for imaging different aspects of music, be that applied to tune on the brain imagery or more functional music-related imaging. Chapter Five extends the experimental technique to apply to one particularly neglected area of research, the perception and imagery of timbre. Timbre is shown to be peculiar in its mental representation, and possible reasons for this are discussed.

Having explored musical imagery under controlled experiment conditions, a contrast was sought by discussing the teaching of aural skills in Chapter Six, and how inner hearing skills can be developed. Three quite different institutions of higher education were selected, to represent different educational emphases placed on music: a music college, a university music department specialising in practical music, and a university music department specialising in academic music. Course tutors were given a chance to discuss their attitudes to inner hearing skills, and to describe ways they had found to develop these. Students were also asked about how important inner hearing was to their musical activity, and how they themselves felt that imagery development was possible. Two perception-based approaches are presented as the most favoured training methods, and the general consensus that imagery can be developed is described.

Chapter Seven presents the very specific experience of imagery through professional music making. Three musicians are interviewed in-depth on the subject of imagery in its relationship to perception. Qualitative data describe how a flux of imagery and perception underpin expert musical activity for these interviewees. Finally, Chapter Eight concludes the research, drawing together data from each study, and describing the role that different musical contexts may have on the relationship between musical imagery and perception.

1.2.2 Terminology

Where this work employs the term 'percept', the reader should not assume that the perception of music leads to a static end product. It is recognised that both perception and imagery elicit constantly shifting mental representations, but that when a person is required to report or make a judgement about those representations something like a 'snapshot' must be involved. The terms 'percept' and 'image' both refer to that temporary 'snapshot'. Very often the specific meaning of these terms is qualified, but in Chapters Four and Five, the experimental use of the terms is taken to mean the particular activities and experiences that are described by the task conditions outlined at the start of each experiment. Unless otherwise stated, the perception and imagery under discussion are musical in nature, and this might reflect the aural, visual, spatial and kinaesthetic dimensions afforded by the musical object. The term 'kinaesthesia' is widely used and is taken to mean the sense of movement. Only rarely are the distinct 'proprioceptive' and 'haptic' senses mentioned separately from the more global kinaesthetic sense.

The term 'functional' is widely used in the thesis, but its usage is context-dependent. Psychological theories in visual imagery refer to the concept of 'functional equivalence' between imagery and perception. These theories based around behavioural data are discussed in depth. In addition, the everyday and music-specific *function* of imagery is discussed. This is slightly different, and comes to form a pivotal role in the conclusions as regards the nature and balance of imagery and perception as a function of their occurrence or context in various musical activities.

CHAPTER TWO –

PERSPECTIVES ON MUSICAL IMAGERY AND MUSIC LISTENING

This chapter reviews literature relating to some of the musicological beliefs concerning musical imagery, before presenting the psychological background which though almost exclusively focused on visual imagery, provides a number of perspectives on imagery in relation to perception. In order to present this research, some challenges in defining imagery for music will be faced, with a particular focus on the activity of imaging in music listening. Discussion of this incorporates a consideration of present-focused music listening, theories of musical expectancy, and imagery in its relationship to cognitive schemata. The only direct method of determining the relationship of imagery to perception is to use brain scanning techniques, so findings in the domain of neuroscience will be outlined as a backdrop to some of the most recent behavioural work on musical imagery.

2.1 Ideas from Musicology

2.1.1 The Nature of Musical Imagery

Musical imagery is assumed to be important in musical activity. For instance, the skill of 'internalising' score is an asset to musicians such as orchestrators, conductors and performers. Halpern (1988a) points out that the ability to conceive a piece of music under a variety of tempi, and to manipulate *accelerandi* and *ralentandi* at will is a frequently used application of musical imagery. Another is the ability to endogenously (in the absence of external stimulation) 'hear' the tone quality that is sought in musical production. Farnsworth (1958) believes that 'Proper imagery is most important for music training' (204). However, it will be seen in Chapter Six that imagery is rarely the focus of aural training for music students. As Dubiel (1999) points out, the very name accorded to 'ear-training' epitomises a lack of understanding of what is an essentially cognitive phenomenon.

Imagery is experienced at many levels of resolution and abstractness. At its most abstract, it is common for musicologists to speak of the intentions of a composer, or interpretations of a piece of music. It is assumed that a person's silent experience of a piece of music may range from very approximate at best, to vividly imagined, including the details of expressive nuances. Generating a musical representation prior to performance is an important process. Without an underlying representation, performing music would be to regurgitate notes as an unrelated stream of sound. Yet despite the possible advantages of fixing an 'ideal' musical image of a musical performance, this cannot remain static in mind, as like all mental traces it is susceptible to 'autonomous change'. Moreover, this propensity for musical concepts to modify over time is important not only for performers, but as Meyer points out, 'It is partly this continual modification of formal conceptions (and, incidentally, general stylistic ones as well) which enables us to rehear a work many times' (1956: 58).

The application of imagery to musical tasks such as composing and conducting is the application of an ephemeral construct in short-term memory, but one which lingers in consciousness for a sufficient period of time to allow the musician to experiment with and manipulate the imagined sound. The process is complicated: for music being a temporal succession of notes, its image may take the form of a sequential stream of imagined events. The transience of music, which may be heightened for musical imagery, is at the root of many theoretical and empirical obstacles to musical understanding. Music is often conceptualised in 'pieces', and analysed as whole objects removed from their temporal course. Meyer (1956: 53) criticises this static approach to music whereby it exists as an entity in memory. Interestingly, this notion of music as an entity is like imagery for a piece of music in that it stands apart from the environmental events occurring in real time. Cook (1990) argues that timelessness is a distinguishing feature of musical imagery:

> Its temporal aspect is different, for there is a kind of static quality in the image that is quite alien to the world of real, audible music. The music does not seem to progress from bar to bar in strict tempo: rather it is focused on a single point in time (Cook, 1990: 86/87).

Conversely, musical imagery is often felt to retain a degree of motion, and as Meyer explains, 'a line or motion is actually a process of the mind rather than a thing' (1956: 92). Imagery, like perception, is a process rather than a product.

The composer Roger Sessions believed that internal imagery is central to musical understanding:

> In the primary sense, the listener's real and ultimate response to music consists not in merely hearing it, but in inwardly reproducing it, and his understanding of music consists in the ability to do this in his imagination. (Sessions, cited by Levinson, 1997: 22)

Levinson agrees with this view, believing that the ability to track music in the mind while listening is important to its understanding. Moreover:

> Intellectual contemplation of aspects of large-scale form is aesthetically virtually meaningless to one who has not gotten the musical substance of a composition, part by part, into his or her "inner ear". (Levinson, 1997: 157)

He takes the argument further, suggesting that an ability to reproduce or continue the musical procession is a sign of basic musical understanding, but acknowledging that not everybody may have the ability to do this (presumably training in musical production would be an influential factor). This view is sharply contrasted by Zuckerkandl's bleak estimation of people's powers of musical production:

> If it were the remembrance of the past tones which made us understand the present tones of a melody, understanding melodies would be contingent upon remembering them. We know what the situation is. Not one of a hundred listeners will be capable of singing or playing from memory a melody that he has heard with pleasure - that is, with understanding. (1956: 230/231)

Whatever opinion is taken of the nature of musical understanding, research by Levitin and Cook (1996) contradicts Zuckerkandl's view. In their study, melodies were selected by experiment participants before being sung and played from memory. That the participants in their study selected their own music from looking at a CD cover implies that their choice might well be based on melodies that have previously been 'heard with pleasure'. However, to claim that the ability to internally track a piece of music is fundamental to its understanding may be to overstate the aural abilities of a listener, particularly one who is little acquainted with the piece or genre.

Very few issues concerning musical imagery have been adequately addressed in either the psychological or the philosophical literature. Perhaps one deterrent is that there is little shared vocabulary to express musical imagery, and homespun terminology exacerbates already hazy concepts. In music theory for instance, Dubiel (1999) employs expressions such as 'state of affect' and 'maintenance of propositions', the former pertaining to fluctuating perceptions and ways of imagining music, and the latter to fixed musical configurations. Meyer employs a similarly open term, 'mental impression', seemingly in the context of general expectations generated in the mind by music. Dubiel also explicitly alludes to a role for the most general vocabulary when describing ways of hearing music: 'The *sense* of the music - a good word, as ambiguous between *conception, perception,* and *feeling* - inheres both in the music's particulars and in the frame of mind that suits the perception of them' (Dubiel, 1999: 268).

2.1.2 Imagery & Perception: Similarities & Dissimilarities

Both imagery and perception are interpretative processes requiring, at least initially, environmental input. Indeed, Dubiel (1999) rejects the segregation of imagery and perception: 'We cannot draw a boundary between "hearing what's there" and "imagining something", because hearing sound as music always involves imagination.' (264). If hearing sound always involves the intervention of mental imagery and imagination, does imaging sound always involve actual perception? On an intuitive level, the answer to this question is that though perception must at some point precede mental imagery, imaging music may stand apart as an entirely separate experience. This speculative suggestion requires psychological validation.

It is known that people may perceive the same event in different ways depending on the immediate context and learned patterns of response from prior experience. For the same reasons, the quality and quantity of imagery may also vary from individual to individual. Boretz (1976) has used the idea of a 'theory of reading' text or music as of a sort of 'filtering image' for experience. He rightly observes that 'the qualification of the *individual* is the devolution point of all reading' (1976: 106). Imagery, like perception, is experienced subjectively, and is of necessity affected by past experience. Moreover, 'musical qualities, as elicited by attribution, are all ontologically distinct, rather than repeatable' (Boretz, 1976: 107). In other words, music cannot be experienced in exactly the same way twice, be that as an imagined or a perceived phenomenon.

A number of philosophers and theorists have turned their attention to imagery and its related concerns. For example, Cook describes musical perception as a non-dualistic continuum of experience, whereby the disparity between perception and imagery is hazy. Imagery could be viewed as an interpretative extension of perceptual processes. This notion has implications for consciousness and attention. Musical imagery may be subconsciously superimposed on perception, as when a composer:

> . . . will hear a connection or a directed motion in his music that nobody else hears, or fail to hear something that is audible to everyone else . . . because he hears the music as he imagines it in his 'inner ear', rather than as it is actually being played. (Cook, 1990: 188).

An important question that has dominated music theory regards communication between composer, performer, and listener. To what extent can the personal mental representation of a piece of music generated through music listening coincide with that of another? Dubiel (1999) reflects upon this issue, pointing out that listener and inventor ideally share a frame of reference. Narmour (1988) speculates that composers, aware of the prevailing musical references shared with their audience, employ certain tactics in order to heighten tensions of expectation from melodic closure and nonclosure. Compositional devices, presumably pertaining to a common musical and gestural vocabulary, must be communicated and understood in order to affect the listener. Whether such devices could be viewed as a form of musical imagery is an open question. As will be seen, consciousness of internal representations and familiarity with music are key to imagery definition.

Unlike many actual music listening circumstances, a person experiencing imagery is often assumed to have a degree of choice over the selection and direction of music 'heard'. McAdoo speaks of directing hearing toward a part of a musical image (1997: 70), and Boretz speaks of a "choice" of image modality, from verbal, symbolic and graphic forms (1976: 105). As will be seen in Chapter Three, even when listening to music, imagery of different music could superimpose, combine with, or obliterate actual sound. While imagery can be deliberate, it may also be triggered involuntarily. As with actual perception, musical imagery can be an annoyance: having a musical fragment 'stuck on the brain' seems to be a frustration experienced by many.

Musical imagery cannot be directly experienced by another nor easily expressed. A parallel exists between the difficulties inherent in expressing the musical experiences of imagery and the bluntness of vocabulary used to express emotion, 'For emotional states are much more subtle and varied than are the few crude and standardized words which we use to describe them' (Meyer, 1956: 8). After all, it is difficult to 'transfer the sense of the music, or any appreciable slice of it, into another medium' (Dubiel, 1999: 274). Imagery remains largely dependent on the vocabulary of perception. Deliberately characterising imagery as at least partially independent from perception could eventually establish its own lexicon and hence broaden an understanding of the subject.

It is accepted that an image does not generally match or duplicate precisely the original object or event perceived. One reason for this shortcoming is that imagery, like memory, is a subjective phenomenon. Gleitman (1995) and Shepard (1978) describe the way in which imagery involves interpretation of original perceptual information (as indeed perception itself is an interpretative process). The example Gleitman uses is in the visual domain: an ambiguous picture which could be perceived as either a duck or a rabbit tends to be imagined or drawn as one or the other, according to the way it has been encoded. Perception and imagery are both interpretative processes, failing to capture environmental input in any pure fashion.

2.2 Theories in visual imagery

Denis (1989) summarises some of the approaches taken to visual imagery research. He states that:

> The contents of imagery activities are shaped by the perceptual processings which preceded them, and the raw material for imagery is ultimately perceptual. (Denis, 1989: 35)

Because imagery derives from perception, the standard perspective has been to use the more advanced understanding of perception as a point of comparison for mental imagery. Denis points out some of the dichotomous imagery classifications that have prevailed. For instance, 'memory images' arise from specific perceptual experience, while 'imagination images' are a combination of several perceptual experiences. Denis describes another pair of categories devised by Piaget and Inhelder in 1966, namely 'reproductive images' and 'anticipatory images'. There is an implied developmental order in these two types, whereby reproductive images must be formed before the mind is experienced enough to generate anticipatory images. However, very little research into the development of imagery has been done, even within the realm of vision.

Psychologists have tested imagery and perception in order to determine the functional similarity of the two. In other words, performance in specifically devised imagery and perception tasks is monitored to see whether it is similar in both conditions, and whether any common effects are of a similar magnitude and are in the same direction. 'Functional equivalence' implies that imagery is a medium for simulating the perceptual properties of the external world (Kalakoski, 2001). In exploring functional equivalence, behavioural effects are used to reveal the relationship of imagery to perception. Some researchers have looked further into the relationship, attempting to determine any structural similarities between perception and imagery processing in vision. Such similarities would take the form not just of behaviour arising from perception or imagery experience, but constitute characteristics represented either in the 'real' or imagined representations. When structural similarity between image and percept is apparent, the notion of analogue is commonly evoked. A visual image that is structurally similar to its perceptual counterpart is at least partially analogous.

Neisser (1976) situates imagery research in the trajectory of cognitive psychology. Firstly, he describes the 'linear cognitive model' of information processing, according to which perception comprises a sequence of stages from the detection of sound to consciousness. Activation of this process in the absence of incoming sound would evoke imagery experience. For instance, Finke (1989) writes that:

> A fundamental question concerning apparent equivalences between imagery and perception is whether these equivalences would ever extend to the earliest stages of information processing in the visual system . . . For example, are neural units in the *retina* ever activated when a person forms a mental image? (Finke, 1989: 43)

Neisser explains that there are two divergent theories within this tradition. One approach has been to consider a mental image as present and available for manipulation once it has reached consciousness. The second approach considers all processing to be done 'offstage', such that a conscious image is 'merely an epiphenomenal trace of work already accomplished' (Neisser, 1976: 129). As these theories concern static visual imagery, it is difficult to determine which is the more correct as a description of the temporal image of music. Neisser's own view on imagery is that though images are derived from perception, 'they are the anticipatory phases of that activity, schemata that the perceiver has detached from the perceptual cycle for other purposes' (130). Accordingly, imagery is a perceptual readiness, a form of conscious schematic representation.

Bregman (1993) claims that a schema is a highly potentiated internal state, ready to be activated. Since the term "schema" is used to mean a certain kind of representation, it must be the case that "presentation" (i.e. perception) logically precedes "re-presentation". In other words, mental schemata are firstly shaped by perception of the environment. This schematic view of imagery is useful in its capacity to 'direct explorations in several modalities concurrently, developing relevant anticipations for all of them' (Neisser: 1976: 143). These modalities are sensory, and can involve, auditory, visual, haptic, olfactory and proprioceptive (motor) components, just as it will be seen that musical imagery, like music perception, generally involves more than auditory perception. The following section is a theoretical exploration of the role of schemata in music listening, with its particular relevance to musical imagery.

2.3 Schemata and imagery in Music Listening

2.3.1 Schematic Representation

Cook describes a conscious awareness of musical imagery, but says that: 'When it comes to testing that awareness against reality, whether by playing it or writing it down, the musical image turns out to be incompletely formed or even to represent a kind of deception' (1990: 90). While this particular description of imagery imperfection concerns difficulties of externalisation or production, it aptly fits the intuition that, in common with most forms of memory, imagery is an inexact version of its perceptual counterpart or of events originally perceived. It is tautological to say that a musical representation of any sort misses things which were present in the 'original' (Dubiel, 1999). Principles of cognitive economy would abstract only key musical events should the piece present too much detail for encoding, storage and retrieval. These ideas are prevalent in work on musical abstraction in perception. Sloboda and Parker (1985) studied the accuracy of folk melody recall and discovered that recollections were often simplifications of the original music. Comparing the structural remnants of recalled music to the structural frame behind verbal recollection, they explain that:

> Verbal recall is rarely word-for-word correct, but it matches the original at a higher level of meaning and structure. We find substitution and inference, selective loss of information, and other distortions, but preservation of essential meaning and structure (Sloboda and Parker, 1985: 146).

Meyer (1956) explains that 'an unstable memory trace will first tend toward stability; and, if this is impossible it will tend to disintegrate' (89). All the above imply that cognitive schemata dictate the sharpness of imagery, adapt towards structural convention, and when an image is longer or more complex, the mind may organise the musical image into moments of musical salience.

These ideas pertain to generative theory. For example, particularly in the visual domain (Shepard, 1978; Kosslyn, Cave, Provost and von Gierke, 1988), it has been argued that imagery is a 'surface' representation originating from a 'deep', abstract underpinning. Accordingly, the mental schema and the mental image are related but not the same. This distinction is also important when considering the work of Deliege (2000) on 'prototype' effects and event categorisation in music listening. She endorses hypotheses that models of musical prototypicality are employed in listening to music, against which new musical cues are compared and stored accordingly. Of relevance to the study of musical imagery is her choice of the word 'imprint' to describe the effects of prototypical cue abstraction.

> In fact - and it is worth emphasising this point - memory *simplifies* the global information and effectively finds "statistical means" - the *imprints* - that retain the essential information about a collection of more or less similar presentations of a given cue (Deliege, 2000: CD-ROM).

Are such imprints tantamount to musical imagery? Internal representation of this type is global and of the highest abstract level. Although schemata may accurately describe an abstraction and common form of representation for less familiar music, they do not convey the sensation of hearing music in the mind's ear. Schneider and Godøy (2001) ask whether schemata constitute long-term or 'slower' kinds of musical imagery. I would argue that musical schemata do not describe music in a note-specific fashion. Images are considered to be particular, albeit shaped by schematic forces, while schemata are generic, though susceptible to alteration by the impact of specific musical experiences.

Boretz (1976) describes an attributive 'theory of reading' through analogy with the experience of re-reading a text in the light of an 'image' formed from the first reading:

> Now I plow that mental image back into a close reading of the appropriate pages of print, and there emerges within my mental landscape the determinate feel of a unique, transformed text, as received print is filtered through the filtering image I had adopted. (104).

Just as musical schemata shape musical imagery, imagery in turn explicitly comes to shape the listening experience. Boretz uses the term 'semantic fusion' (1976) to describe the bonding between present reception of the music's character with past mental images now transformed. Theme and variation form is a useful example of a listening structure in which an internal image of the theme is intentionally fixed and in turn affects the perception of subsequent variations. If asked to internally 'hear' the theme this would be theoretically possible, yet it is used only as a subconscious template of musical expectation while hearing the variations. As Levinson explains,

> A listener does not silently rerun the theme while auditing each variation . . . . Instead, the listener hears each variation through the original theme, retained in memory, which theme thus acts as a kind of aural lens. (1997: 92).

Imagery could be considered as an object transferred to the mind from a perceptual object in an isomorphic fashion, or something that the mind creates endogenously. Cook articulates the phenomenon of imagining music as follows:

> There is a kind of static quality in the image that is quite alien to the world of real, audible music. The music does not seem to progress from bar to bar in strict tempo: rather, it is focused on a single point in time. . . . That is to say, the temporal evolution of the phrase as a whole forms an essential part of my imaginative experience. . . even though the experience itself does not seem to change from one moment to the next, or at least not in the same manner as the real, audible music does. (Cook, 1990: 86/87).

He differentiates between sequential musical perception and the focal point experiences described above in the following manner:

> There can be something peculiarly compelling about the kind of musical images I have described; it is as if what is heard sequentially in the concert-hall were distilled into a single, heightened experience that embodies everything that is characteristic of the music. (Ibid.: 89).

Johnson (1999) refers to this 'distilled embodiment' as *temporal compression*, while Levinson (1997) provides a useful spatial analogy, that of a 'mental landscape', to articulate consciousness of the connections of musical events. Accordingly, the nearer to a musical object, the more focused the view, and the further away the more expansive and global the view (Zuckerkandl, 1956). However, Levinson argues that:

> A piece of music, unlike a rational structure, is an irreducibly perceptual affair. What this means is that no conceptual condensation of its core content is really possible, and no analytic distillation of its concrete form is central to its appreciation. (Levinson, 1997: 171)

Ryle realised a difficulty inherent in the synoptic conceptualisation of musical thought, because 'trying to hear the tune as a whole is clearly not reducible to the bare thought of the tune' (McAdoo, 1997: 67). Rather Ryle referred to the 'concept of the "quasi-sensory vivacity of auditory imagined notes" . . .' (1971, see McAdoo). McAdoo expresses the relationship of perceptually isomorphic imagery to musical essence imagery in the following manner:

> Contrary to the misplaced empiricist belief that our sense of the vivid presence of something must depend on an ideal of one-to-one

> correspondence . . ., what we also know from experience is that it is often the case that the sparsest perceptual and mental images will evoke the most vivid sense of larger spatio-temporal experiences. (McAdoo, 1997: 73)

It is interesting to note that he distinguishes between perceptual images and mental images. The distinction is not explained, nor repeated by other theorists. It could be taken to indicate McAdoo's appreciation of the role of image creation during perception, and the alternative state of 'pure' imagery that is temporally independent from perception. In other words, perceptual imagery is generated during musical listening (or playing) while mental imagery occurs separately from the listening context.

2.3.2 Present-focused listening

As music unfolds in time, music listening focuses attention on a present stream of perceptual events. In addition to problems defining the nature of musical imagery, philosophical opinion is divided concerning the parameters of a perceptual present-focused 'now moment'. Zuckerkandl furnishes an exemplary model of a seemingly contradictory argument when he claims first that: 'Between the immediate present, stored past, and anticipated future play the relations that make the individual tone a meaningful part of the tonal *Gestalt*' (1956: 230). This is immediately followed by the following claim: 'In the hearing of melodies, nothing is remembered and nothing anticipated.' (230). These two statements appear contradictory, yet they imply that there is no conscious bind between past, present and future musical events during music listening, but that perceptual binding is a sub-conscious process.

While the events which music comprises are atomistic in nature, perception concerns the organising of events into patterns, and grasping segments as a whole (Dowling and Harwood, 1986; Levinson, 1997). McAdoo writes that music depends on 'a perceptual and not a merely conceptual synthesis, which can only yield itself in time' (1997: 68). 'Perception, then, just is the ability to hold a lot of elements, both spatial and temporal, together' (Ibid.: 72). Imagery also serves to unite musical elements in cognition; leading to the suggestion that musical imagery may act as the link between memory and observation that facilitates perceptual processing. An alternative way to view perception is as a process that encompasses imagery. Philosophy is particularly concerned with the relationship of an object to its perceived counterpart. For instance, the term 'perceptual presence' relates to that experience in which the perception of an environmental object is brought to consciousness (Natsoulos, 1997). According to this theory of perceptual processing, the conscious internal representation of an object or event is an integral part of perception.

A music theorist whose work concerns the perceptual (and imaginal) processes of listening is Levinson. He introduced the term 'quasi-hearing' to refer to an experience when actually present sound is accompanied by almost-present sound; a form of imagery. 'We might then say that although one literally *hears* only an instant of music at a time, one generally *quasi-hears*, or vividly apprehends, a somewhat greater extent of musical material' (Levinson, 1997: 15). However, the term is never psychologically defined, but couched in vague notions of having an aural grasp beyond the immediate. Levinson explains that quasi-hearing comprises actual hearing, vivid remembering, and vivid anticipation, it is 'a kind of expanded perception' (20). It is clear that quasi-hearing imagery cannot be divorced from a real-time listening experience. The characteristics of a listener for whom such quasi-hearing would be experienced are outlined: such a listener must be not only acculturated, but also familiar with the specific musical material in question. The role that imagery may play in the moments surrounding a perceptual instant is not described for listeners new to a particular genre or piece of music.

Zuckerkandl is dismissive of theories in which a listener consciously perceives anything but the immediate present:

> It is even a condition of hearing melody that the tone present at the moment should fill consciousness *entirely*, that *nothing* should be remembered , nothing except it or beside it be present in consciousness. (Zuckerkandl, 1956: 231)

Yet, without some transcendence of the present moment, temporal *gestalten* in music would not be possible. As Levinson states:

> Vivid memory and vivid anticipation might be thought to provide tonal images that exist for listening consciousness simultaneously, yet somehow

> noninterferingly, with the current sound impression, in something like the way the peripheral objects of vision are present to the eye, though obliquely, at the same time as the object that is in central focus. (Levinson, 1997: 16)

McAdoo (1997) explains that, in philosophy, Husserl referred to a 'now-point' of perception through time as being surrounded by a 'halo' of memories and expectations, named 'retentions' and 'protentions'. The inclusion or exclusion of imagery in defining the moment of perception is important to this discussion. It is certainly deceptive to claim, like McAdoo, that music comes 'towards us from a silent future' and disappears 'into an equally silent past' (McAdoo, 1997: 66), as no listening takes place in a musical vacuum. Indeed, McAdoo later contradicts his argument, by acknowledging that in the absence of real musical sound, there is a 'sense of the vivid *presence* of the absent tune' (67). There is clearly a lack of agreement between philosophers and within themselves as to the boundaries between conscious imagery and perception in music listening.

Comparisons can be made, and musical similarities detected, during present-focused music listening (Narmour, 1991). Is a mental image of a previous musical passage actively consulted at such moments? Levinson concedes that apart from quasi-hearing, a middle ground between present consciousness and reflective contemplation of music may be found in the guise of 'intermediate, semiperceptual relatings of widely separated architectonic elements' (1997: 130). Interestingly, he states that the 'memory image' or 'memory representation' is separate from perception:

> What happens *within* a perception, of a complex sort, is simply of a different order than connections that might exist *between* a perception and something standing *outside* it, such as a memory image of an event long past or well in the future. (Ibid.: 20)

For Levinson this distinction is qualified by the temporal factors involved in music listening, but I would argue that the role of consciousness in understanding types of imagery is also important. Imagery of the type implied in quasi-hearing is subconscious, while some form of consciously accessible image of the music is often responsible for the ability to recollect distant musical episodes, even beyond the span of quasi-hearing.

Meyer speaks of the memorable nature of musical episodes in terms of phrase completion. 'For the mind is constantly striving toward completeness and stability of shapes' (Meyer, 1956: 87). 'The less complete the part, the more probable that we shall have to revise our opinion of some or all of its terms' (49). The more complete the musical whole, the easier it is to internalise.

> In any particular musical work certain melodic patterns because of their palpable and cohesive shapes become established in the mind of the listener as given, axiomatic sound terms. They set the mode of continuation, completion, and closure which are the norms of the particular work. And if part of such a pattern is introduced, it will arouse definite expectations as to the manner of continuation and completion. (Meyer, 1956: 140).

Influenced by the work of Gurney and principles of *gestalt* psychology, Levinson also proposes that greater musical cogency may lead to greater resolution of musical mental representation. 'Where there is cogency of sequence there is resistance to any imagined substitution for any part in the musical chain' (Levinson 1997: 7). In listening to familiar music, Gurney notes, 'one seems to evolve it from within oneself, one seems to construct the melody, with its characteristic tensions and overall flavor, by the very act of listening' (see Levinson, 1997: 5). Nevertheless, incomplete patterns are noteworthy events in music and may consequently lead to memorisation. What then of the transition sections between 'complete' musical passages? Is imagery less distinct at such moments? Claiming that musical transitions have less psychological reality than homogeneous units, Levinson suggests that 'at an abrupt break, . . . quasi-hearing reaches back plausibly only to the preceding measure or two' (1997: 86).

Regarding the anticipation of musical events during listening, Zuckerkandl makes the following controversial statement about melody:

> The normal process - that, in a state of expectation, one simultaneously imagines the future event which will satisfy the expectation - is foreign to the hearing of melodies and, indeed, is incompatible with it. (1956: 231/232)

Certainly, psychological understanding is balanced more toward the influence of past rather than future events on present music listening. When it comes to listening to music that is not well known, imagery based on recollection is felt to be more vivid than anticipatory musical imagery: 'Probably the quality of imaging occurring in respect of tones already heard is different from and more substantial than, that occurring in respect of tones not yet heard' (Levinson, 1997: 16). This may be due to the "comet's tail" effect (see McAdoo, 1997: 70) whereby as time passes, immediately past events are in a sense "contained" within the present moment.

In spite of the emphasis placed on the influence of past rather than future events on music listening, there is a bulk of research dedicated to the understanding of musical expectancy. Theories of expectation have been influential in both music theory and psychology. The following section will describe this work in its relationship to musical imagery

2.3.3 Models of Expectancy

Can musical expectancies or implications be said to constitute musical imagery? Imagery can be 'heard' and is generally accessible to some form of introspection, while musical expectancies *per se* are sub-conscious phenomena. Yet it is conceivable that note-specific expectancies occurring in listening to highly familiar music may resemble the tracking of a sequential memory trace, or musical image. Therefore, where musical expectancies and imagery differ fundamentally is in the perception of 'new' music. What happens when unexpected musical events occur? Leonard Meyer (1956) suggests that a rapid 'mental synthesis' of the new event may take place, but if this is not attained, the mind may either suspend judgement pending clarification, reject the experience, or interpret the new stimulus as a mistake. It should be noted that any of these courses of action would automatically occur at a subconscious level, unlike imagery proper, which is open to conscious introspection.

Physiological insight into the relationship of musical imagery to perception ranges from speculation to precise information about areas of the brain involved in music listening. Narmour's description of Meyer's 1973 'implication-realization' model (see Deutsch and Feroe, 1981) incorporates the idea of top-down and bottom-up activation of neuronal pathways as a physiological basis of musical perception. This work describes the actual perception of music, but of interest to the current research is the previously neglected question of the extent to which musical expectancies and preparatory set elicit physiological changes when *imaging* music. Meyer looks beyond the perceptual moment in asking the following question:

> Is the tendency of the eye to continue its motion in a given way or the "mental ear" to continue its motions to some extent a product of the natural tendencies of motor behavior? (1956: 82)

The relationship of motor to mental and sensory response in music listening is pertinent to theories of musical expectancy. 'Motor attitudes not only form part of the preparatory set but also play a part in the perception and response sequences made to the changing progress of the musical form' (Meyer, 1956: 80). For Meyer, 'it seems clear that almost all motor behaviour is basically a product of mental activity rather than a kind of direct response made to the stimulus as such' (81). It follows that imagery as a mental activity may evoke motor behaviour similar to that occurring in actual musical perception.

Meyer's theories are not only helpful as regards the balance of motor and mental behaviour in music listening and expectancy. His three stages of meaning in the listening process are useful to a consideration of musical imagery. These are; 1) 'hypothetical meaning', arising *during* expectation and thus dependent on ambiguities from the probability of the consequent event, 2) 'evident meaning', arising *after* the consequent has been perceived, 3) 'determinate meaning', arising from all the relationships established in the music.

> In other words, determinate meaning arises *only after the experience of the work is timeless in memory*, only when all the meaning which the stimulus has had in the particular experience are realized and their relationships to one another comprehended as fully as possible. (Meyer, 1956: 38, author's italics)

Accordingly, determinate meaning could be said to overlap conceptually with memory imagery for music. Meyer takes the degree of conscious attention paid to meaning and expectation during music listening into account. For instance, the automatic tendencies with which he is concerned in expectation are deemed 'meaningful experience', while on the other hand: 'Meanings become objectified only under conditions of self-consciousness and when reflection takes place' (1956: 39). A problem in imagery research stems from the need for conscious introspection, and this is also found in examining the mental processes in musical perception:

> Since the target psychological process is, let us say, not a reflective one, while the examining one is explicitly so, we may worry that the examining consciousness may import some reflectiveness into its target that is not properly there. (Meyer, 1956: 18)

The sub-conscious occurrence of musical expectancies as compared to the ability to consciously 'hear' musical imagery is the primary distinction between the two forms of musical experience. A second difference may be found in the notion that 'probability' underlies the onset of a consequent musical event, as described by Meyer (1956). In musical expectancy, events are implied according to a range of probabilities determined by a given context. This functioning of probability relationships is an entirely subconscious mechanism. In musical imagery however, the mind has in a sense already chosen or registered a consequent imagined sound event, without recourse to react to the perceptual present. Thus Meyer's notion of event probability does not translate directly to the definition of musical imagery adopted in this essay.

Although Narmour describes Meyer as an empiricist (1988: ix), his work is essentially intuitive and theoretical. The gathering of psychological evidence in favour of his model has been left to others, such as Schellenberg (1996). Deutsch and Feroe (1981) also express musical expectation in similar terms to Meyer, but are specifically concerned with anticipation in pitch sequences:

> One may . . . view the acquisition of a sequence representation as an ongoing process in which the listener, when presented with an initial sequence of pitch events, generates a set of alternative representations, some of which are confirmed by later pitch events and others of which are discarded (Deutsch and Feroe, 1981: 518).

This description would aptly fit the frequently missing account of the imagery experiences of a listener new to certain music. Chapters Four and Five of the current work will describe empirical work designed to explore both musical imagery and musical expectancy in familiar melodies.

In the 'implication-realization' model of musical expectation (see Narmour, 1988, 1991, and 1999), Narmour acknowledges the automatic responses intrinsic to music listening, but also points out that mental representations of music have varying degrees of conscious accessibility:

> Matching an emerging implicative pattern to the learned continuation of a previously stored schema tends to be automatic; we are rarely aware of it. Yet many stylistic representations lie just below the conscious surface. These are introspectively accessible. (Narmour, 1999: 441)

His model defines style or schema as interplay between bottom-up, pan-stylistic principles such as pitch, duration and timbre perception, and top-down structures which depend on hierarchic relations such as mode (called 'style structures'). Aesthetic pleasure in hearing familiar music is explained by the simultaneous persistence of both systems; 'the learned, top-down system never completely penetrates or controls the bottom-up, "brute" system' (Narmour, 1991: 23). Narmour explains that:

> From the perspective of analytical music theory, we may regard a given hierarchical style structure as a kind of "theme" that listeners implicatively map from the top down onto incoming foreground "variations" (1999: 444)

Can this 'theme' be viewed as a form of imagery? According to the model, differing stylistic levels simultaneously operate in music perception, producing different levels of implicative mapping. These levels range from lower, empirical levels, to higher, rationalistic levels (1999). Principles such as 'intervallic motion' and 'registral direction' in the model involve the specific relationship between individual note events, thus bringing musical expectation down to a detailed level of representation. Though expectancies are largely sub-conscious phenomena determined by schemata, Narmour's stylistic levels demonstrate that they are also a form of internal representation closely related, though not equivalent, to conscious musical imagery.

A factor to consider in assessing the role accorded to imagery by theories of music listening is the degree of piece- or genre-specific musical knowledge presumed to be held by a listener. Generally speaking, the more familiar the listener is taken to be with musical material, the greater the theory's convergence with descriptions of musical imagery. For instance, Levinson argues that 'a listener who follows a piece comprehendingly is typically disposed to inwardly parallel the music as he listens' (Levinson, 1997: 24). His theory of concatenationism assumes that the listener has heard a musical piece at least two or three times, and fails to describe the listening process of 'novice' listeners. Bharucha (1999) explains that 'veridical expectancies' are generated by memory of a specific piece of music. They are 'the cues that enable us to anticipate or recognize the next event in a familiar piece and that underlie our ability to perform from memory' (430). Meyer does not articulate this idea, as his theory of emotion and meaning in music relates to global response tendencies arising from general music experience. Strongly expected stimuli may be processed more quickly than unexpected musical events, but this mode of response is never expressed in terms relating explicitly to a conscious mental representation of music. This idea is much closer to Bharucha's notion of 'schematic expectancies' – the more general and non-specific expectancies that arise out of a person's exposure to, and experience of, the general properties of a musical style.

As Bharucha (1987) observes, schematic expectancies are comparable to semantic knowledge. On the other hand, veridical expectancies can be likened to the episodic knowledge of a piece of music. Indeed, Leman (2001) presents musical imagery as a product of episodic memory, as this concerns the very specific mental image of a particular piece of music. Under these terms, mental representations of music would integrate specific episodic information with the semantic knowledge of music and musical genre arising from enculturation or training. These ideas will be developed further in Chapter Eight with specific reference to mental representations of music. Set against the theoretical background outlined above, the following section reviews the existing psychological evidence for musical imagery.

2.4 Psychological research in Musical Imagery

Only recently have psychologists made musical imagery their research focus. This section presents a chronology of the some important work in the area. Mainwaring (1932) was one of the first psychologists to conduct empirical research in musical imagery. He examined the extent to which musical memorization involves the kinaesthetic sensory modality, though he recognised that 'it is difficult to compare experimentally the relative efficiencies of auditory and kinaesthetic methods of learning new vocal material' (1932: 288). To do this, he devised introspective imagery tests. In one of these, he played music to children before asking them questions related to the music they had perceived. He subsequently asked children whether they had recalled the tunes in trying to answer his questions, and whether, if this had been the case, they had been 'heard' on the instruments that had originally played them (piano, violin or whistled). Most of the respondents claimed to have imaged a neutral timbre or their own voice.

Weber and Brown (1986) are unusual in their research on imagery in which musical sequences rather than isolated tones form the focus. They devised an experiment to determine whether songs or non-vocal melodies would take more processing time. First of all, participants learned either songs or non-vocal melodies. They subsequently marked the pitch contours of these melodies while either singing the melody in the 'overt' mode, or imaging it. Instructions specified that participants were to write the contour as quickly and accurately as possible. The purpose of writing down the contour was to control kinaesthetic and visual processing during the task. The result showed an absence of overall effect for the overt-imaginal mode, though processing time was greater for melodies than songs. Imaging the material was shown to be an effective means of tracking tonal progression in music.

Crowder conducted many experiments in auditory imagery with a particular focus on timbre and pitch. However, his research concerns isolated tones rather than the more ecologically valid experience of music. In 1989 the focus of his experiments was primarily the timbral relatedness of an imaged and perceived tone, but this is framed within a pitch change task. Participants were presented with a sine wave followed by an instrument tone. Between the sine wave and the instrument tone participants were asked to image what a certain instrument would sound like playing the same pitch as presented by the sine wave. Participants were then required to judge whether the pitch of the two tones was the same or different. When the imagined and presented timbre matched, response time was faster for the judgement of same pitches than for a timbral mismatch. This was important preliminary evidence for the ability of participants to image timbre. Crowder inferred from his data that in view of the inability of human beings to physically reproduce timbre, not motor but sensory imagery is responsible for the mental representation of timbre. However, Crowder is right to observe that:

> Subjects were not obliged to comply with the desired processing . . . They could, if they wanted, simply match the pitch of the sine wave directly with the pitch of the second tone, bypassing the generation of an internal image. (1989: 475).

The issue of compliance in imagery experiments is important, as it is difficult to determine whether or not a participant generates the requisite image. As a consequence, inferred and not causal relationships are most frequently described by behavioural data.

Auditory Imagery, edited by Reisberg in 1992, represents a turning point in imagery research with a new interest in auditory rather than visual concerns. A chapter by Halpern considers explicitly *musical* imagery, in which she observes that, 'Auditory stimuli are ephemeral and dynamic, making mental manipulations more reliant on short-term memory and therefore more difficult than in the visual domain' (Halpern, 1992: 3). She reports a simple experimental technique with which it is possible to test the veridicality of imagery, and discover whether musical imagery can be experienced in real time as a perceptual analogue. Her method was to use a scanning task as a musical equivalent to visual scanning tasks. In the first of these (1988b), participants saw a song lyric, and then had to judge whether a second lyric belonged to the same song as the first. In the second task, participants were required to mentally compare two pitches in the music. For instance, a participant might be asked to imagine the song *Jingle Bells*, and judge whether the word 'sleigh' is higher or lower in pitch than the word 'way'. Reaction time was measured and found to increase the greater the time distance between the lyrics, suggesting real-time imaging.

Levitin and Cook (1996) conducted a study with long term memory for tempo as its focus. They moved away from reductionist studies of the controlled imaging of individual sounds, by asking participants to select songs from a choice of CDs on display, to close their eyes, and to imagine the music playing, before trying to reproduce the music by singing, whistling or humming it. Their theoretical concern was to determine the balance of absolute to relative information in the memory trace, in other words whether memory for tempo seemed to be anchored to a fixed internal representation or not, (as in the phenomenon of absolute pitch). They found evidence for the absolute encoding of tempo in familiar music. Similarly, Halpern (1988a) found that the metronome setting participants chose for perceived and imaged familiar music correlated with their preferred tempo for that music. As Halpern writes, 'The representation of tempo may be so intrinsic to the song representation that subjects would have a difficult time imagining tempos too far removed from the preferred ones' (1988a: 199). Accordingly, her data indicate that tempo is represented in musical imagery.

Exploring the potential parallels of imagery with perception for various auditory (and not necessarily musical) components, Intons-Peterson (1992) points out that the functional and structural models of equivalence favoured in theories of visual imagery present a problem for certain aspects of auditory imagery. Her research (1980) suggests that loudness, timbre, and kinaesthetic dimensions of audition are only optionally present in the image, depending on how important their inclusion is for an experimental task. She argues that optional inclusion cannot be adequately accounted for by either functional or structural theories that imply an isomorphic relationship between imagery and perception features. Instead, she suggests that a different model must account for these 'ancillary' features, taking into account factors such as attention paid to different dimensions during perception, and the type of experimental task set. She concludes that parallels between perception and imagery are at their strongest when tasks are out of the ordinary, and that the two are most dissimilar when 'tasks afford the opportunity to draw on real-world knowledge' (1992: 45). This is potentially revealing as regards musical research: it implies that an examination of musical imagery in 'natural' contexts would highlight differences from perception, while more controlled experiment tasks might elicit greater similarity. This is a suggestion that will be returned to in Chapter Eight.

Schneider and Godøy (2001) review past research on musical imagery, identifying some key challenges for the subject, namely the neurological basis, functional equivalence, cross-modality, and the factors that trigger musical imagery. Cross-cultural occurrences of musical imagery represent a new area of concern for the subject. For example, Neuhaus (2001) uses neuropsychological techniques to learn about the mental images of various different heptatonic scales for Western, Turkish and Indian listeners, finding overall that strict cultural differences were not discernible. Another area of imagery research is that of modelling. Leman (2001) takes this approach, focusing on perceptually constrained spatio-temporal representations. Incorporating an ecological perspective, he examines the constraints on dynamic or creative imaging, speculating that they are 'strongly connected to the existing perceptually constrained spatio-temporal representations' (Leman, 2001: 60). Leman makes the important observation that imagery is both 'free because it is not driven by the outer environment, constrained because it is (i) embedded in a space that was first moulded by the outer environment, and (ii) subject to autonomous processing' (2001: 67).

Similarly relating his imagery ideas to the perception of environmental events, Godøy (2001) argues that 'images of sound-producing actions . . . can enhance [the] capacity for imagining sonorous qualities' (237). By sonorous qualities he specifically refers to the frequently neglected musical dimensions of timbre and texture. He presents a model in which motor control and motor imagery are central to the capacity to image sound. This assumes a strong link between sound knowledge, sound source, and the formation of a related image. Godøy separates out sound excitation and sound resonance: excitation, or the action of producing a sound, is related to motor imagery, while resonance is related to 'materials imagery'. He speaks of the appropriateness of the term 'simulation' to refer to the imaging of sound as it is:

> An endorsement of the idea that cognition and imagery are incessant re-enactments of the process of perception, including all the motor components that go into the perceptive act (Godøy, 2001: 240).

This idea of imagery involving the motor components that shape perception is important. There is a tendency in thinking about musical imagery to focus on the mental processing involved and the purely auditory dimensions of the experience. However, as Godøy argues, the internal representation of physical action is integral to musical thinking.

While Intons-Peterson (1992) compared data from auditory imagery research with theories of visual imagery, Kalakoski (2001) makes the same comparison with specifically musical imagery. Arguing that 'the essence of mental imagery is its similarity with perceptual processes' (44) she describes the work of Farah and Smith (1983), Halpern (1988b), Hubbard and Stoeckig (1988), and Zatorre *et al.* (1996) as fitting an 'interactive model' of imagery/perception relations. According to this model, imagery is not only functionally and structurally similar to perception, but is mediated by the same cognitive and neuronal mechanisms employed in perception. In the following section, current knowledge of the neural basis for equivalence in musical imagery and perception is described.

2.4.1 The Neuroscience of Imagery and Perception equivalence in Music

Janata (2001) has considered the neurophysiological mechanisms of imagery in the context of musical expectancy. From the start he defines this as a different sort of imagery from that which is experienced endogenously and independently of aural input. Janata's work involves images dependent on 'an interaction of memory-dependent processes (expectancies) with representations of incoming auditory input' (Janata, 2001: 28). 'The presence of a sequence of distinct topographies that was unique to the imagery conditions indicates that the instructions to imagine successive notes result in a measurable series of brain states' (Janata, 2001: 39). These brain states are highlighted for various levels of resolution from abstract (melody imaged with no particular instrument associated) to eidetic[1] (imagery includes a strong impression of timbre).

Musical imagery has much in common with musical perception, not least because the mind's 'inner ear' is ultimately a pattern of neuronal activation, demonstrably over-lapping with many of the same areas of the brain employed in perception itself. Evidence for this is reviewed by Kosslyn, Ganis and Thompson (2001) who write that 'imagery engages brain mechanisms that are used in perception and action . . . [and] that control physiological processes such as heart rate and breathing, having effects much like those that occur with the corresponding perceptual stimuli' (636). This evidence takes the form of many studies focusing on anatomical, electrophysiological and blood flow activation research (see Zatorre and Halpern, 1993)[2]. An important advantage of such work is that 'it is unlikely that people have any knowledge of the neuroanatomical loci of their cognitive activities, or can alter physiological indices in just such a way as to mimic perception-imagery concordances' (Zatorre, Halpern, Perry, Meyer and Evans, 1996: 30).

Those areas of the brain found to be active in the perception of melody primarily involve the auditory cortex, but particularly the right hemisphere. In imaging melody, similar areas of the auditory cortex are activated (Zatorre, 1999). In spite of sharing some neural mechanisms, there are also differences since 'imagery, unlike perception, does not require low-level organizational processing, whereas perception, unlike imagery, does not require us to activate information in memory when the stimulus is not present' (Kosslyn *et al.*, 2001: 636). Though many of the same areas of the brain are activated in parallel imagery and perception tasks, the pattern is not identical, and activation is not uniform in strength. According to Zatorre *et al.* (1996), results of PET scanning during song imaging indicate more activation in secondary than primary areas

[1] Janata's use of the term 'eidetic imagery', referring to the strength of the mental impression and its closeness to the original, coincides with the use of the expression used later in this thesis.
[2] Techniques commonly used are positron emission tomography (PET), and functional magnetic resonance imaging (fMRI)

of the auditory cortex.

> This distinction may be important, and supports the idea that primary sensory regions are responsible for extracting stimulus features from the environment, while secondary regions are involved in higher-order processes, which might include the internal representation of complex familiar stimuli. (Zatorre *et al.* 1996: 38).

Zatorre and Halpern (1993) conducted research on patients with temporal-lobe excision to determine which areas of the brain might be crucial for auditory imagery. The task involved hearing a familiar song in order to judge the relative pitch height of two words in the music. In the imagery condition, no music was played, and the participant was required to 'run through' in his or her head in order to make the pitch comparison. These authors found that some of the neural structures activated in the perceived pitch discrimination were similarly activated in imaging. Later research by Halpern, Zatorre, Bouffard and Johnson (2002) explored imagery for timbre. This came about as a result of the finding that the supplementary motor area of the brain (SMA) was activated during auditory imagery, even though no overt motor involvement (musical production) was required (see Zatorre, 1999). It was hypothesised that sub-vocal processes were responsible for this effect (the inner voice rather than the inner ear) as the melodies employed could be easily sung. As instrumental timbre is not a sound quality that can be produced by the voice, it was decided to measure SMA activation during a timbre-imaging task. In an imagery task comparing the timbre of two named musical instruments, no SMA activation was seen. The similarity of the behavioural data for imagery and perception tasks suggests that participants were able to image timbre. It would seem 'that timbre can be processed without motor rehearsal mechanisms' (Halpern *et al.*, 2002: 134).

Due to the cross-modal nature of musical activity and thought, visual and motor imagery[3] is frequently implicated in imaging music. Kosslyn *et al.* (2001) describe recent neuroscientific knowledge of both these areas. As with imagery in the auditory modality, the overall finding is that mental imagery draws on

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[3] According to Reybrouck (2001), Berthoz (1996) defined motor imagery as 'the manifestation of the normal internal simulation which accompanies the planning and execution of movements'.

many of the same neural areas that are activated in perception or performance of equivalent tasks. As the authors note, the finding that motor imagery activates the motor system 'could help to explain why 'mental practise' can improve actual performance' (639). One significant finding in imagery research is that individuals vary in their imagery abilities (Kosslyn *et al.*, 2001). This is an area that would benefit greatly from further neuroscientific research, not least given a certain controversy over the extent to which individual differences are important in imagery research (see Crowder, 1989, for discussion).

In general, neurophysiological data can both inform and constrain psychological research on the relationship of imagery to perception. However, it cannot describe how imagery feels, as the techniques do not allow for an understanding of the qualia of imagery experience. This thesis will explore the relationship of imagery to perception in experiential terms.

2.5 General Discussion

This chapter has reviewed literature concerning musical imagery and the listening process, as an early stage in elucidating the phenomenon in its relationship to perception. Many parallels between musical imagery and perception have been drawn. Indeed, it has been argued that imagery and perception may be conceptually separate parts of one musical phenomenon. Both involve similar neuronal pathways, both are subjective, neither can be experienced in the same way twice, and both present difficulties for research through a reliance on verbal expression. Moreover, imagery requires perceptual input, just as perception requires an imaginary component. One way in which imagery and perception may differ is in the ability to select music to hear and music to imagine. Furthermore, researching musical imagery is not equivalent to the investigation of perception, as the former explicitly concerns the formation of a mental representation, and the latter is conceptually broader in scope.

Disparities between definitions of present-focused music listening in philosophical and theoretical literature make it clear that consciousness is a central means of establishing the parameters of perception and imagery. For instance, the perceptual organisation of musical events within a perceptual 'now moment' may involve sub-conscious retentions and anticipations. These are not equivalent to imagery as defined in this thesis. However, mental representations of past and future events in a piece of music relate musical events to their context in a way that may be open to conscious introspection. Yet, in accordance with *Gestalt* psychology, musical perception is the grouping together of elements, and imagery may be said to function similarly. It has been argued by at least some traditions within psychology (for a discussion see Eysenck and Keane, 1990) that forming representations is an integral part of perception, and as such imagery and perception are closely related.

It has been shown that accounts of music listening describe varying levels of abstraction and varying degrees of conscious introspection or capacity to introspect. Musical expectancies are not readily subject to introspection and conscious will. That is not to say that the direction of a specific musical expectation cannot be identified, but rather that response is an automatic 'tendency'; a combination of sensory and cognitive activation. 'The more automatic behavior becomes, the less conscious it is' (Meyer, 1956: 24). Narmour describes the 'bottom-up' dimension of musical expectancy as 'an automatic, unconscious, pre-programmed, "brute" system' (1991: 3). By contrast, musical imagery is defined as the 'inner hearing' of music or musical elements, implying conscious access. According to these criteria, where can Levinson's 'quasi-hearing' be situated (combining as it does conscious awareness of anticipatory and recollective musical events with conscious attention to the present moment)? It would be hard to switch the focus of attention to either anticipatory or recollective parts of the experience without forfeiting the forward motion of the listening experience. Thus while quasi-hearing involves musical imagery, on a practical level it does not meet the criterion of being open to conscious reflection.

It is important to distinguish generic musical schemata from specific musical images. While the two are inter-linked, they are not conceptually equivalent. Similarly, musical expectancies in music listening are generally abstract mental representations, while anticipatory musical imagery are related but take a more veridical form. The problem is one of understanding the position of imagery and perceptual experience between episodic and semantic mental representations, and veridical and schematic expectancies. From the theoretical discussion of music listening, it can be speculated that a continuum rather than a binary opposition exists between the schematic, sub-conscious semantic knowledge that accompanies perception, and the veridical, conscious episodic musical image.

Recently, musical imagery has begun to receive serious psychological attention, with work in the field of neuropsychology, work on imagery in its relation to memory, cross-cultural considerations of musical imagery, concern over the relationship of motor and sensory dimensions of music, and timbral imagery. However, this work has only touched the surface of possible knowledge about mental imagery in music. There are significant gaps in the literature as regards the development of musical imagery, imagery for timbre in musical contexts, the impact of musical skill on imaging ability, and 'inner hearing' in music education. Of most concern is the assumption that musical imagery is widely experienced, with no reported attempt to determine its prevalence. Due to the disparate disciplines concerned with musical imagery, there has been little methodical consolidation of results and research techniques. In order to progress, potential factors such as the impact of task type on the similarity between imagery and perception behaviour must be carefully explored (Intons-Peterson, 1992). Moreover, as the musicological and philosophical literature illustrates, neglected considerations such as the level of familiarity a listener has with a particular piece of music might affect musical imagery, with more familiar music corresponding to higher and more veridical levels of imagery. Until such issues have been adequately addressed, the key question remains; are imagery and perception inseparable components of the listening process? Intuitively, inner hearing is a poor substitute for the richness of real sound when listening to music. As Levinson states: 'Memory and imagination may provide surrogates, of course, for purposes of inner contemplation, but at that point we have left perception behind' (1997: 163).

Investigating the situation is problematic, as there is always a pull between what is imagined and what is observed, making musical training and verbal expression important factors in imagery research. For both perception and imagery, problems of indirect access to inner experience have been an obstacle. In order to gather direct data about musical imagery, the next chapter presents a sampling study investigating the prevalence and nature of 'tune on the brain' experience. The advantages of this method are a more immediate access to the everyday occurrence of musical imagery than methods of retrospective report allow.

CHAPTER THREE –

A SAMPLING STUDY OF THE NATURE AND PREVALENCE OF 'TUNE ON THE BRAIN' PHENOMENA

3.1 Introduction

All people are presumed to have experienced musical imagery, yet the prevalence and nature of the phenomenon remain empirically unknown. As hypothesised in Chapter One, the characteristics of imagery, and its relationship to perception, are likely to be influenced by the intentionality and the musical nature of the imagery context. In order to address both the true prevalence of imagery experience and its characteristic relationship to perception, it is fitting to begin with an investigation into the most general sort of musical imagery, that of the unintentional, involuntary 'tune on the brain'. Because there is no precedence for empirical research on 'tune on the brain' imagery in its daily occurrence, this chapter takes an exploratory approach to determine when such imagery might occur, and how it is experienced. Driving this exploration is the key theoretical concern to elucidate the relationship between musical imagery and perception in its various occurrences.

The most basic question is to ask how prevalent the experience of musical imagery is. It is taken to be particularly common amongst musicians whose involvement with imagery ranges from composition and performance to listening. The idea that musicians are particularly prone to image music demonstrates a fundamental belief that the amount that an individual perceives music is matched by a relative propensity to hear 'inwardly'. This connection between music heard and music imagined explains the frequent experience of having a recently perceived musical fragment 'on the brain'. It is generally understood that the greater an individual's familiarity with music, the greater the likelihood of it stabilising in the mind as a mental representation. The greater the exposure to a stimulus, the deeper the imprint on memory for that stimulus. If, as Clynes and Walker (1986) observe, memory for an event is allied to the opportunity for the concept to stabilise, then it might be anticipated that musical imagery reflects high familiarity with the music. Moreover, Finke's (1989) description of Craik and Lockhart's 1972 theory of 'depth of processing' is relevant to image formation, as it states that the extent that an item has meaningful associations determines the probability of its recall.

This chapter will adopt an empirical approach to the prevalence of musical imagery and the role of musical familiarity in its experience. It will also question the *nature* of musical imagery. For instance, when it comes to musical memory, do people merely image the latest music heard, or do other factors have their part to play in the musical content of an individual's thought? Information processing accounts of musical memory would claim that the manner in which musical information is processed has a direct bearing on the consequent memory image (Crowder, 1993). Thus attending to a particular musical dimension in listening would affect the corresponding musical image in some way.

Matters of musical memory have been the focus of much psychological research and the findings indicate that we are less likely to imagine a long sequence of musical notes than to recall salient moments of structural importance. Bearing this in mind, a systematic investigation of the nature of musical imagery might reveal a fragmentary replaying of key events instead of the imaging of a piece of music from start to finish. Gurney (see Levinson, 1997) conceptualised musical 'cogency of sequence' as an important unity or organic quality in successful musical form. Levinson quotes from Gurney's 1880 *The Power of Sound*:

> A long succession of phrases which exhibits nothing but perceptual differentiation will escape the grasp of the ear, and will seem rambling and aimless. But whether or not united in some such special manner, any paragraph which is to be musically valuable must satisfy the test that each bit shall necessitate, as it were, and so enter into organic union with the one next to it... (Gurney, cited by Levinson, 1997: 6)

It follows from Gurney's theories that cogent passages of music would resist any imagined modification or substitution, given that each part belongs to the next. Perhaps the experience of having a 'tune on the brain' reflects principles of cogency, meaning that particularly well-formed musical episodes retain their identity even in imagination. Gurney and Levinson might argue that the tendency for music to be imaged in cogent units would reflect the structural sense of the music 'heard'.

Previous research (see for example Bailes, 1999; Zatorre *et al.*, 1996; Weber and Brown, 1986) has demonstrated the frequently multi-modal nature of musical imagery. In other words, imagery is not restricted to an auditory experience, but might, for example, comprise the visual, spatial, and kinaesthetic features reminiscent of a particular musical performance. For a synaesthete, imagining music, as hearing it would carry associated experiences of colour. Consequently, when exploring the experience of a 'tune on the brain', it should be expected that dimensions other than the purely auditory are revealed.

Until recently, few researchers outside the field of ethnomusicology have explored music as an integral experience of everyday life. However, DeNora (2000) and Sloboda, O'Neill and Ivaldi (2001) have done so, approaching music as a function and not just as an art form. They found that, disproportionate to the literature devoted to music listening as an activity in its own right, music plays a predominantly functional, accompanying role to everyday activity. What then can be speculated about the everyday role of musical *imagery*? Musical mental representations variously occur either as involuntary 'tunes on the brain', as involuntary but necessary corollaries of musical activity, or as deliberate aids to activities such as reading musical score. These three different types of imagery are distinguished according to their voluntary nature and their function. On the surface, 'tune on the brain' experiences appear to serve little purpose in everyday life, with musical imagery largely redundant outside of its role in specifically musical activity. For example, somebody wanting to listen to music would employ 'real' material rather than an imagined substitute. 'Real' music fulfils many social purposes, yet it is difficult to see a parallel social use for musical imagery, with the possible exception of being able to think of (image) music that forms the subject of a conversation. However, 'tune on the brain' could be evoked to avoid silence, or perhaps it relates to mood or mental state.

While increasing attention has been paid to the everyday 'use' of music, an increasing emphasis has also been placed on the importance of conducting research under real circumstances (Robson, 2001). Not only does this necessitate situating the investigation in a natural location, but also exploring events in real time. Music is perceived as a temporal art so it can be speculated that its mental representation takes some time to 'hear', and that it is liable to occur spontaneously or be triggered by events through time. There seems to be little research on the subject of specifically musical imagery and human development: the stages at which imagery is prone to occur and the nature of imagery at these stages is open to speculation (see Chapter Six for a consideration of developmental issues). However, as musical imagery is presumed to be a ubiquitous experience, and it is postulated that perception is an important pre-requisite for mental representation, it can be taken that imagery will occur variously at stages of human development as long as there is a favourable musical environment. On a micro scale, it could also be speculated that imagery will occur throughout the day, although there are grounds to believe that the mind is more receptive to auditory images in dream (Willin, 1999), so that musical imagery experience might be heightened when going to sleep, or waking up. Only a study conducted in real time would adequately address questions concerning the nature and prevalence of musical imagery.

In order to answer these questions about 'tune on the brain', and in keeping with the need to explore musical imagery as it occurs naturally, a method of sampling real-life experience is required. Sloboda *et al.* (2001) provide a model for the use of experience-sampling methods (ESM) in music research. Their exploratory study looked at functions of music in everyday life by sampling episodes throughout the week of eight non-musicians. Pagers were employed to cue participants at random times throughout the day, during a seven-day period. When paged, participants filled out an experience-sampling form (ESF) which asked for information about music heard, activity, location, mood, and control of the music. Findings showed that music was rarely the focus of episodes, though experiencing music might have a positive effect on mood and state of alert where participants had control over their musical environment. The authors note that the immediacy of sampling experience in real time avoids the distortions involved when asking people to report retrospectively. They claim that it is 'a method which comes as close to direct observation of daily musical life without intervention as is practically and ethically permissible' (2001: 11). Such a methodological advantage is crucial to the study of imaging, which already necessitates introspecting on a fleeting experience. For musical imagery, the impact of immediate experience would probably be lost without the means to record it as it occurs. While it cannot be denied that even the completion of an ESF requires a degree of 'thinking back' to the exact moment of being contacted (albeit over the space of a few seconds or minutes), the method is direct and immediate.

Csikszentmihalyi and Larson (1987) evaluate the more general use of ESM approaches, stating that 'The purpose of using this method is to be as "objective" about subjective phenomena as possible without compromising the essential personal meaning of the experience' (1987: 527). Such a goal is commensurate with the imagery research of this thesis, and is made possible by 'observing' the musical thoughts of volunteers in a relatively unobtrusive fashion. As the focus of this thesis is the relationship of imagery to perception, and, as noted above, musicians are believed to hear music inwardly to a great extent due to their involvement with heard music, musicians are the subjects of this study. By employing ESM techniques, the aim was to determine the prevalence and nature of 'tune on the brain' and actual music experiences for music students. This would allow an exploration of concurrent heard and imagined music patterns for each individual, and for the volunteers as a representative group.

3.2 Method

The principal aims of this study were to establish how frequently musical imagery is experienced in everyday life by music students, and to explore the nature of that experience through an investigation of the relationship between imagined and heard music.

3.2.1 Participants

Eleven university music students responded to an email advertisement for the study. Five men and six women volunteered, with four participants on undergraduate and seven on postgraduate courses. The university music department is a closed environment, with the inevitable result that most participants were known to the investigator and to each other. There was a chance of mutual influence in ESF response and of anticipating a signal if another participant was called in the vicinity. However, this was difficult to eliminate and not deemed problematic enough for the investigator to recruit from elsewhere.

3.2.2 Materials

Participation in the study required the use of a mobile telephone and experience-sampling forms (the ESF).

Ideally the telephone was set to silent mode or vibrate, though in the absence of this facility a couple of participants set their phone to a one-tone ring. Participants programmed the investigator's number in their telephone address book so that when they were called the screen would read 'fill in form'. The phone was allowed to ring three times and participants were requested not to answer the call.

The ESF (see figure 3.1 on page 52) is two sides long and is closely based on that used by Sloboda *et al.*, (2001), comprising both open and closed questions. It was designed to take no more than a few minutes to complete. Space was given for respondents to note the time they were called and the time they filled out the ESF, and so any time discrepancies could be monitored and data discounted given too long a delay in response. Part A of the form gathered

information about location, main activity and the company of others. Part B was to be completed in the case of hearing music, and Part C, the largest section of the form, asked for detailed information about any music being imaged.
In the case that the name of the music heard or imagined was not known, style categories for best fit with the music were provided. In both hearing and imagining parts, respondents were asked to rate, on a scale of 1-7, their levels of concentration on the music, the importance of the music to the moment, and whether they would have preferred to listen to alternative music or no music. An open question invited comments about anything important or noticeable about the music.

Imagery section (Part C)

Based on the assumption that state of mind has a close bearing on musical thought, and vice versa, some of the mood pairs employed in the 2001 study by Sloboda *et al.* were included. Those that were omitted (irritable/generous, secure/insecure, nostalgic/in the present, distressed/comforted) were similar to the pairs included, and an open question later on the form captured any extra information relating to the imagery experience that also might relate to mood.

As the study sampled a population of music students, one question aimed to distinguish general memory imagery from own composition imagery. Respondents were also asked whether they had actually heard the music imaged since the last time they were contacted, and invited to offer any possible explanation for why they were imaging that music. In addition, various musical dimensions (such as melody, timbre, texture, and dynamics) were listed so respondents could indicate how absent or vivid (scale of 1-7) those dimensions were. In the case that the respondent had ever performed the imaged music, a question asked for the rating of their physical memory of playing. Finally, an open question was included to gather extra information about the nature of the imagery experience.

Figure 3.1
Experience-sampling Form

Date:__________ Time Contacted:______a.m./p.m. Time Filled Out:______a.m./p.m.

As you were contacted, were you **hearing** any music? YES NO
If YES, please fill out parts A & B of this form with respect to the time you were contacted

If No, were you **imagining** any music as you were contacted? YES NO
If YES, please fill out parts A & C of this form with respect to the time you were contacted

If you were neither hearing nor imagining music at the time you were contacted, please just fill in Part A with respect to the time you were contacted.

PART A
Where were you?____________________________________
What was the MAIN thing you were doing?________________________
____

Who were you with? (Circle as many as are applicable)

Alone	Partner	Person/people you live with
Family member(s)	Friend(s)	Professional(s) (e.g. dentist)
Acquaintance(s)	Strangers	Person/people you work with

If not alone, how many people were you with?_

PART B (Hearing music)
Where was the music coming from?

Radio	TV	Walkman	PA System (public place)
Record/Tape/CD	Concert	Busker	Rehearsal/Practice
Whistling/Humming	Mobile phone	Other________________	

Can you name the music you were hearing? YES NO
If YES, please name it____
If NO, please circle all style categories that best describe the music you were hearing

	Dance		Contemporary
Pop	Chart	Classical	Opera/vocal
	Soul		Orchestral
	Rock		Solo instrument/Chamber
Folk		Jazz	

Other____

How much personal choice did you have in hearing the music?

None at all						Completely own choice
1	2	3	4	5	6	7

	Not at all						Very much so
How much were you concentrating on the music?	1	2	3	4	5	6	7
Was the music important to the activity/moment?	1	2	3	4	5	6	7
Do you wish you had been hearing different music?	1	2	3	4	5	6	7
Would you have rather not been hearing music?	1	2	3	4	5	6	7

Was there anything in the music that you found particularly important or noticeable?__________
____

PART C (Imagining music)
For each pair of moods, tick the category that most closely describes the way you felt while you were imagining music.

	Very	Quite	Somewhat	Neither	Somewhat	Quite	Very	
Alert								Drowsy
Happy								Sad

	Very	Quite	Somewhat	Neither	Somewhat	Quite	Very	
Lonely								Connected
Energetic								Tired
Involved								Detached
Tense								Relaxed
Interested								Bored

Was the imagined music your own composition? YES NO
Can you name the music you were imagining? YES NO
If YES, please name it____
If NO, please circle all style categories that best describe the music you were imagining

	Dance		Contemporary
Pop	Chart	Classical	Opera/vocal
	Soul		Orchestral
	Rock		Solo instrument/Chamber
Folk		Jazz	

Other____

Had you actually heard this music since the last time you were contacted? YES NO

If possible, please explain why you might have been imagining that particular music____________

____

	Not at all						Very much so
How aware of the imagined music were you?	1	2	3	4	5	6	7
How much were you concentrating on the music?	1	2	3	4	5	6	7
Do you wish you had been imagining different music?	1	2	3	4	5	6	7
Would you have rather not been imagining music?	1	2	3	4	5	6	7

Was there anything in the music that you found particularly important or noticeable?____________

____

Please describe how sharp your mental image of the following musical elements was at the time you were contacted:

	Absent						Very sharp
Melody	1	2	3	4	5	6	7
Harmony	1	2	3	4	5	6	7
Texture	1	2	3	4	5	6	7
Timbre	1	2	3	4	5	6	7
Dynamics	1	2	3	4	5	6	7
Lyrics (if applicable)	1	2	3	4	5	6	7
Expression	1	2	3	4	5	6	7

In the case that you have played this music, please describe how sharp your mental image of the following was at the time you were contacted:

	Absent						Very sharp
Physical memory of playing	1	2	3	4	5	6	7

Please give a brief description of how complete the experience was, e.g. Was the music playing in your mind as a whole piece? Were you hearing a repeated fragment of it? Was there a visual or spatial dimension to your musical image ...?_________________________________

____

Are you imagining the same music now? YES NO
If NO, are you imagining different music now? YES NO
If NO, are you actually *hearing* music now? YES NO

Please write below any additional information or comments about what was happening and/or how you were feeling when you were imagining the music at the time you were contacted______________

3.2.3 Procedure

All respondents were assembled for a ten-minute training session prior to the start of the study. Here instructions were given, and the full involvement required of participants was explained. A block of 42 ESFs was given to each participant, representing one form per episode, with 6 forms per day to be used for a full seven-day week. Along with the forms was an instruction sheet (see Appendix A). This outlined the potential contact hours of the study during which time phones should be switched on and set to silent or vibrate mode, and the importance of filling out the form as honestly as possible in view of the anonymity of the study. At this stage each participant detailed times when they envisaged that it would not be possible to have their phone switched on. These times were noted and collectively became the basis for the call schedule.
Call times on the schedule were prescribed by the investigator for the entire week (but not made known to the participants) to fall between 10am and 10pm each day, for seven consecutive days. One call would be made within every two-hour block, and times were avoided when the phones of many students would be turned off such as during lectures, or a music performance. Calls were made in quick succession to each participant (starting with a different participant each time). Participants were called within three minutes of each other, allowing the possibility to examine a cross-section of data at any particular time episode. The minimum period between calls was 20 minutes, and the maximum was 3 hours 45 minutes.

3.2.3.1 Interviews

Approximately a week after the study's end all participants were interviewed about their experiences. The interviews took the form of semi-structured interviews (see Appendix B) prompting respondents to explain: the typicality of their week; their experiences of taking part in the study; what they may have learned about their musical imagery; and their perceived balance of hearing, imaging, and music-free experiences from a retrospective standpoint. As in the study of Sloboda *et al.* (2001), a few completed forms relating to imagery episodes from the week were selected at random from each individual's data to encourage participants to elaborate on their specific experiences of imaging. As the ESM methodology was being newly applied to imagery research, participants were asked various feedback questions relating to the practicalities of the study, matters of ESF design and layout, and how often forms had been filled out a long time after the signal.

3.2.4 Analysis

All completed ESFs were used in the analysis of general trends between imaging, hearing and no music episodes (N = 417).

More detailed analyses of imagery and hearing episodes considered only those forms that had been completed within 30 minutes of the signal (N = 350). At first, data were pooled across participants, allowing for a general exploration of emerging patterns.

When later analysing the reported veridicality of imagery for different musical dimensions, mean data for each individual respondent (across episodes) were analysed in an ANOVA. Individual participant data were also used in analysing the variety of music experienced, and the variety of individual weightings of imagery, hearing and 'no music' episodes. The data from each participant were also separated out in the qualitative analysis of post-study interview feedback.

There were relatively few unanswered questions on the forms, but these are discounted in the analyses.

Totterdell and Briner (1996) warn against using summary data in the analysis of ESM studies, as these ignore any temporal dependencies. However, the purpose of this research was to explore general trends and cross-sectional patterns, rather than to monitor longitudinal patterns.

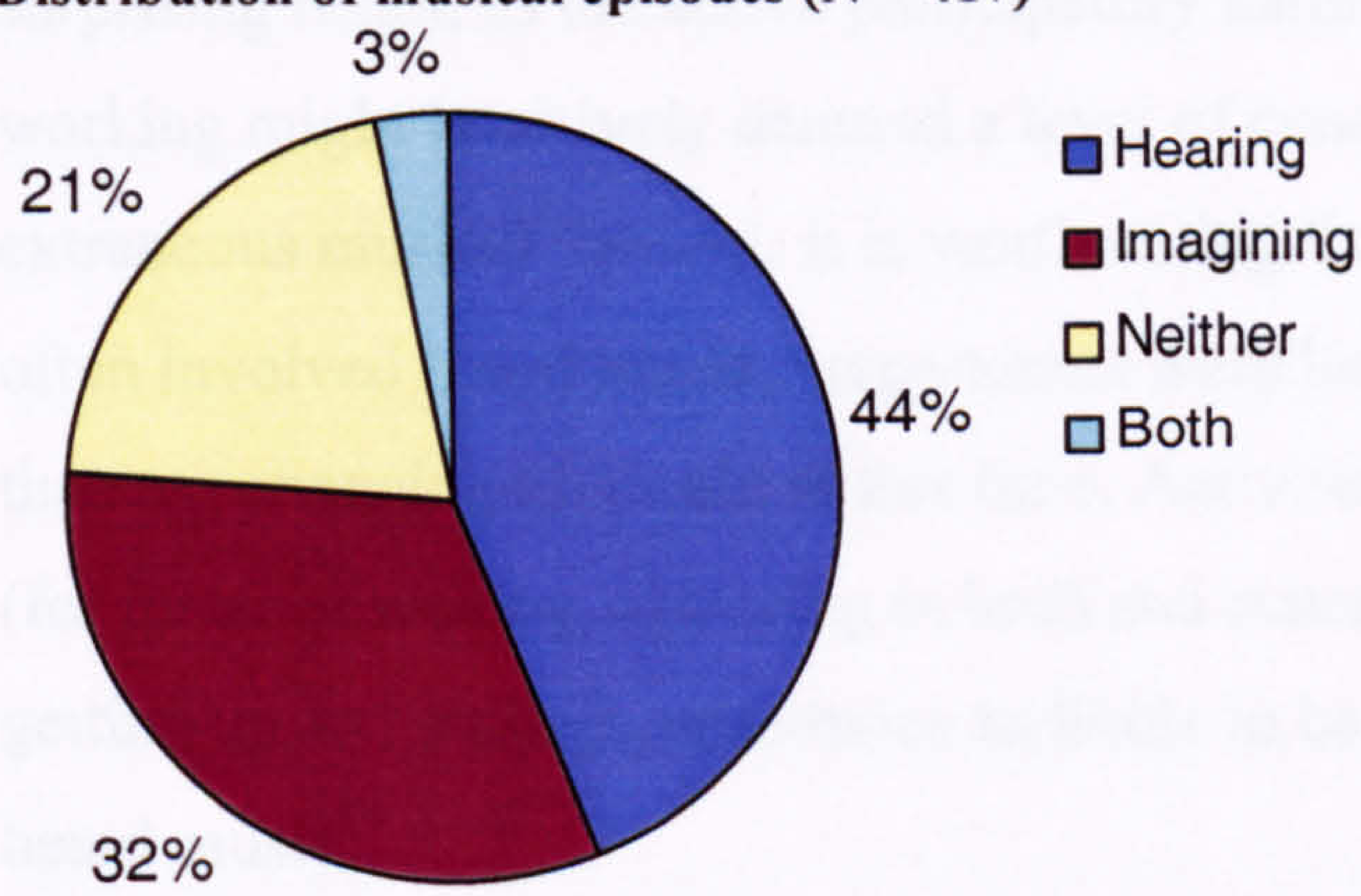
Qualitative data were coded by the investigator. As Stone, Kessler and Haythornthwaite (1991) observe, coding can have substantial effects on the magnitude of any associations made between coded categories. This must be taken into account when considering the results in this study.

3.3 Results

A total of 417 completed ESFs, called 'episodes', was recorded (90% response rate). Because experience was semi-randomly sampled throughout the week, time spent in each musical state could be calculated. These results (figure 3.2) are a measure of the prevalence of 'tune on the brain' experiences among music students during a seven-day period. The proportion is quite high, and certainly justifies proper research into the phenomenon of musical imagery. The category 'both' applies to seven out of eleven respondents who indicated that they had simultaneously heard and imagined music.

Figure 3.2

Distribution of musical episodes (N = 417)



There is great individual variation within this global measure of the prevalence of imagery. The participant who experienced the least imagery did so for 12% of the time, while one participant imaged music as much as 53% of the time.

The main activity of respondents at the time of signal was measured, and activities were subsequently grouped into categories of activity-type (see Appendix C for categories). This was to look for any apparent influence of activity-type on musical thought.

Figure 3.3

Activity type per music condition

	Hearing	Imaging	Neither	Both
Working	20	26	16	1
Travelling	8	23	11	1
Leisure (ex. TV)	20	9	10	1
Leisure – music	9	1	1	1
TV	28	5	13	/
Interacting	26	29	17	/
Music-making	36	1	0	/
Time filler	5	9	0	1
Being	5	10	6	1
Maintenance	30	19	12	3
Other	0	0	1	/

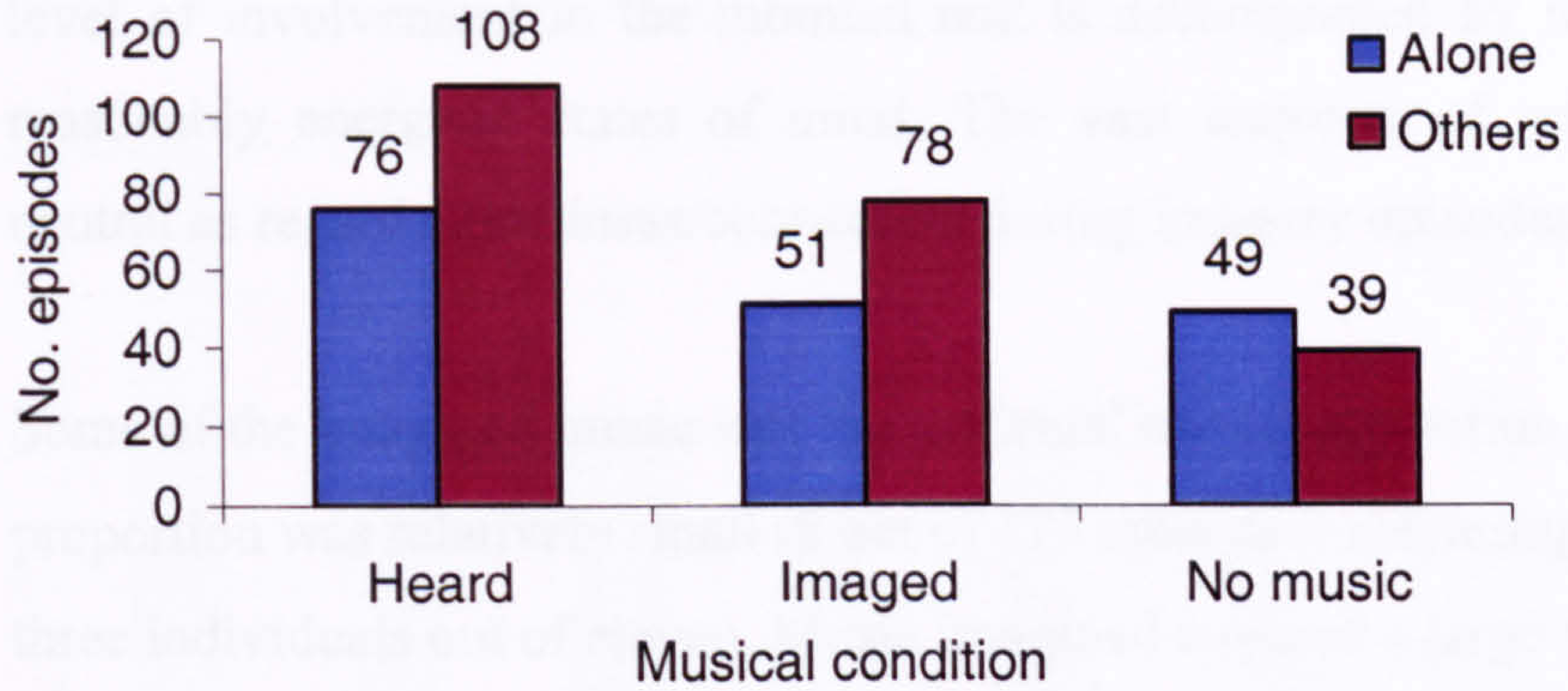
(Highlighted figures represent highest count of episodes per music condition)

Figure 3.3 shows that imaging episodes are most frequent during interaction with others, with working the second most frequent activity. This is perhaps a surprising result, as the active participatory nature of reacting to others and working might intuitively demand a level of concentration likely to suppress extraneous musical thought. It is worth noting that while watching television often involved heard music, respondents were less likely to be imaging music than experiencing no music at this time. Activities categorised as 'time filler', (for instance waiting, and lying in bed) and states of 'being', (for instance getting up and sitting), were twice as likely to be accompanied by imagery as by heard music.

When no music is physically present, the company of other people might have a bearing on whether an individual is prone to image music or be music-free. For this reason, a chi-square was calculated of the frequency with which heard, imagery and 'no music' episodes coincided with the presence of others. The result was significant ($p < 0.05$). Figure 3.4 illustrates the distribution. It is noteworthy that imagery data resemble patterns for heard music more than those for music-free episodes.

Figure 3.4

Musical condition and the presence of others



Overall, episodes of heard music increased throughout the day (33% through to 61%). The number of imagery episodes however remained constant, before dropping to almost half their number during the final testing period (from 8pm to 10pm). While difficult to account for this trend, it seems likely that the increase in perceived music during this evening period is the main reason for the reduction in imagery episodes.

Fifteen per cent of all completed ESFs were filled out more than half an hour later than the time of signal: all these data were discounted for the purposes of the more detailed analyses. This left a collection of 350 responses (76% of all possible returns). Of these, imagery episodes were isolated and the possible correlation of mood to imaging was investigated. Figure 3.5 presents the sum of mood ratings for all imagery episodes. The most frequent ratings per mood are highlighted.

Figure 3.5

Table of mood ratings for imagery episodes

	Very	Quite	Somewhat	Neither	Somewhat	Quite	Very	
Alert	13	**39**	27	17	22	8	5	Drowsy
Happy	14	**42**	29	25	8	4		Sad
Lonely		1	9	**43**	18	37	14	Connected
Energetic	2	**32**	31	14	21	13	4	Tired
Involved	12	28	**30**	28	14	8	3	Detached
Tense	2	5	23	25	23	**31**	11	Relaxed
Interested	11	34	29	**39**	6	2		Bored

The data indicate that respondents felt neither interested nor bored while imaging music and that they also felt relaxed. This does not preclude a positive level of involvement in the moment and is accompanied by happy, alert and reasonably energetic states of mind. The vast majority of respondents were neutral as regards loneliness/connection during imagery episodes.

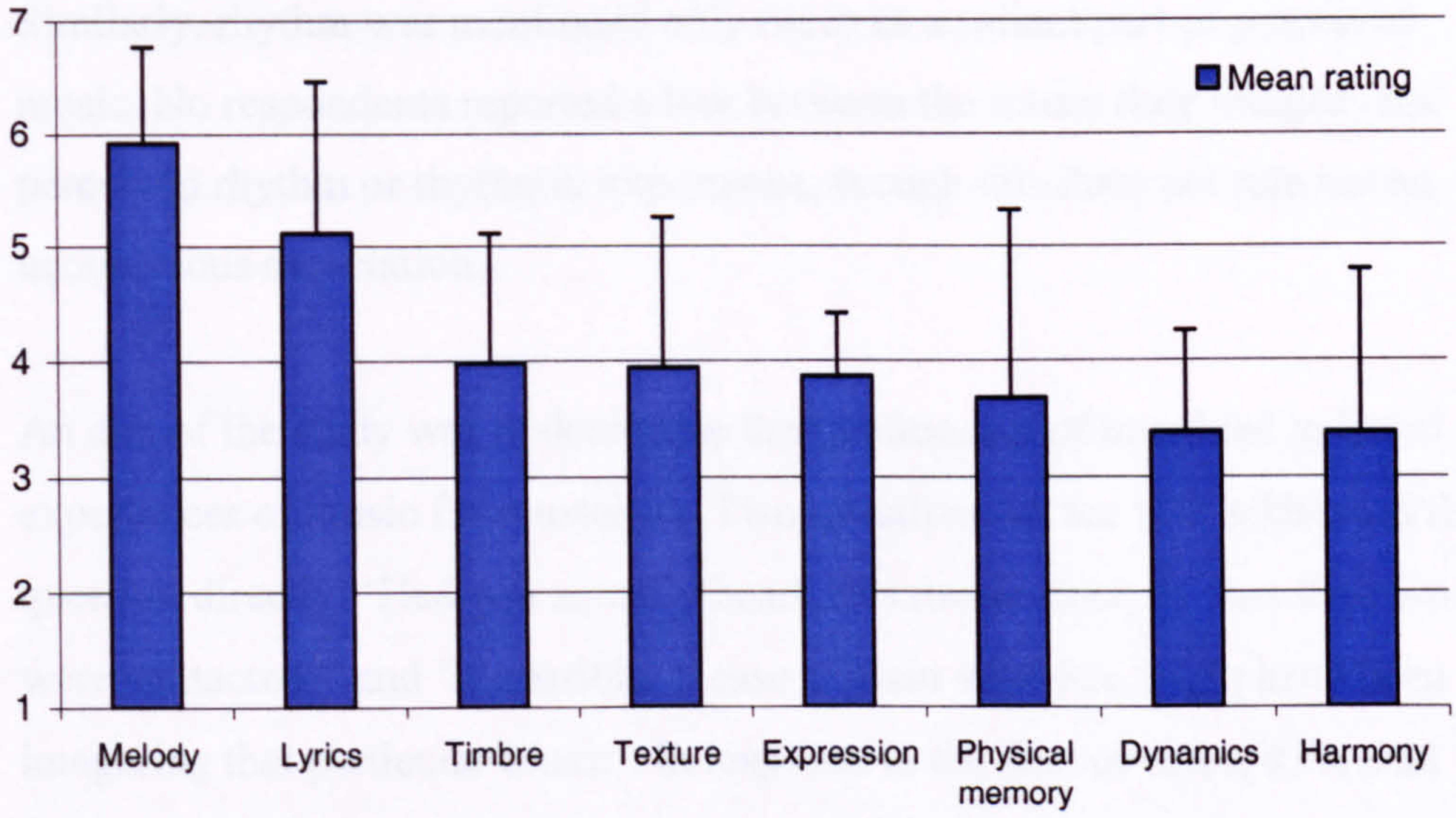
Some of the imagined music was the students' own composition. However, the proportion was relatively small (8 out of 123 episodes) stemming from only three individuals out of eleven. Music imagined covered a large variety of genres. Named and un-named imagery pieces are listed in Appendix D. Across all episodes, a total of 89 different named pieces of music were imaged (18 unnamed pieces) and 81 different named pieces were heard (103 unnamed pieces). A generalised chi-square shows this distribution to be significant ($p < 0.0005$). On the whole, respondents were able to name the music they were imagining: this declarative knowledge suggests a fairly high level of familiarity with the perceptual source of their imagery.

Respondents were quite aware of the music they imagined (rating above average on a scale between 'not at all – very much so'), though not concentrating particularly on it (mostly average rating and under). Contrary to the common belief that music 'on the brain' is an irritant, respondents mostly stated that they wouldn't wish to be imagining different music, or even no music at all.

Ratings were collated of how vivid each mental image was in terms of its musical components (scale of 1-7, from 'absent' to 'very vivid'). A mean value for each component per participant was calculated, and these data were analysed with a one-way ANOVA. The result was significant [$F_{7,49} = 5.45$, $p < 0.0001$] and figure 3.6 illustrates the resultant hierarchy of vivid features (1 = absent, 7 = very vivid), averaged across all participants.

Figure 3.6

Vividness of Imagery Dimensions (scale 1-7) with standard deviation



Melody and lyrics are rated as being the most vivid dimensions of musical imagery (and not significantly different from each other). Timbre is significantly less vivid than melody ($p < 0.001$) for these respondents. This could be related to the human ability to reproduce melody and lyrics, while timbre and texture are not necessarily easy to replicate. However, this theory does not account for the low veridicality of expression and dynamics - features that can be humanly produced. More plausible is the perceptual salience of each of these musical attributes for the individual.

Standard deviation bars have been included in figure 3.6 to give an idea of the amount of agreement between participants on the veridicality of each dimension. For those times when the respondent reported having performed the music they were imaging, the degree to which they imagined a physical memory of playing was measured. The majority of these responses indicated that a physical memory was barely present, but there was high variability between them on the extent to which this was the case. By contrast, most participants were agreed that expression was not particularly vivid in their imagery.

The ESF did not include a separate category to measure the vividness of imagery and perception for rhythm, though one participant was keen to point out that his imagery was often most centred on this. Perhaps surprisingly, only two participants named rhythm as a noticeable feature of an imagery episode. Similarly, rhythm was mentioned only twice as a salient part of perceived music. No respondents reported a link between the music they imaged, and perceived rhythm or rhythmic importance, though this does not rule out an unconscious association.

An aim of the study was to determine the relationship of imagined to heard experiences of music for musicians. Two questions on the ESF addressed this question directly: 'Had you actually heard this music since the last time you were contacted?' and 'If possible, please explain why you might have been imagining that particular music'. In response to the first of these, 43% said 'yes' and 54% replied 'no' (3% answers missing). This question only related back in time to the last call received and it is possible that hearings of music in the less recent past might also have an important influence on music imagined. The second question allowed for a more open-ended explanation for the possible occurrence of particular music. Results in figure 3.7 are categorised, and relate to the 107 complete data for this question.

Figure 3.7

Reasons given for imaging particular named or unnamed music

	Music named	Music not named
Visual trigger	2	0
Music that will be performed	7	0
Analytical listening	3	2
Music that has been performed	13	0
Reaction to experiment	2	0
Person association	4	0
Heard	42	7
Talked about	6	0
'Stickiness'	1	0
'No idea'	6	0
Automatic	2	1
Memorising	1	0
Similar to something heard	1	1
Name trigger	1	0
Like it	1	1
Nostalgia	0	1
Other	0	2

It can be seen that by far the most common reason provided for imaging a particular piece of music is having heard it. It is striking that only two episodes report liking the music to be the main reason behind the musical image. Only two responses state that imagery was experienced as a reaction to the experiment and this number is matched by post-study interview data in which most respondents explain that while they occasionally found themselves imaging music and wishing a call would coincide with this, it rarely, if ever did.

3.3.1 Discussion

A summary of the main findings from the completed ESFs shows that musical imagery is prevalent among music students and that interacting and being in the presence of others does not inhibit the process of imaging music. That respondents were able to name most of their imagery implies a high familiarity with the original music, and a clear association between imagined and heard music was made by the respondents themselves. The elements most likely to be imagined in a veridical fashion were melody and lyrics, and contrary to the common belief, musical imagery *per se* is rarely reported to be irritating.

An open question asked respondents to outline how complete an experience their imagery was. The majority of episodes describe the image as a repeated fragment rather than a full mental run-through. Very often the repeated segment was the chorus of a song. Varying levels of clarity in the image were sometimes described in this section of the ESF. For instance, detail down to the imaging of Baroque instrument timbre contrasts with what has been described as ‘hazy’ imagery. Often a spatial location in the head is associated with the image: music is ‘heard’ at the back of the mind, or salient elements appear at the front. Multi-modal aspects of musical imagery are described, such as imagining the notation, imagining the video of a pop song, imagining the physical aspect of getting a piece right, dancing, and visualising a specific performer. One participant had recently purchased an album, and music from this album occupied many of his musical thoughts throughout the week. In one episode he says that he is imagining several songs from the album 'spliced together'. This transformation of music is common among participants, and their training as music students enabled them to describe such experiences in a way that might prove difficult for a ‘non-musician’.

There was a great deal of individual variation in terms of genre of music imaged. For instance, while three participants imaged exclusively pop music and commercial jingles, two others imagined only classical music. An interesting trend is the reported recurrence of a personal imagery leitmotif for a couple of the participants. Sometimes this was merely reported in the post–experiment interview, and did not show up in the ESM data. For example, one respondent reported frequently imagining *Fly me to the moon*, particularly at moments where he was tired, bored, or uninterested in the music around him. For another participant, a particular radio jingle was cited as being often in his mind. However, for both these respondents the music only emerged as an image in one ESM episode.

It was important to discount responses filled out more than thirty minutes after the time of contact for the detailed analysis of imagery data, yet the post-study interviews amply demonstrated that participants had a good memory for the moments they had been contacted. Two or three completed ESFs from imagery episodes were presented to each individual to see what could be remembered and whether the music would still be imaged. In most cases, participants claimed to have a vivid memory of the occasion, often exclaiming as the memory was felt, and frequently able to sing the music back. Of course, retrospective reports are prone to distort the original event through the inevitable process of time: an apparent memory for an imagery moment might not resemble the image as it was originally experienced.

The freezing of a moment in order to fill out the ESF and limitations of vocabulary mean that imagery has been frequently described as an entity. However, imagery is a process and music unfolds in time. For this reason, the ESF included questions to measure whether during the course of filling out the form participants had lost sight of the image. 71% of all imagery episodes were still 'on the brain' on completion of the form, while 29% were not[1]. The

[1] N.B. Four data are missing from this analysis

majority of episodes in which the image was no longer being 'heard' seem to be attributable to newly perceiving music.

The ESF did not take into account the possibility of imagining and hearing music simultaneously. Post-experiment interviews checked that all respondents who did experience this managed to note it down in some form. When asked what this experience was like, one respondent provided a visual analogy:

> Isn't it a bit like, I think I'm aware of it when I'm on the phone to somebody and . . . usually you're looking at the same thing all the time, like you know the same boring view when you're on the phone – I'm always seeing other stuff as well. So I don't necessarily think it's a case of blocking one thing out and then the other, but just a continuous stream of both. Because it's easy to do when you're seeing something because you're imagining stuff all the time, visually.

Other respondents who reported simultaneous hearing and imaging spoke of concentration being shared between both, and of multiple layers of awareness. For one participant a particular piece of music was heard 'passively', but as it was unfamiliar to him he had continued to imagine some familiar music that he had previously heard. Another participant said that if she found an image annoying she would deliberately listen to music to banish it from her thoughts, and that this could cause a perception/imagery overlap. Another participant stated that she would be more inclined to imagine music concurrently with hearing different music if this were not at too high a volume.

An interview question asked how typical the week in which the study took place had been. The purpose of this was to gauge how representative the sampled episodes might be of a music student's daily musical experiences. Most participants claimed that their week had been typical, both in terms of everyday activity, and in terms of the amount of music making and music listening that took place. Those for whom the week was not typical (four participants) explained that this was either related to a personal issue and did not affect musical listening habits; or that for them a 'typical' week could not be described and that the week in question was no less typical than any other.

3.4 General Discussion

In order to investigate the possible influence of context on musical imagery, this study began by exploring its unintentional occurrence in presumably its most ubiquitous and least musically specialised form - 'tune on the brain'. The prevalence of imagery experiences has been measured for the first time. In addition, this study has provided a body of empirical evidence to support links between heard and imagined music. For instance, it suggests that there is a strong element of memory imagery for music recently perceived. Moreover, attending to particular musical dimensions in listening appears to have affected the characteristics of the consequent image for the music students in this study.

While knowledge of the investigator's interest in 'tune on the brain' experiences might have led participants to inflate their real imagery experiences, the ESF design for quick response and the prospect of a total of forty-two episodes to complete throughout the week would probably have discouraged participants from over-analysing the process. The data are likely to be a fair representation of everyday music experience, and this makes the finding that these music students experience 'no music' on average only 21% of the time remarkable.

In spite of a general confidence shown in recalling past episodes when asked to elaborate on them in interview, such retrospective data must be considered in the light of potential bias effects. A musical image is difficult to hold on to, given its elusive and temporal quality. Moreover, there were often occasions in interview where the difficulties of introspecting on imagery were expressed. There was a general feeling that though the ESF was not overly intrusive and detailed, participants would not naturally think about their imagery in such a conscious way in their normal daily life. This process of introspection inevitably made processes conscious that might not otherwise be so. According to the definition of imagery as a 'conscious mental representation of music', this study might be eliciting a higher level of such experiences than would normally arise. However, the ESM technique is a viable alternative to retrospective reports, and represents the closest possible method of learning about the real-time nature of the experience.

Issues of imagery definition and the ability to perceive and image different things simultaneously relate to a problem in this type of research - namely how to distinguish between singing, humming and imaging music. Interviews suggest that a couple of respondents considered imaging music and humming it as equivalent. It would seem pedantic to call humming music 'perception' and not 'imagery', yet humming music is essentially a production of music. By such a criterion, could a distinction be made between imaging music and singing it? A nominal distinction lies in the voluntary or involuntary nature of imagery. When imagery is referred to in the sense of a 'tune on the brain', it is generally an involuntary occurrence: humming it is no more than an outward manifestation of a 'present' but passive image. In cases of more voluntary musical imagery, such as score reading, humming the music would be more active and deliberate, perhaps entailing listening to the sound produced, as feedback associated with the musical activity.

Respondents made a very clear link between music recently heard and music imaged. 43% stated that they had heard the music imaged since the last time contacted, while 58% offered having heard or performed the music recently as a possible reason for their imaging it. The dependence of imagery on perception is supported by the significant majority of imagery episodes as compared with heard music episodes that could be named by respondents; this implies familiarity and repeated perception prior to imaging.

The phenomenon of simultaneously hearing and imaging separate music is interesting, making it apparent that the mind is capable of processing music on multiple levels, and of representing many layers of consciousness at once. Reybrouck (2001) names this phenomenon as 'coperception'.

> It is possible . . . to have imaginative projections in the presence of perceptual input as well. Imagery then is *coperceptual* rather than purely *autonomous*. (Reybrouck, 2001: 117).

Verbatim evidence from this study corroborates the natural tendency to both hear and imagine music when both are passive activities.

Brown (paper presented at CMI-99) describes the sensation of a 'perpetual music track' playing in the mind. This imagery may take the guise of 'looped' fragments of music, or a sequential musical unfurling. Based on his own anecdotal experiences, Brown believes that verbal processing, such as perceiving speech, interferes or otherwise interacts with his imagery, leading him to postulate that musical imagery provides evidence for split consciousness. His theories relate to the subjective accounts provided by many. The 'perpetual music track' may even continue in dreams. Shepard and Cooper (1982) discuss visual rather than musical imagery, but they point out that dreaming may be particularly conducive to the formation of mental representations because the mind is:

> At the same time, (a) aroused and active and yet (b) liberated from the pre-emptive demands of sensory input and, perhaps, from the distractive machinations of the more discrete, sequential, and linguistic apparatus of logic and syntax (Shepard and Cooper, 1982: 7).

The current study could not provide information about imagery in sleep. However, it does demonstrate that, far from being suppressed by the 'demands of sensory input' described by Shepard and Cooper above, participants were more inclined to image music in the presence of others than alone. This is surprising in view of the fact that interaction with others presumably required the use of language.

There are certain drawbacks in the sample used in the present study: self-selecting volunteers are not representative of the music student community at large, and students might have come forward because they imagine music more than their peers. Stone *et al.* (1991) write that:

> Demographic and personality characteristics of those willing to participate in demanding protocols may be different from those not interested, and the findings from such participants may not generalize to nonrespondents (Stone *et al.*, 1991: 597).

Still, it is interesting to compare the data gathered for heard music occurrences with those of Sloboda *et al.* (2001). These authors did not investigate music students but a group comprising eight staff and students from various departments in a British university. They reported that the sample heard music 44% of the time. This figure is surprisingly close to the figure in the present study (44% hearing, 3% 'both' so 47% total), despite the use of music students.

The difference is perhaps in the role of music for the two groups. While those in the study of Sloboda *et al.* tended to experience music as an accompaniment to other activity, 24% of all hearing episodes in the current research were taken up with 'leisure – music' (for example listening to music), or music-making. Though comparative imagery data for the sample used by Sloboda *et al.* do not exist, it could still be hypothesised that higher active involvement in music might be associated with more incidents of imagery than is experienced in a population in which active music listening is less frequent.

At the beginning of this chapter it was asked whether musical imagery could be described as serving a function in everyday life in a parallel manner to some of the functions of actual heard music. It is difficult to imagine any deliberate decision to image music during the normal course of the day. However, imaging music might occur through a sub-conscious correspondence with mood, provide a rhythm conducive to a task in hand, or relieve boredom when time filling. Data from this study are equivocal as to a link between desiring to achieve such ends and the actual employment of imagery, although individuals occasionally mentioned that imagery served such a function. Outside of musical activity, the imaging of music is not a consciously deliberate act, so while music is shown to fulfil many social functions (DeNora, 2000; Sloboda, 2001) musical imagery does not operate in such a purposeful way. Shouse (2001) asks why it is that 'tune on the brain' experiences exist, reporting that it is a side-effect of evolved memory processes in which 'chunking' as a means of efficiently retaining information translates to the repetition of a catchy melodic fragment in the mind. Perhaps this link to more general cognitive process lies behind the phenomenon, as well as the culturally useful skill of being able to deliberately evoke a musical image as part of a discourse about a piece.

ESM techniques do not totally by-pass the need to reflect upon a mental phenomenon that would not normally be reflected upon in any detailed way. A further methodological point concerns the need to learn more about participants' distinctions between imaging, singing, whistling and humming music. Nevertheless, this study has clearly shown that music students imagine music for a large proportion of their waking time. It seems that hearing music or performing it is a probable trigger to 'tune on the brain' and this association warrants further examination of the veridical properties of imagery. Though individual variation was demonstrated between participants, clear global differences between the vivid character of different musical dimensions were found, with melody and lyrics rated higher than dimensions such as timbre, harmony and expression. This exploratory study suggests a hypothesis about the nature of musical imagery whereby different musical dimensions are imaged to differing degrees of veridicality. The following chapter will examine the veridicality of imagery for pitch and timing in a controlled experiment. This experiment will also continue to address the comparison of imagery with perception, inferring the vividness of musical elements in the experience of both.

CHAPTER FOUR –

IMAGING PITCH AND TIMING: EXPERIMENTS

4.1 Introduction

In the previous chapter the prevalence and nature of 'tune on the brain' experience was explored. Results showed that various dimensions such as pitch, timing, and timbre were differently rated for their veridicality in the unintentional, 'tune on the brain' musical image. This chapter aims to test the vividness of experiencing different musical dimensions under controlled conditions, comparing more deliberate imagery with perception. While the relationship of imagery to perception has been explored theoretically, it has been difficult to develop satisfactory experimental techniques to uncover imagery processes in music. The psychological investigation of music is complicated by its temporality. 'Tune on the brain' phenomena and the role of imagery in music listening implicate the temporal mental representation of music. This temporal quality contributes to the suggestion that perception and imagery are in some ways analogous. To test this an experimental method focusing on the comparison of parallel imagery and perception conditions is required. Ideally this should involve a task that is musically meaningful in its correspondence to the sort of listening activity that might naturally occur. This chapter reports two experiments that use just such a technique, comparing performance on a priming task under parallel imagery and perception conditions.

In psychology, priming is generally understood to refer to an experimental technique in which a stimulus (the 'prime') is presented to subjects following which they are required to make a judgement concerning a target stimulus. The possible influence that the relationship of the target to the prime may have on participant behaviour can then be examined. For instance, if the prime context is closely related to its target and this facilitates task judgement (making it faster, or more accurate, or both), priming is said to have occurred. The purpose of the experiments reported in this chapter is to benefit from the implicit nature of priming methods to tap directly into the musical imagery of subjects for pitch and timing information in familiar music. The background theory and hypotheses of these experiments will first be explained, and the results and implications of each experiment will be summarised in the concluding section.

4.2 Empirical Precedents

Two particular fields of empirical research have influenced the design of the experiments in this chapter. First, the relationship of imagery to perception is in question. Imagery studies have a propensity to use perception tasks as a control against which to check imagery task data. 'The central contention is that if auditory imagery approximates audition, it will show the same dependence on perceptual attributes' (Intons-Peterson, 1992: 47). However, few experiments have made the relationship of musical imagery to perception their specific focus. As seen in Chapter Two, those that have, tend to belong to the area of neuropsychology. The second field of relevant musical research concerns expectations in music listening. With respect to this domain, priming techniques traditionally used in the area of perception are of particular interest.

4.2.1 Comparing Imagery and Perception

Dubiel (1999) argues against drawing a boundary between musical imagery and perception (see Chapter Two). Certainly, perceiving and imaging music seem to have a degree of mutual dependence, overlapping importantly in their everyday application to musical activity. How could this relationship be tested experimentally? Were experiments examining the relationship to find quantitatively different behaviour patterns from perceived music as compared with imagined music, this might constitute evidence to suggest that the two are situated along an experiential continuum. In other words, a functional equivalence would be found, with mental imagery for music a weak version of perception for the corresponding music. However, qualitatively different behaviour patterns might indicate that the relationship is more complex, allowing for the possibility that quite different processes are at work during musical imagery and musical perception[1].

In addressing this issue, it is beneficial to consider a few constituent parts of auditory experience at a time. For instance, information might be sought on the subject of the timing of musical imagery. Here a technique is required to gain an insight into what is essentially a private imagery experience, and to compare it to the perceived experience of musical time. Another feature of music about which little is known are the similarities of perceptual and imaginary experience in the judgement of intonation.

4.2.2 Matters of Musical Expectation

In listening to music, a recently heard passage affects the hearing of succeeding events, both in terms of abstract mental representation, and, in the case of familiar music, as a conscious image of events to come. Underlying the approach of priming experiments such as those reported in the current study is the need to examine any influence that exposure to the prime may have on subsequent behaviour. Such a scenario is consistent with the conditions inherent in music listening. As an example of priming techniques, McKoon and Ratcliff (1980) conducted a study of language in which they exposed participants to four unrelated sentences before asking them to study a word list and to press a button when they encountered a word that had already appeared in the sentences. When one such word was preceded by another word from the same sentence, reaction time was faster, constituting a priming effect. A more interesting priming effect however was found when a word was preceded by another from the same concept or proposition.

Most cognitive accounts of priming concur with the view that when a stimulus is processed, internal activation of a unit takes place, facilitating reactivation of the unit at the onset of a second, related, stimulus (Neely, 1977). Bharucha explains that: 'Events are . . . expected, implied, erroneously judged to have occurred, and rendered more consonant, to the extent that their mental representations have been activated in anticipation of their occurrence' (1987: 3). Exploring musical expectancy, Bharucha and Stoeckig (1986) describe priming tests in which participants compare major and minor (or 'in tune' and 'out of tune') and 'related'

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[1] Throughout the experiments of this and the next chapter, imagery is taken to mean an intentional memory image.

and 'unrelated' prime and target chords. As predicted, the finding was that 'Both major and minor in-tune targets were identified faster when related than when unrelated' (Bharucha and Stoeckig, 1986: 403). In 1987, Bharucha describes an effect of harmonic 'distance' between prime and target chord, as reaction time and error rate increased the further 'apart' in harmonic terms the chords were.

The principal advantage of employing priming methods as a research tool in memory is their implicit nature: 'in implicit memory tasks, participants are not explicitly asked to retrieve information about prior encounters with stimuli. Yet their performance is often affected by those encounters' (Ratcliff, Allbritton, and McKoon, 1996). In imagery research, an implicit memory task would require the generation of a mental image to perform the task, but direct attention away from it. This is particularly advantageous when attempting to avoid an over-reliance on conscious introspection about imagery phenomena. Priming studies divert the direct attention of a participant away from the variable or variables in question. Thus participant behaviour is considered to be a fairly immediate reaction to the variable of interest. An instance of this would be to ask experimental subjects to indicate whether a sounded musical note in a nursery rhyme context is 'on time' or 'out of time', while varying the metrical position of the target event. It might be predicted that notes 'on time' or 'out of time' on a strong beat of a bar would be detected more quickly than any timing alteration to a metrically weak beat.

It is important to reiterate the distinction of musical imagery *per se* from the sub-conscious activity involved in musical expectation/implication when listening to a piece of unfamiliar, or barely familiar music (see Chapter Two). The role of consciousness is the defining element in the meaning of imagery adopted in this thesis: people can 'hear' and are aware to some extent of their imagery, while the sub-conscious expectations learnt as features of a given musical style are taken to be different phenomena. Conscious musical imagery is the focus of the experiments described in the following section.

4.3 Experiment One – Pitch and Timing

The aims of this study were to explore the abilities of participants to hear timing and intonational change when imagining and perceiving familiar song melodies. In the timing task, subjects judged whether a target note occurred at the right time, or had been shifted forwards or backwards in time, whilst either listening to the melody or imagining it. The pitch task required subjects to judge whether a target note was in tune, or had been raised or lowered in pitch, whilst either listening to the melody or imagining it. Both tasks incorporated conditions testing for the possible effect of metrical or tonal hierarchy: in the timing task the target note was on either a strong, middle, or weak beat, and in the pitch task the target note was either the original melody note, or replaced by a note a fifth from the original, or a tritone away from the original. The hierarchy of metrical stability corresponds to the levels of strong and weak beat recognised in general music theory, and described by Lerdahl & Jackendoff (1983). The hierarchy of tonal stability was borrowed from stability values recognised both in music theory and psychology (see Krumhansl and Kessler, 1982). Imagery and perception conditions were identical in both timing and pitch tasks except that in the imagery condition participants heard only the first musical phrase, and imagined the continuation until the onset of a sounded target note.

One feature of priming techniques is the use of reaction time data. These may be precisely recorded, giving an accurate impression of the size of any priming effect, with minimal conscious manipulation by participants. On the subject of the priming of chords, Bharucha and Stoeckig claim that 'A reaction time paradigm should be able to detect any facilitation, whether conscious or not' (1986: 404). Measurement of the reaction time to make a decision about the target stimulus is the most common method of examining the priming effect, but a low incidence of task error may be another indicator.

4.3.1 Hypotheses

It is commonly believed that the perception of music is experienced as a more veridical musical experience than its image. Consequently, it was hypothesised that the immediacy of the perception condition should better facilitate the judgement of the target note's intonation or timing as compared with the more 'virtual' context of the imagery condition. Faster reaction times and higher success rates for the perception task as compared with the imagery task should reflect this facilitation. According to Lerdahl and Jackendoff's theory of tonal music (1983), musical events are related in a hierarchical fashion, such that they are variously stable in the musical texture. Events falling on strong beats of the bar, or pitches that are stable within their tonal context are represented at high levels of the hierarchy. Based on such theories of tonal and metrical hierarchy, it was further hypothesised in the current experiment that the stability of targets high in their respective metrical or tonal hierarchy will enable faster and more accurate judgement than targets that are lower in the metrical or tonal hierarchy.

1. Reaction times will be faster and success rates higher under perceptual rather than imagery conditions
2. Participants will be faster and/or more accurate in detecting changes in timing or intonation the stronger the note's position in the metrical or tonal hierarchy.

4.3.2 Participants

Sixteen participants with some degree of musical training volunteered (minimum qualification of A-level music), aged between 19 and 34 years old.

4.3.3 Materials

Two familiar melodies were selected: the nursery rhyme *Baa-Baa Black Sheep*, and the Christmas carol *Away in a Manger*. They were set in D major and F major respectively, so that the pitches would be within a fairly comfortable vocal range. MIDI sequences of these melodies were created and played in the experiment using a MIDI Synthesiser set to a piano sound. A degree of equivalence was sought between the two pieces in terms of metrical strength and distance into each piece of the notes to be altered for the timing task (the three target notes indicated by the box in figures 4.1 and 4.2). For the intonation task, one target moment was selected from each piece, as indicated by the star on the following score representations:

Figure 4.1
***Baa-Baa Black Sheep* score**

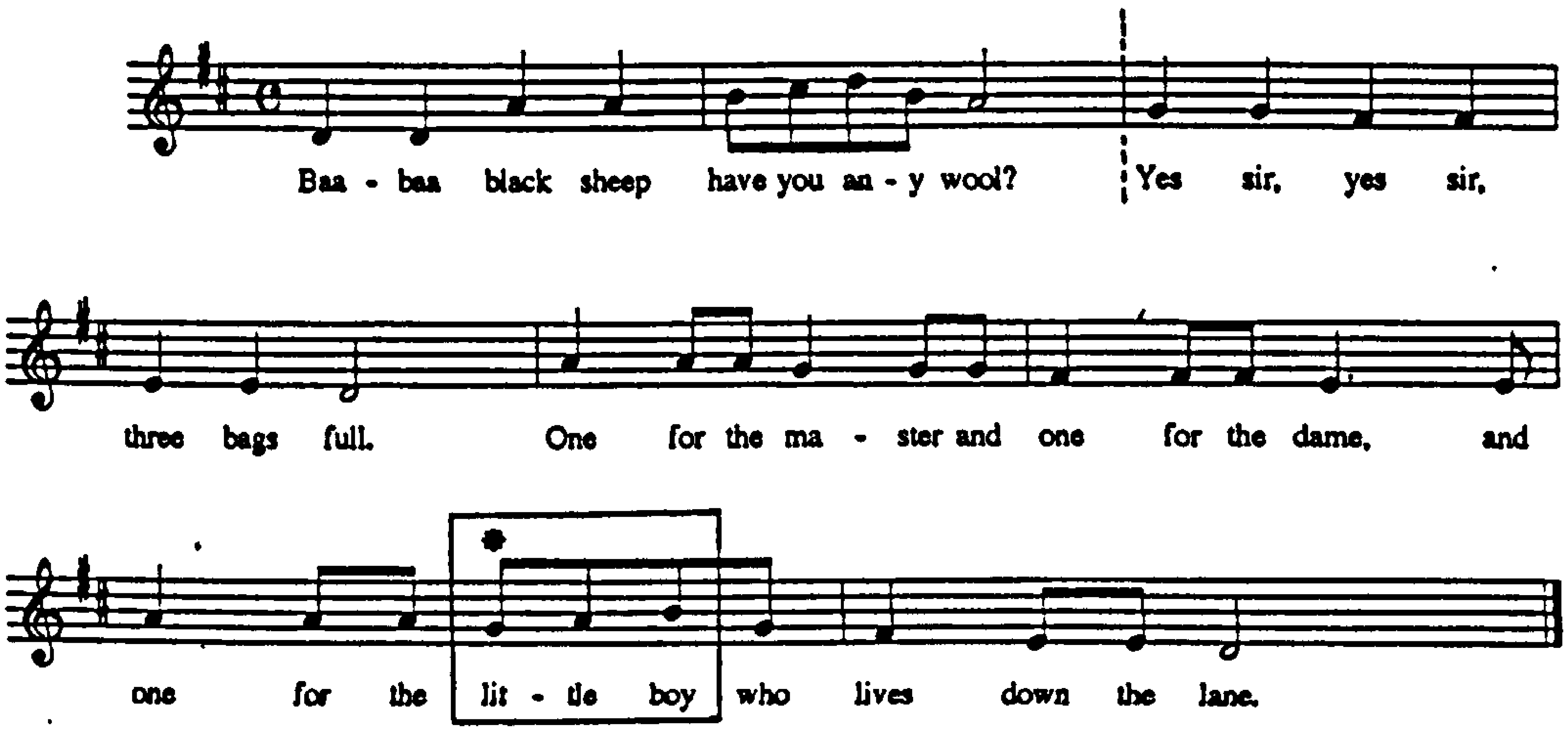
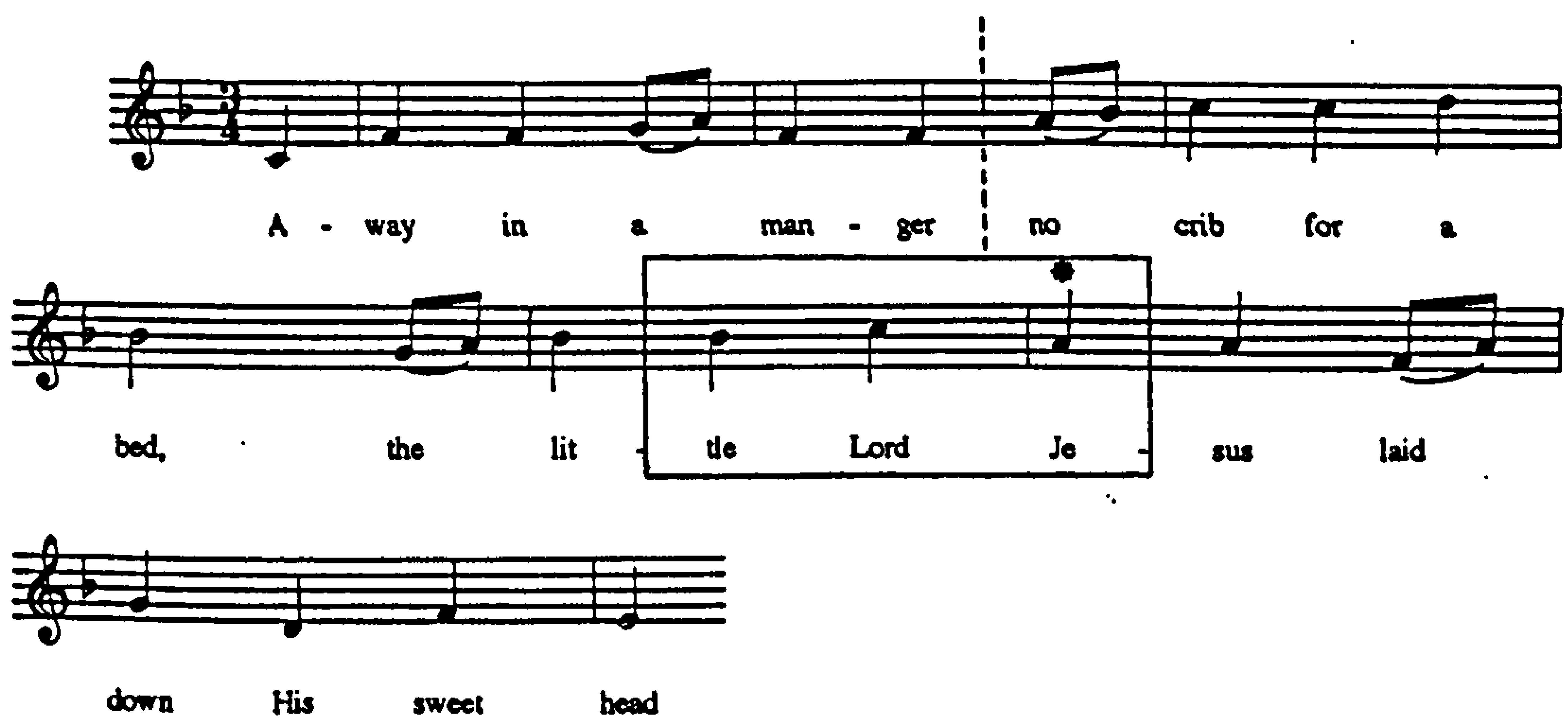


Figure 4.2
***Away in a Manger* score**



Initially sequences for the perception condition of each task were created with three different targets of different hierarchical strength in each piece. These were either "horizontally" selected for timing tasks, to include a strong, middle and weak metrical beat, or "vertically" altered for pitch tasks, to include the 'original' melody note, a note a fifth from the original, and a note a tritone from the original. Each of these metrical and tonal targets (three each per piece) were further manipulated, creating three variations per target: either early/on time/late for timing, or flat/in tune/sharp for intonation (see figure 4.3). 'Early' and 'late' targets were displaced by 200ms, exceeding the tolerated variation in timing as suggested by Longuet-Higgins (1987). 'Flat' and 'sharp' targets were displaced in pitch height by almost a quarter of a tone (chosen by the investigator to be perceptually effective).

Figure 4.3

Materials – Target note manipulations

	Pitch			Timing		
	Original	**Fifth**	**Tritone**	**Strong**	**Middle**	**Weak**
Note One	Flat In tune Sharp	Flat In tune Sharp	Flat In tune Sharp	Early On time Late	Early On time Late	Early On time Late
Note Two	Flat In tune Sharp	Flat In tune Sharp	Flat In tune Sharp	Early On time Late	Early On time Late	Early On time Late
Note Three	Flat In tune Sharp	Flat In tune Sharp	Flat In tune Sharp	Early On time Late	Early On time Late	Early On time Late

Counterpart sequences for the imagery task made use of those created for the perception task and 'silenced' all but the opening phrase and target note of each sequence. The resulting gap between the opening phrase and target note was to be filled with a mental image of the melody (the start of the imagery zone is indicated by a dotted line). No sequences continued after the onset of the target note. For pitch tasks a flashing icon on the computer monitor in front of the participants provided a visual indication of the onset of each melody note so as to provide a 'tempo track' for the participants' imagery.

4.3.4 Procedure

At the start of the experiment, each participant heard the original melodies four times each before being asked to confirm their familiarity with the music.

Participants made a pitch/timing judgement by pressing one of two keys on the computer keyboard. Key press was recorded using the 'MAX' software environment (Opcode). Having completed a questionnaire designed to elicit background information (including voice type, musical training, and whether the participant has normal hearing or perfect pitch), the procedure was explained and instructions as to which two keys to press were given (one for 'on time' or 'in tune', and one for 'out of time' or 'out of tune').

Subjects were instructed to respond as quickly and accurately as possible to target notes (see Appendix E for procedure transcript). Targets were identified by the corresponding song syllable, for example, in *Baa-Baa Black Sheep* participants might be asked to make an intonation judgement about the note that would normally coincide with the syllable 'lit-' of 'little'[2].

Instructions for the imagery components of the experiment requested that participants refrain from humming the melodies or beating the rhythms in any way. Indeed, sweets were distributed as a form of articulatory suppression. As target notes were labelled by song syllable, lyrics were provided (without the musical score) as a reference. Music was heard over headphones.

Participants were tested individually, but were arbitrarily allocated to one of four equally sized groups. These groups performed the timing and intonation, and imagery and perception blocks of the experiment in a counterbalanced order.

The experiment was split into timing and intonation halves. Within each half, participants performed separate blocks of perception and imagery trials. All trials within each of the perception and imagery blocks, and across the two pieces (3 targets x 3 manipualations per piece) were presented once and in random order. A total of eighteen trials per block were presented (2 x 2 x 18, or 72 trials in the experiment session). Six practice attempts for each block (condition) were allowed.

[2] Sound examples 1 and 2 correspond to this task for perception and imagery respectively.

4.3.5 Results

Data were collected and analysed according to a repeated measures design. Response timings (RT) and accuracy rates were gathered. Accuracy rates were assessed using a generalised chi-square, while RT for both 'right' and 'wrong' answers were pooled for analysis using a multifactorial ANOVA with one between-subjects factor (order) and five within-subjects factors (task, condition, piece, hierarchy, and position). The primary reason for including 'wrong' responses in the RT analysis was to enable direct comparisons between accuracy and response data to discern any speed/accuracy trade-off.

Piece

An effect of piece was found for accuracy data ($\chi^2 = 4.02, p < 0.05$) but not RT[3], with greater accuracy in *Baa-Baa Black Sheep* than *Away in a Manger*. There is no obvious reason for such an outcome. However, this result interacted with condition, such that the effect of piece was only discernible in the imagery condition, and not in the near perfect perception condition. In terms of accuracy (but not of RT), the effect of hierarchy was apparent for *Away in a Manger* ($\chi^2 = 14$, $p < 0.0005$) with more inaccurate performance at lower levels of the tonal or metrical hierarchy. This effect did not occur for *Baa-Baa Black Sheep*.

Task

No effect was found for the order of performing each condition (group allocation), consequently this variable was removed from the analysis, showing an effect of task for RT [$F_{1,12} = 31.6$; $p = 0.0001$]: pitch tasks took significantly longer overall to perform than timing tasks (see figure 4.4). This might indicate that pitch tasks were harder than timing tasks, but the accuracy data indicate that pitch tasks were completed substantially more accurately than timing tasks for the imagery condition. This suggests a speed/accuracy trade-off for imagery, with longer, more effective processing time taken for pitch tasks than timing tasks.

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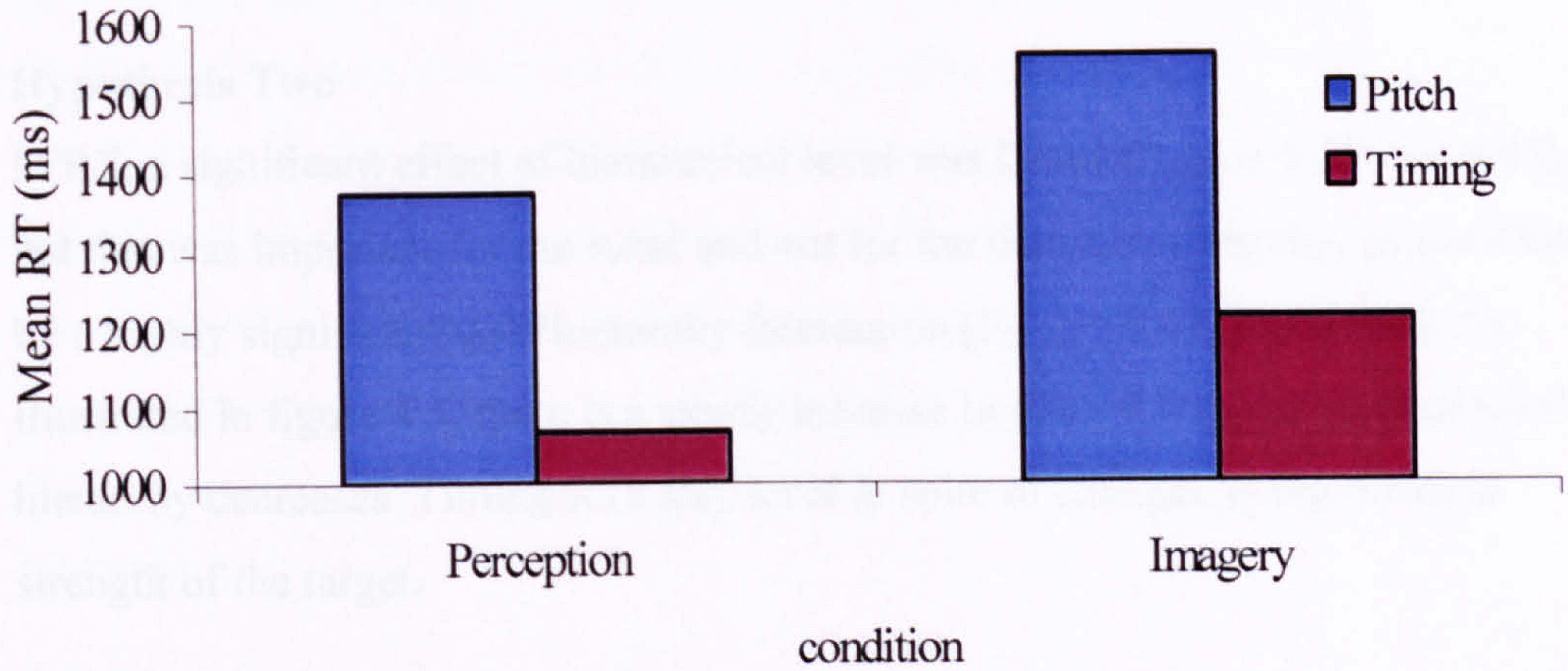
[3] An alpha level of .05 was used for all statistical tests

Figure 4.4
Task*Condition: Mean RT (ms)



While a comparison of pitch and timing data is of interest as regards the specific material and procedure employed in this experiment, there is little reason to assume that task performance on two such different musical parameters should be comparable.

Position

The factor 'position' describes whether a target is flat/in tune/sharp, or early/on time/late. An analysis of task*position was made for both RT and accuracy rates. This highlighted an unexpected difference in accuracy in the pitch task between judgements of flat and sharp targets ($\chi^2 = 7.2$, $p < 0.05$), whereby flat notes were more readily judged to be out of tune than sharp notes.

Hypothesis One

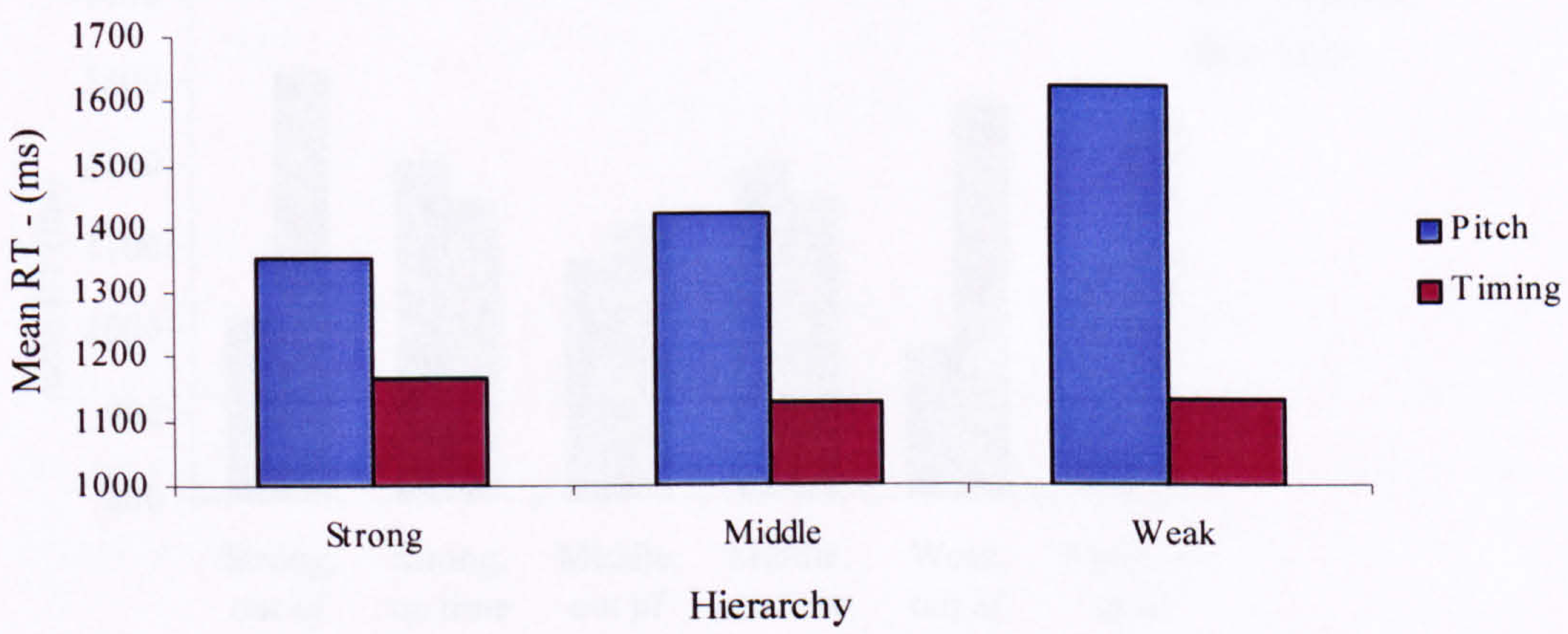
RT data revealed an expected main effect of condition [$F_{1, 12} = 18.77$; $p < 0.001$], in which imagery tasks took longer than perception tasks to perform. This result is highly significant, although the mean RT was only 140 ms (10%) longer for imagery tasks than for perception tasks. Accuracy rates showed that imagery tasks were also completed with significantly less success than perception tasks ($\chi^2 = 75.6$, $p < 0.001$) in line with the first experimental hypothesis. Note that accuracy under imagery conditions was above the 33% level of chance, suggesting that imagery did facilitate task performance in some way.

Hypothesis Two

In RT, a significant effect of hierarchical level was found [$F_{2, 24} = 4.39$; $p < 0.05$], but this was important for the tonal and not for the metrical hierarchy, as testified by a highly significant task*hierarchy interaction [$F_{2, 24} = 9.44$; $p < 0.001$]. As illustrated in figure 4.5, there is a steady increase in pitch RT as the level of tonal hierarchy decreases. Timing RTs stay level in spite of changes in the metrical strength of the target.

Figure 4.5

Task*Hierarchy: Mean RT (ms)



In terms of accuracy (but not of RT), hierarchy was found to interact significantly with condition, being significant for perception ($\chi^2 = 11.6$, $p < 0.005$) but not for imagery. For a post-hoc exploration of this pattern, and in order to emphasise the different nature of timing and pitch halves of the experiment, results have been separated out below for each.

4.3.5.1 Timing

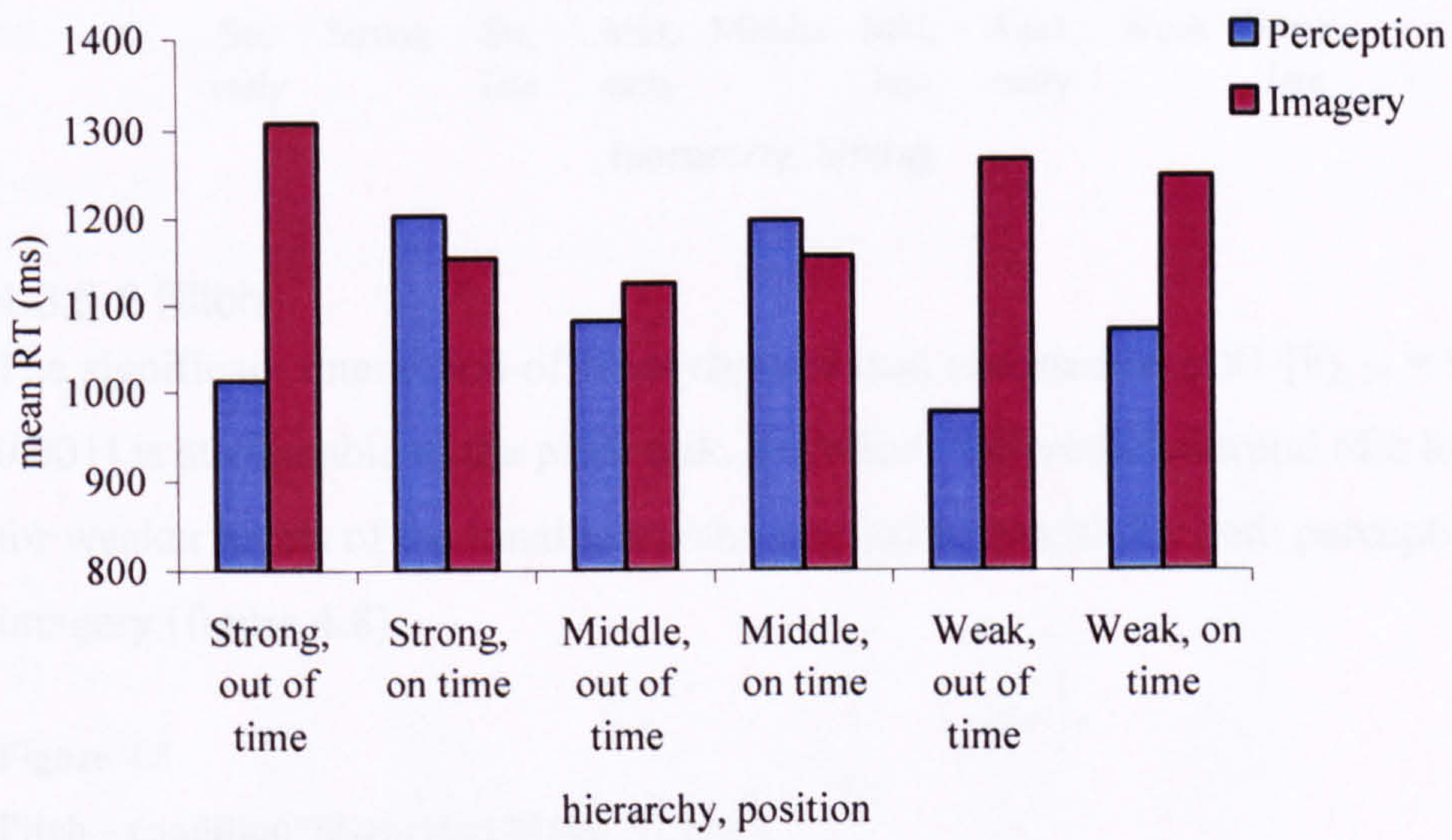
a) Perception

Beginning with RT data from the perception task, there is no evidence to support the hypothesis that weaker levels of the metrical hierarchy would elicit longer RT.

It can be seen in figure 4.6 that 'on time' targets produced marginally (though not significantly) longer RT for perception at the strong hierarchical level than 'out of time' targets (data collapsed across 'early' and 'late' positions). Given that two-thirds of all trials involved 'out of time' or modified target notes, subjects may have taken longer to realise the onset of an 'on time' target, which would arrive as a natural continuation of the melodic sequence. Paradoxically, the 'correctness' of the target reduces its salience, requiring participants to check or confirm their timing judgement, an operation that takes longer than simply noticing that a note is out of time. This effect is not marked for targets at the lower levels of metrical hierarchy.

Figure 4.6

Timing task - condition*hierarchy*position: Mean RT (ms)

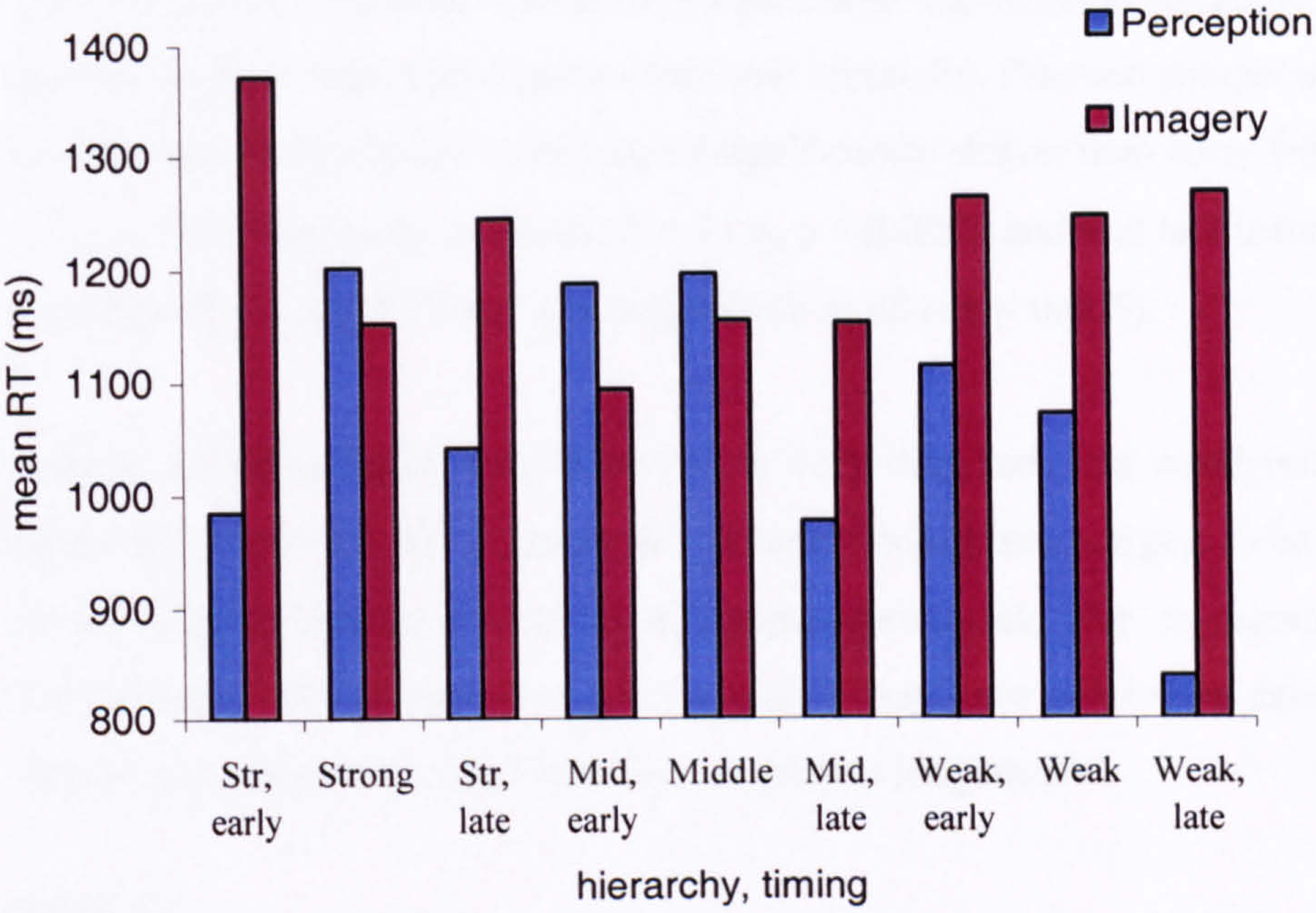


b) Imagery

It has been seen that, as anticipated, imagery tasks elicited generally longer RT than perception tasks. An apparent anomaly in imagery data is the slowness of response to early sounding strong metrical targets (see figure 4.7). Mean RT for this target is significantly longer than that for the 'early middle' target ($F = 4.3$, $p < 0.05$), a result that is difficult to account for.

Figure 4.7

Timing task – condition*hierarchy*position: Mean RT (ms)

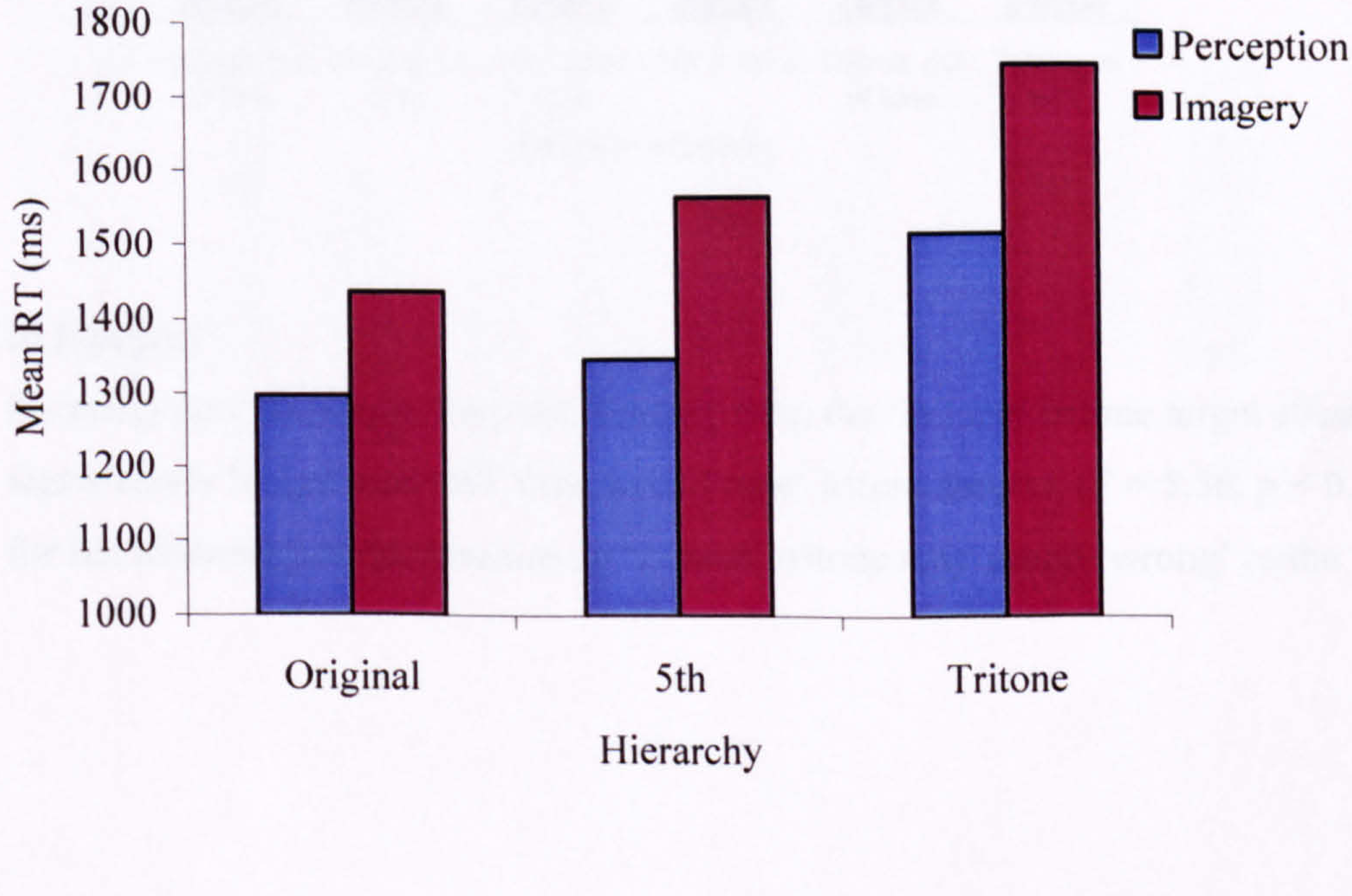


4.3.5.2 Pitch

The significant interaction of hierarchy and task reported on p.81 [$F_{2, 24} = 9.44$; $p < 0.001$] is attributable to the pitch task, for which the predicted trend of a longer RT for weaker levels of the tonal hierarchy applied to results for both perception and imagery (figure 4.8).

Figure 4.8

Pitch – condition*hierarchy: Mean RT (ms)

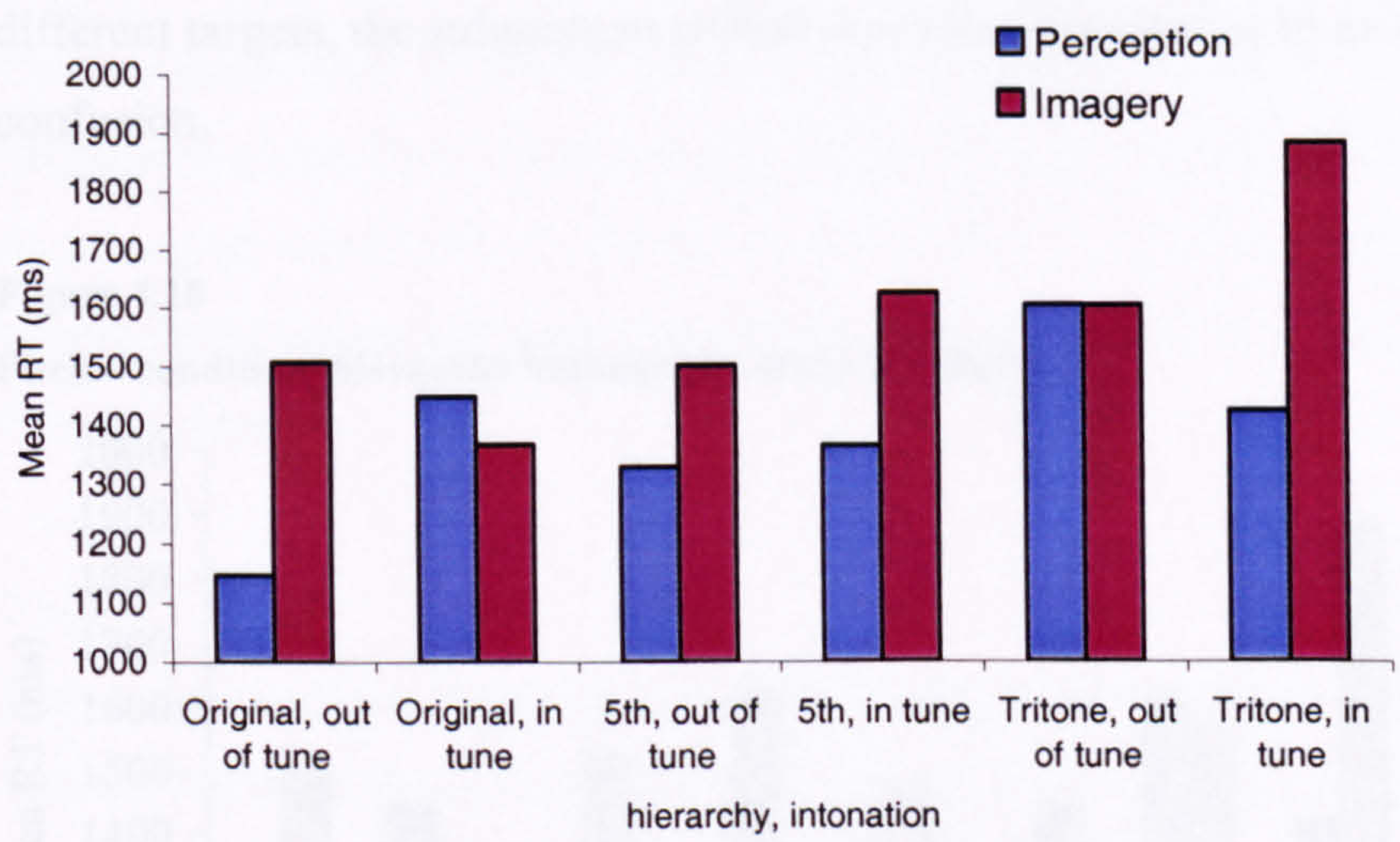


a) Perception

Overall, and as predicted, tritone targets produced significantly longer RT for perception than targets stronger on the tonal hierarchy. Planned comparisons showed that early tritones were judged significantly slower than early fifths, ($F = 4.7$, $p < 0.05$) and early originals ($F = 11.4$, $p < 0.005$), and that late tritones elicited significantly longer RT than late originals ($F = 12.1$, $p < 0.005$).

Because of its similarity with behaviour in the timing task, it is worth noting that figure 4.9 shows the RT tendency for 'in tune'/'out of tune' targets to be reversed for the original note and the tritone of the perception task. The 'correctness' of the strong hierarchical unaltered target ('original') may have reduced its salience, requiring participants to confirm their intonation judgement.

Figure 4.9
Pitch – condition*hierarchy*intonation: Mean RT (ms)



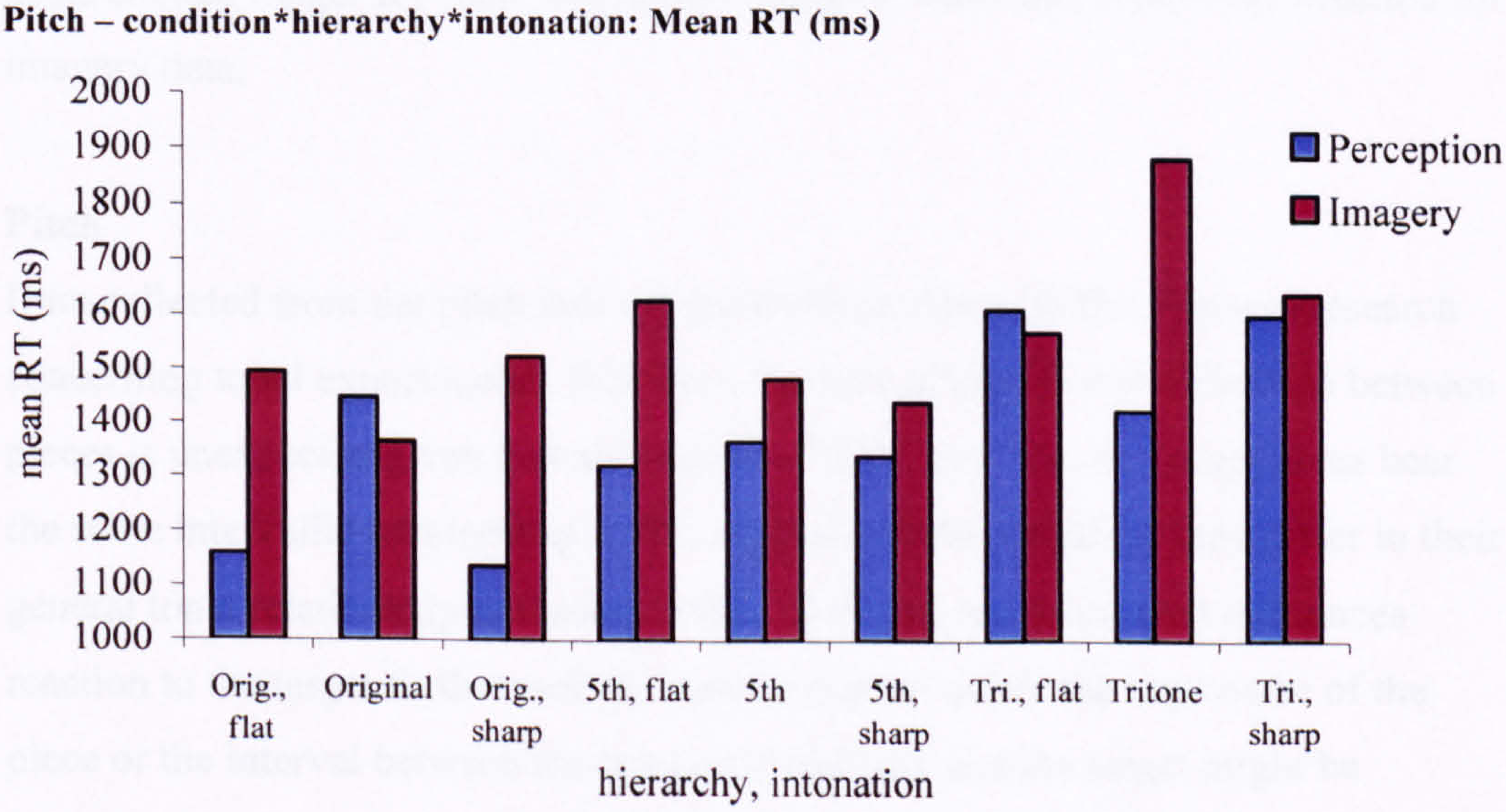
b) Imagery

Focusing now on results from the imagery task, the 'in tune' tritone target elicited a significantly longer mean RT than 'out of tune' tritone targets, ($F = 5.56$, $p < 0.05$ for flat tritones) perhaps because an 'in tune' tritone may sound 'wrong' to the listener, causing hesitation, while 'out of tune' tritones could be detected as such more readily (see figure 4.9). The RT for the 'in tune' tritone is significantly longer than that of the original ($F = 14.9$, $p < 0.0005$) and fifth ($F = 9.1$, $p < 0.005$) 'in tune' targets. This long RT is attributable to the potential confusion between tonal appropriateness (tritone) and intonation ('in tune') of the target.

As with timing task data, RT results (but not accuracy rates) from the imagery task tend towards an inverted pattern in relation to those for the perception task for strong hierarchical targets. In other words, 'out of tune' targets elicit slightly longer RTs than 'in tune' targets in imagery, and shorter RTs than 'in tune' targets in perception (figure 4.9).

Though not quite a significant difference, it is interesting from a methodological perspective to point out that the flattened fifth took longer to process than the sharpened fifth (see figure 4.10). One explanation is that the proximity in pitch of the tritone and the mistuned flat fifth helped to create this effect. By choosing different targets, the subsequent experiment (see below) tries to avoid this possible confusion.

Figure 4.10
Pitch – condition*hierarchy*intonation: Mean RT (ms)



4.3.6 Discussion

As predicted, perception elicited faster RT and greater accuracy than imagery, confirming hypothesis one. Evidence for a hierarchy of tonal strength was found, but none for a metrical hierarchy. This tonal hierarchy affected both perception and imagery task performance. Interestingly, RT results from the imagery and perception tasks formed complementary patterns for strong hierarchical targets. It is suggested that this reflects the different demands of each task: because the perception tasks require a comparison between the prime and target, paradoxically an unaltered target fitting well into the context might cause a delayed reaction because of the need to 'confirm' the perceptual judgement. In the imagery task, participants hearing the target in the context of their image might be more immediate in their detection of the correct response.

Timing

Overall, this first experiment displays several properties of imagery for timing. First, imagery tasks produced longer RTs than perception tasks. Also, as regards the judgement of 'on time' targets, participants were more accurate under perception than imagery conditions. In the perception condition, 'on time' targets for strong beats elicited longer RT than 'out of time' targets, while this effect was inverted for imagery data.

Pitch

Data collected from the pitch task are generally in line with theories and research concerning tonal expectancies. However, the lack of significant difference between pieces is unexpected given that although the 'fifth' and 'tritone' target notes bear the same intervallic relationship to the original in both melodies, they differ in their general tonal relationship to the key centre. Defining the prime that influences reaction to the target further complicates the matter: either the key centre of the piece or the interval between the last perceived note and the target might be important. It is reasonable to consider both elements to be influential. It is also worth considering Dowling and Bartlett's claim (1981) that for well-learned melodies such as the stimuli used in the present experiment, interval or chroma information is more readily retained than contour.

More needs to be done to test the distinct RT patterns found for perception and imagery conditions, as it seems that imagery may lead to qualitatively different (i.e. inverted patterns of 'in tune'/'out of tune' data for perception and imagery conditions depending on the hierarchical level) as well as quantitatively weaker performance. In order to refine problematic areas of methodology arising in Experiment One, (such as the perceptual proximity of a flattened fifth to a sharpened tritone, and the attempt to compare targets across two separate pieces), and to clarify hierarchical pitch effects, it was decided to follow this experiment with a priming investigation focused specifically and solely on perception and imagery for pitch.

4.4 Experiment Two - Pitch

A main aim of this subsequent study was to clarify the hierarchical pitch effects found in Experiment One. As in the previous pitch task, subjects were required to judge whether a target note was in tune or out of tune whilst either listening to a melody or imagining it.

This time a novel melody was used, introduced by means of a controlled familiarisation phase, as opposed to the more variable approach of assuming the familiarity of a well-known tune.

Again, the task incorporated conditions testing for the possible effect of tonal hierarchy. In Experiment One, one melody note in each piece was used as a target in the pitch task. This single note was substituted by a fifth or a tritone representing three different levels of hierarchical value (1 x 3). In this second experiment, three separate notes from the melody are used to counterbalance the tonal status of the original note against its substitutes (3 x 3). For example, a tonally less stable pitch in the original melody is substituted by a pitch that is tonally more stable. Therefore, three target pitches chosen for their relation to the tonic chord of the melody, close proximity to one another, and distance into the piece were selected. In order to avoid any confounding effect caused by the pitch proximity of a flattened fifth to a sharpened tritone (as in Experiment One), the targets chosen were separated by more than a tone, namely the tonic, submediant and tritone. Each of these target notes was either left unaltered as the original melody note, or substituted with one of the remaining from the tonic, submediant, tritone options (see figures 4.11 and 4.12 below).

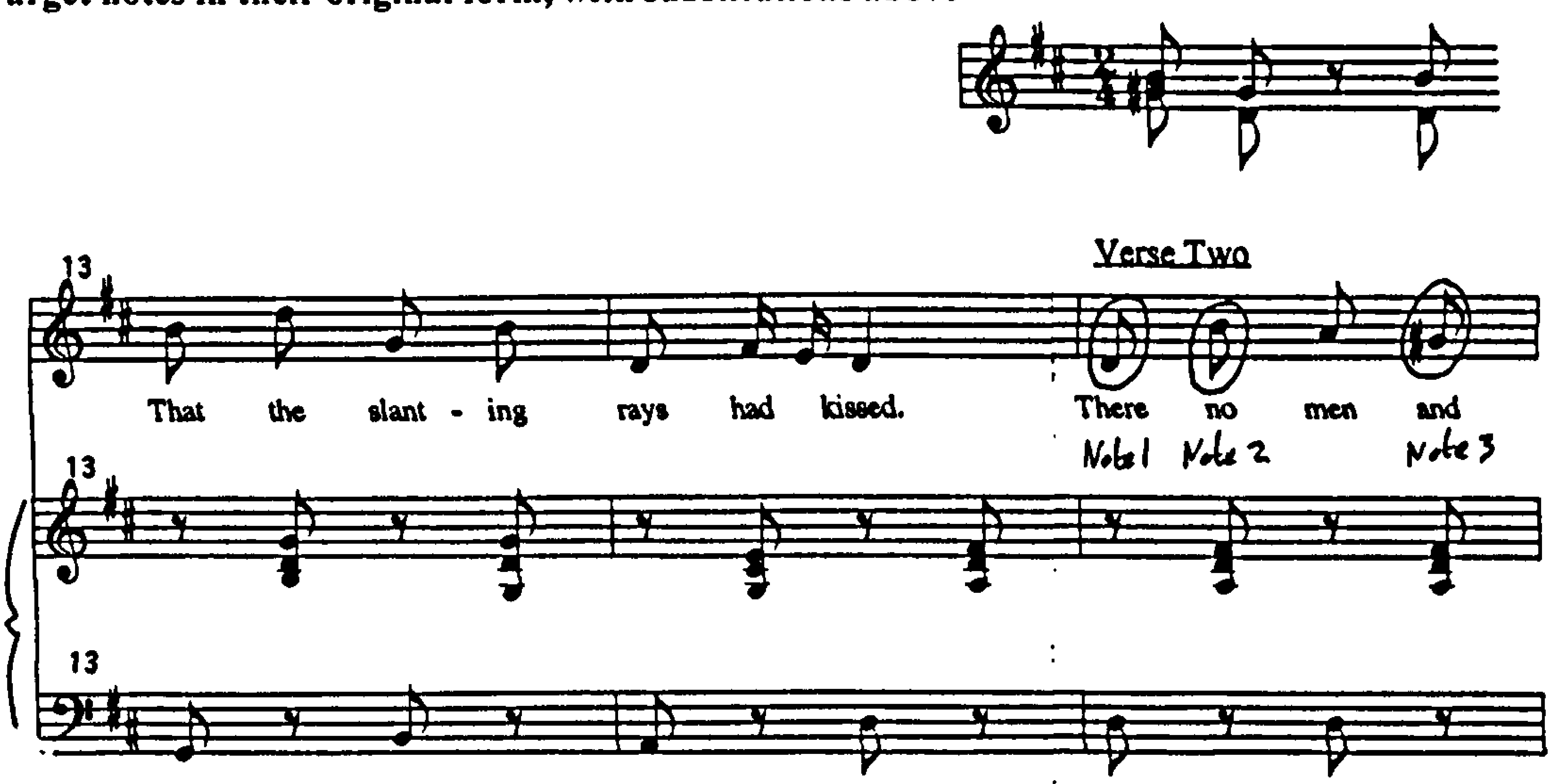
Figure 4.11

Table of 3 x 3 target types

	Original target	Substitution	
	Original	***Hierarchy level 2***	***Hierarchy level 3***
Note 1	tonic	submediant	tritone
Note 2	submediant	tonic	tritone
Note 3	tritone	tonic	submediant

Figure 4.12

Target notes in their original form, with substitutions above



A possible criticism of the earlier experiment is that judgements in the imagery condition were based solely on the opening extract of music and not on an intermediate mental image. In order to control for this possibility, an additional 'inference' condition was introduced, before participants undertook the familiarisation phase. This presented trials as in the 'imagery' condition (three separate notes of the triad which begin the piece were heard, silence followed, and then the target note) but gave subjects no directions to imagine a melody, simply asking for an isolated intonation judgement for the target note. This precaution was to test for the effect of merely judging intonation based on the opening tonal triad arpeggio.

4.4.1 Hypotheses:

1. Reaction times would be faster and success rates higher under perceptual rather than imagery conditions
2. Reaction times would be faster and success rates higher under imagery rather than inference conditions

An additional aim of this experiment was to explore the finding from Experiment One that the position of a note in the tonal hierarchy affected participant response, but that this was different for perception and imagery conditions. A replication of this result predicts the better detection of change in intonation the stronger the note's position in the tonal hierarchy under perception conditions, but less so for imagery and inference conditions.

4.4.2 Participants

Eighteen music students in the first year of their undergraduate course at university volunteered to take part in the experiment. None of these participants had taken part in Experiment One.

4.4.3 Materials

A Schubert song (*Heidenröslein*, Op. 3, no. 3) for female voice and piano was modified in the following way:

- Bar 17 of the original song (which becomes bar 15 of the modified score, shown below in figure 4.13) incorporated tonic, submediant, dominant and tritone quavers in place of the original repeated mediant quaver note pattern. This was to constitute the 'target' bar.
- Bar 1 was altered so as to resemble closely the target bar, so that the tonic chord of the key was presented as an arpeggio from the beginning.
- Bar 5 was also altered to retain the salient tonic/mediant pattern now established.
- Verse three and the two-bar piano interlude between verses were omitted for the sake of brevity.

- As in the previous experiment, targets were lyrically identified, requiring an English alternative to the original German text. Lyrics were adapted from Mary E. Coleridge's poem *A Fairy Town.*

Figure 4.13 shows a score of the material that was used.

Figure 4.13

Fairy Town

(continues...)

This piece was chosen for its rate of harmonic progression, which is such that the entire target bar unambiguously comprises a root tonic chord. It was also felt to be sufficiently melodic to facilitate 'inner hearing'. The original song is well known among classical music singers, and this could entail interference between memory images of the piece. All participants in the experiment were asked to indicate their familiarity with the original, and the intensity of the familiarity phase of the experiment was deemed sufficient to ensure that the 'correct' version was learned[4].

The song was digitally recorded, creating a cassette version for use by participants in the familiarisation phase of the study (sound example 3). While the music on the cassette was of a live performance by singer and pianist, MIDI sequences of the vocal line melody only were created for use in the experiment sessions. These were played to subjects using a MIDI Synthesiser set to a piano sound.

Sequences for the perception condition of each task were created with three different targets, and allocated three variations each for intonation: flat/ in tune/ sharp. Counterpart sequences for the imagery task and inference condition borrowed those created for the perception task and 'silenced' all but the opening phrase and target note of each sequence. Figure 4.13 shows the start of the imagery zone marked by a dotted line. The resulting gap between the opening phrase and target note was either to be filled with a mental image of the melody ('imagery') or silence ('inference'). No sequences continued after the onset of the target note. A flashing icon on the computer monitor in front of the participants provided a visual indication of the beat in imagery and perception conditions. This was not provided in the inference condition in which participants had no frame of reference apart from the tonic triad of the melody. Subjects made a pitch judgement by pressing one of two keys on the computer keyboard, recorded using the 'MAX' software environment (Opcode).

[4] The decision to use only one piece of music arose from the practical need to control the tonal context at a very local level of detail. It should be noted that it is consequently difficult to generalise the results to other pieces of music.

4.4.4 Procedure

Volunteers were tested individually and in two sessions. Session one, lasting about 20 minutes, comprised the inference condition and distribution of a cassette of the stimulus song. Between the first and second sessions, an unsupervised familiarisation phase took place, during which time participants listened to the music on the cassette, noting the date and time of each hearing. A minimum of ten hearings was required, though participants were encouraged to listen many more times if they wished.

Session two lasted about one hour. Before it began, participants were asked to sing the beginning of verse two of the song (recorded by a portable DAT machine) so as to confirm sufficient internalisation of the melody, and to look for evidence of correct pitching of the starting note.

The test procedure was explained and instructions as to which two adjacent response keys to press on the computer keyboard ('I' for 'in tune' and 'O' for 'out of tune') were given. Subjects were asked to respond as quickly and accurately as possible to target notes. Instructions for the imagery components of the experiment requested that participants refrain from humming the melodies or beating the rhythms in any way. As target notes in session two were labelled by song syllable, lyrics were provided (without the musical score) as a reference. Participants heard the music over headphones.

Between the imagery and perception conditions (or vice versa) of session two, a three minute break was allowed, and participants used this time to fill out the same questionnaire used in Experiment One, designed to elicit general background information.

The debrief and further questions at the end of the experiment were also recorded on DAT in order to register any feedback and qualitative descriptions of the experience of imagery. Questions asked how well participants had previously known the original Schubert song, what music they had heard prior to participating in the experiment, and how detailed their imagery for different musical dimensions had been.

Participants were assigned to two groups corresponding to the counterbalanced order of performing perception and imagery blocks:
Group A - Inference, Perception, Imagery (n=9)
Group B - Inference, Imagery, Perception (n=9)

All trials within each of the inference, perception and imagery blocks (3 x 3 x 3 trials, corresponding to three target, three hierarchy and three tuning manipulations) were presented once and in random order. Thus twenty-seven trials were presented in the first, inference, session, and a total of fifty-four trials were presented in the second experiment session (perception and imagery blocks). Three practice runs for each condition were allowed.

4.4.5 Results
As in Experiment One, no effect of group was found (as measured by RT). Those doing the imagery task before the perception task were not disadvantaged by having heard the melody on average twenty-eight times less than those in the other group, implying that participants had committed the song to memory sufficiently.

Quantitative data were analysed according to the same methods as in Experiment One: ANOVA (5-factor repeated measures design, with 'group', 'condition', 'target', 'hierarchy' and 'tuning') for RT measurements, and generalised chi-square for accuracy rates.

Hypotheses One & Two
The predicted overall effect of condition (inference, imagery, perception) was observed in RT data [$F_{2,24} = 17.9$; $p = 0.0001$], as shown in figure 4.14. A significant effect of condition was also observed for accuracy rates ($\chi^2 = 62.8, p < 0.0005$, see figure 4.15) but accuracy in performing imagery and inference tasks

was not found to be statistically different. In general, these findings would seem to confirm the quantitative differences between behaviour in perception and imagery tasks found in the previous study.

Figure 4.14
Condition: Mean RT (ms)

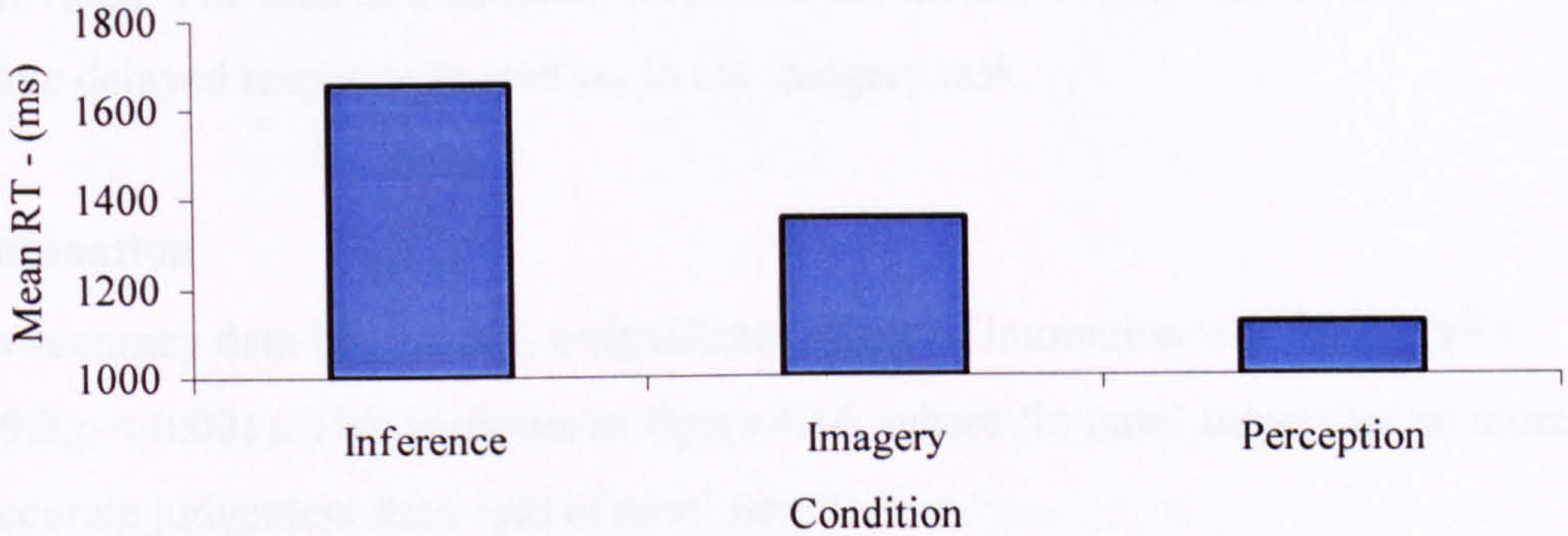
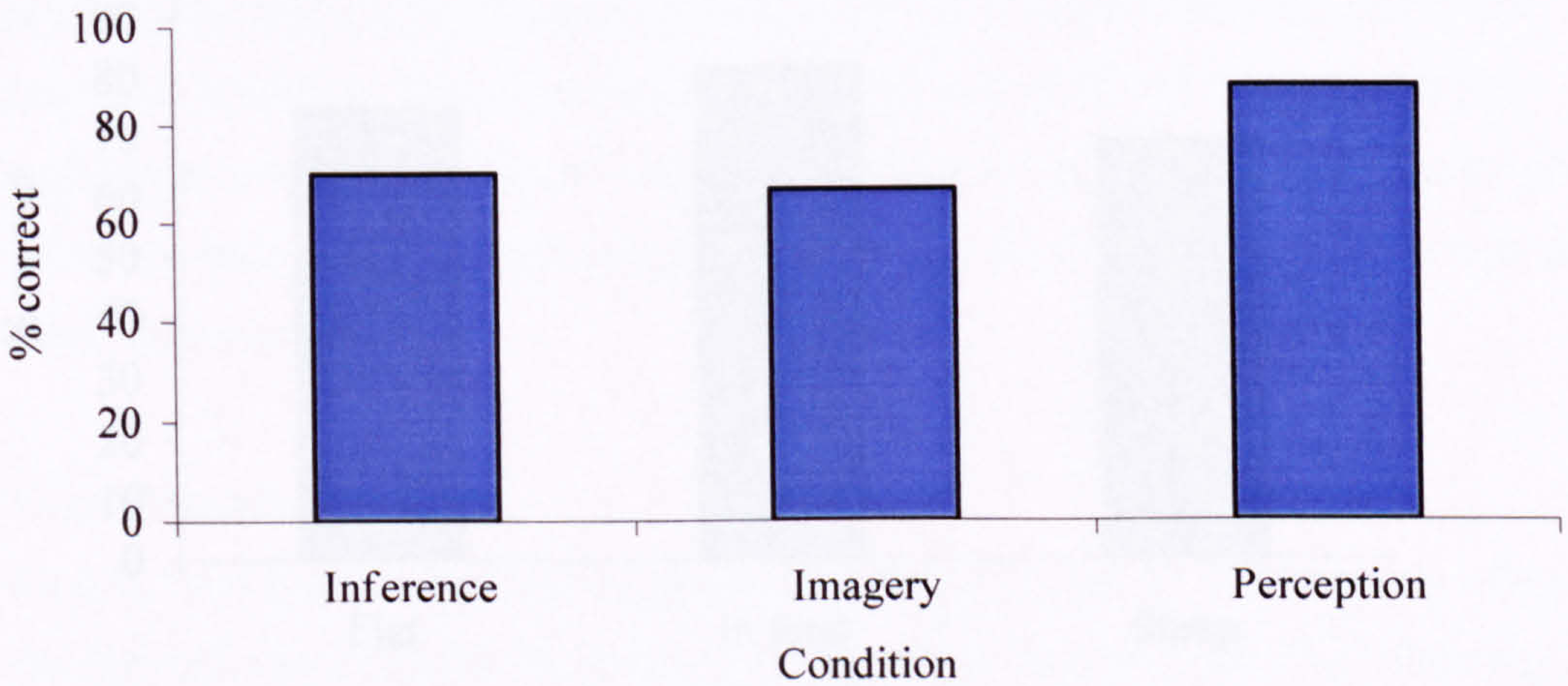


Figure 4.15
Condition: % accuracy

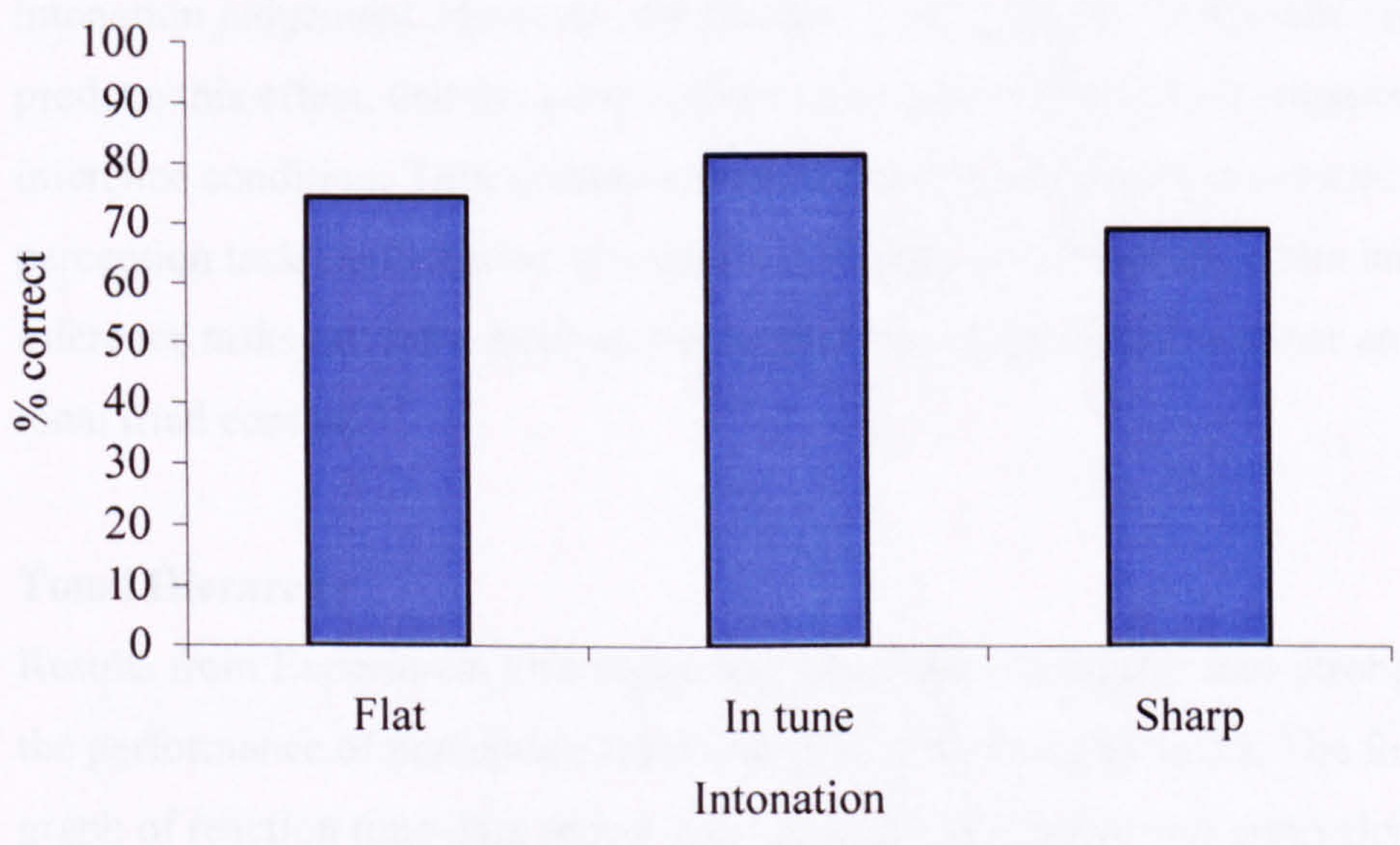


Imagery tasks were completed significantly faster than inference tasks ($p < 0.005$), suggesting that participants were complying with instructions to imagine the music, and that imagery had the effect of speeding up responses. However, as accuracy was not greater for imagery tasks than inference tasks this evidence is problematic in determining the veridicality of a musical image. Imagery may not have been sufficiently strong to aid task performance, or may even have hindered response. The task was difficult: participants had to image the music for the long duration of 30 seconds. Moreover, the inference condition might be expected to produce long RTs: the only information participants had in the inference condition was a wait of approximately 30 seconds' duration, while in the imagery task a song syllable was provided. The lack of a temporal anchor in the inference task may be expected to have delayed response in relation to the imagery task.

Intonation

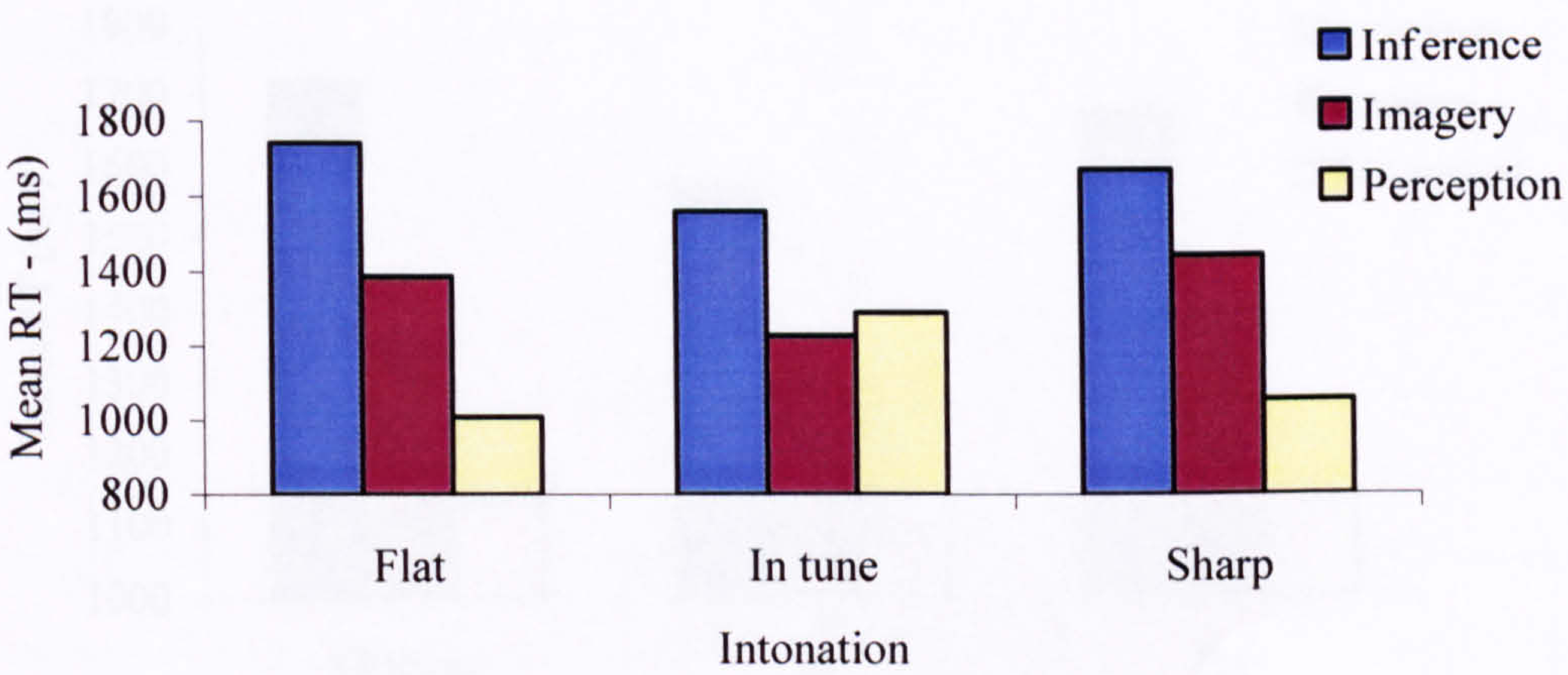
In accuracy data but not RT, a significant effect of intonation was found (χ^2 = 19.3,$p < 0.001$). This is shown in figure 4.16, where 'in tune' targets led to more accurate judgement than 'out of tune' targets.

Figure 4.16
Intonation: % accuracy



The qualitative differences discovered between imagery and perception results in the previous study are replicated. This can be seen in the highly significant condition*intonation interaction of reaction time results [$F_{4, 48} = 4.3$; $p = 0.005$] plotted in figure 4.17.

Figure 4.17
Condition*Intonation: Mean RT (ms)



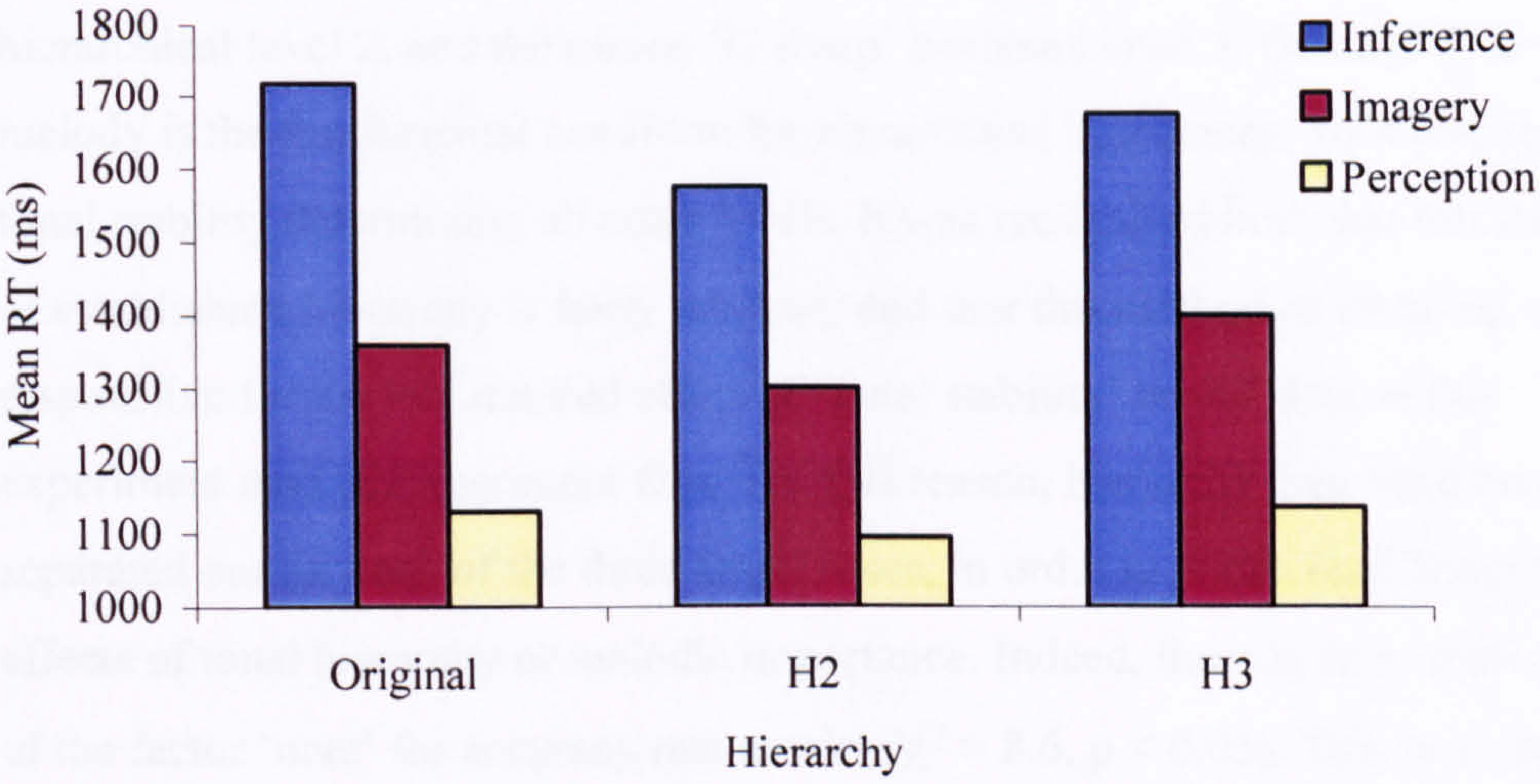
While ‘in tune’ targets under the perception condition elicit longer RT than ‘out of tune’ targets, the reverse is true of imagery and inference conditions. What is causing such different behaviour following perceived rather than imagined or absent music? It is possible that the ‘correctness’ of an in tune target following a perceived prime reduces its salience, requiring participants to ‘double check’ their intonation judgement. However, the imagery task lacks the veridicality required to produce this effect, and the same appears to be true of participant response to the inference condition. Task demands seem to elicit two different processes: in the perception task confirmation of a note’s suitability is demanded, while imagery and inference tasks ask for a more active comparison of the target to either an image or tonal triad context.

Tonal Hierarchy

Results from Experiment One suggested that a tonal hierarchy may strongly affect the performance of perception tasks, but less so for imagery tasks. The following graph of reaction time data shows that hierarchy as a factor was equivalent across all three task conditions (figure 4.18).

Figure 4.18

Condition*Hierarchy: Mean RT (ms)



This result is unlike that found in Experiment One. However, the method of attributing hierarchical status in this experiment has an important bearing on the interpretation of these data. All three targets in their original form occur above a root tonic triad. Their original note status was taken to be their highest hierarchical level, given that these pitches would be an expected part of the melody. Figure 4.19 serves as a reminder of each target's substitute.

Figure 4.19

Target notes in their original form, with substitutions above

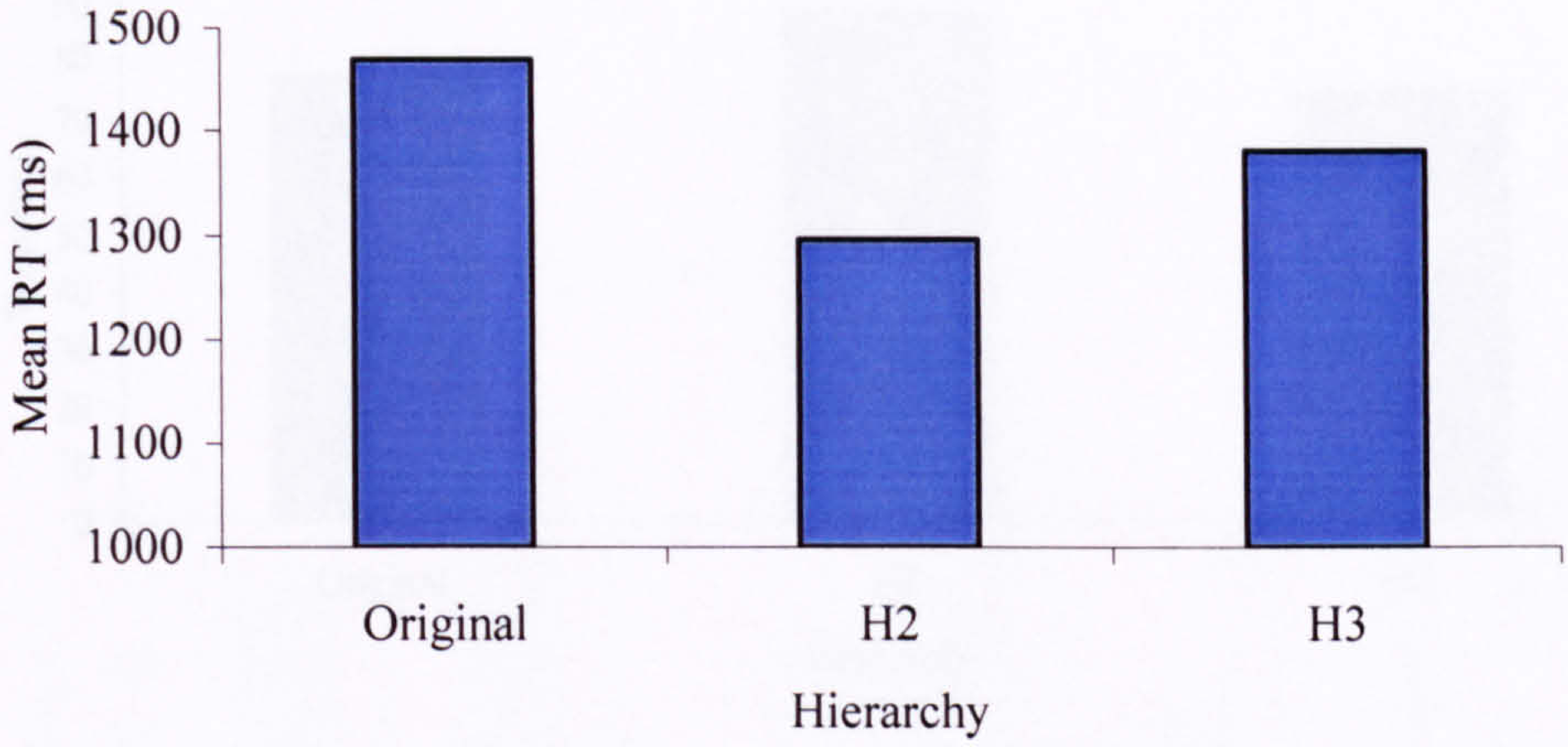
Note Two is originally a 'B' in the melody, and this is thus defined as its highest level of expected stability. Consequently, the harmonic root 'D' would be accorded hierarchical level 2, and the tritone 'G sharp' becomes level 3. Belonging to the melody is the fundamental condition for hierarchical supremacy, with traditional tonal stability determining all other levels. It was recognised both that this method of establishing hierarchy is fairly arbitrary and that this method of labelling may be responsible for the less marked effect of 'tonal stability' on RT data in this experiment than in Experiment One. For this reason, hierarchy data have been separated out for each of the three target notes, in order to understand better any effects of tonal hierarchy or melodic importance. Indeed, there is an overall effect of the factor 'note' for accuracy rate results ($\chi^2 = 8.6$, $p < 0.05$). This is evident in the high level of accuracy at Note 3. It is possible that this target note's melodic position was responsible for such an outcome, as part of a downward scale in its original form, and as a leading-note.

A significant interaction [$F_{4,48} = 3$; $p < 0.05$] of note with hierarchy for RT data was found. Such a result is not surprising given the previous explanation of the method of labelling hierarchical level.

As in Experiment One, no globally significant effect of hierarchy was found for RT data, but when timings for notes 1, 2, and 3 were separated, the anticipated effect of tonal hierarchy on speed of response was significant for Notes One and Three ($F_{2,28} = 3.5$; $p < 0.05$ for Note One, $F_{2,30} = 5.15$; $p < 0.05$ for Note Three). Interestingly, note 2 in its original form of 'B' (a diatonic target, but not in the chord) elicited very slow RT (significantly slower than mean RT for the middle hierarchical level, $p < 0.05$, see figure 4.20).

Figure 4.20

Note 2 Hierarchy: Mean RT (ms)

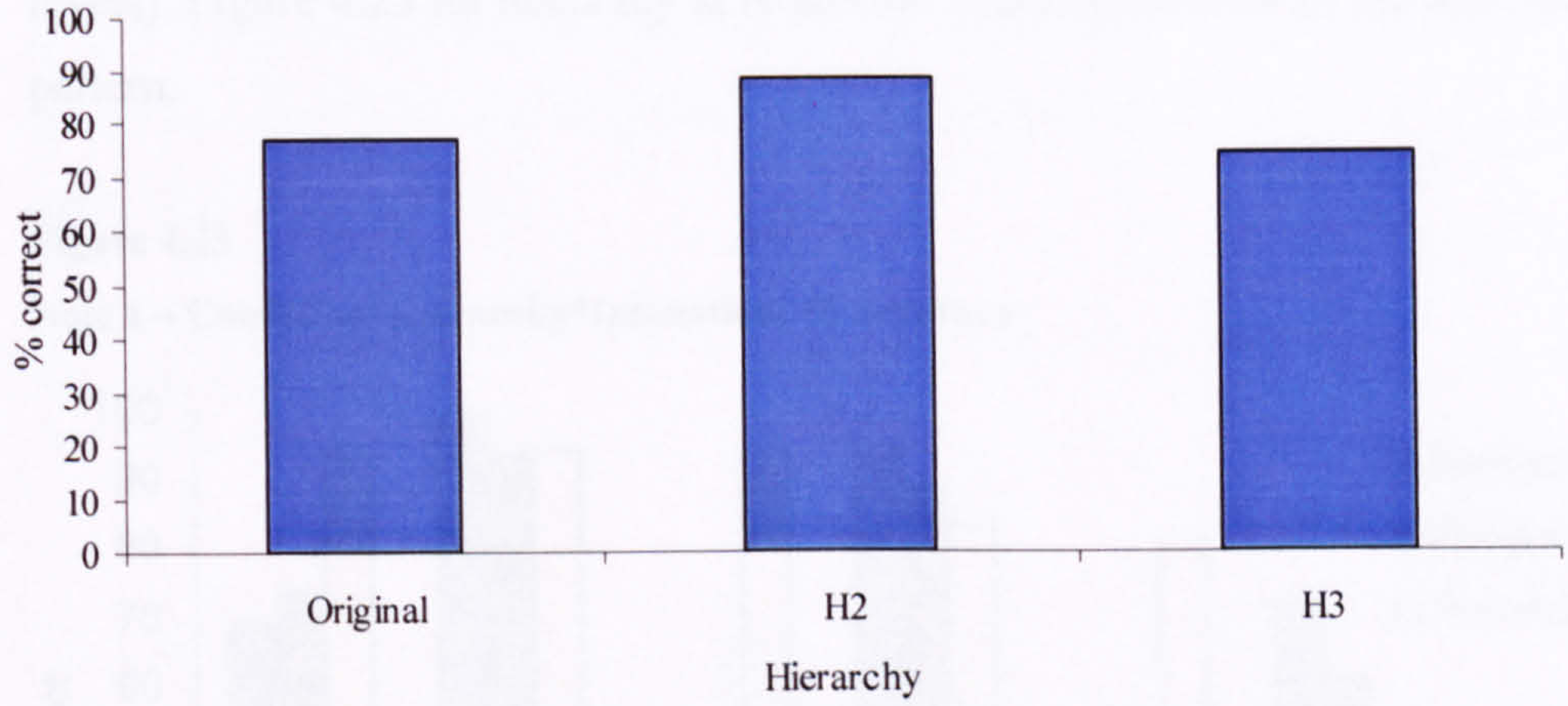


Despite this target corresponding to the original melody note, it might, in part, have been subordinated in stability to the prevailing harmony of the bar.

Hierarchy was a significant factor for accuracy data ($\chi^2 = 31.3$, $p < 0.0005$). The significant pattern of accuracy rates for Note 3 ($\chi^2 = 11.1$, $p < 0.005$, see figure 4.21) is not in the anticipated direction, as the original melody note 'G sharp' elicited a slightly more accurate response than the so-called weakest level of the hierarchy, the 'B'. The reason for this tendency is that melodic rather than tonal hierarchy has to a certain extent taken precedence, unlike data from other note positions in which tonal hierarchy rather than melodic origin was the stronger factor. However, the tonal centre 'D' is represented by the middle hierarchical level (H2) which for this note produced the most accurate response.

Figure 4.21

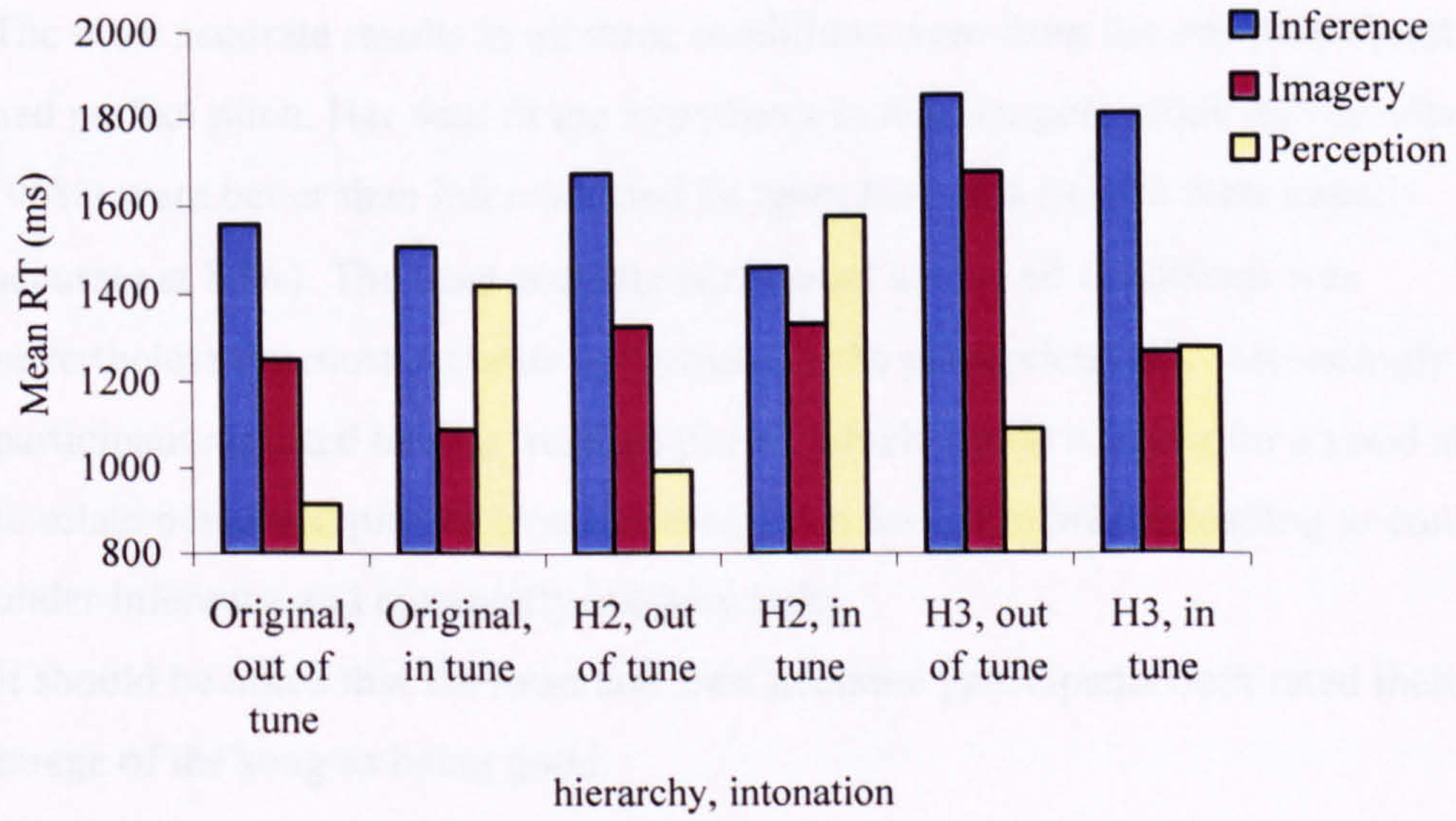
Note 3 Hierarchy: % accuracy



In order to examine in detail the interaction of condition and intonation with hierarchy, it has been necessary to separate data for each note. In the remainder of this section, data for Note One will form the focus of the analysis. The following graph illustrates RT data for condition, hierarchy, and intonation at Note One.

Figure 4.22

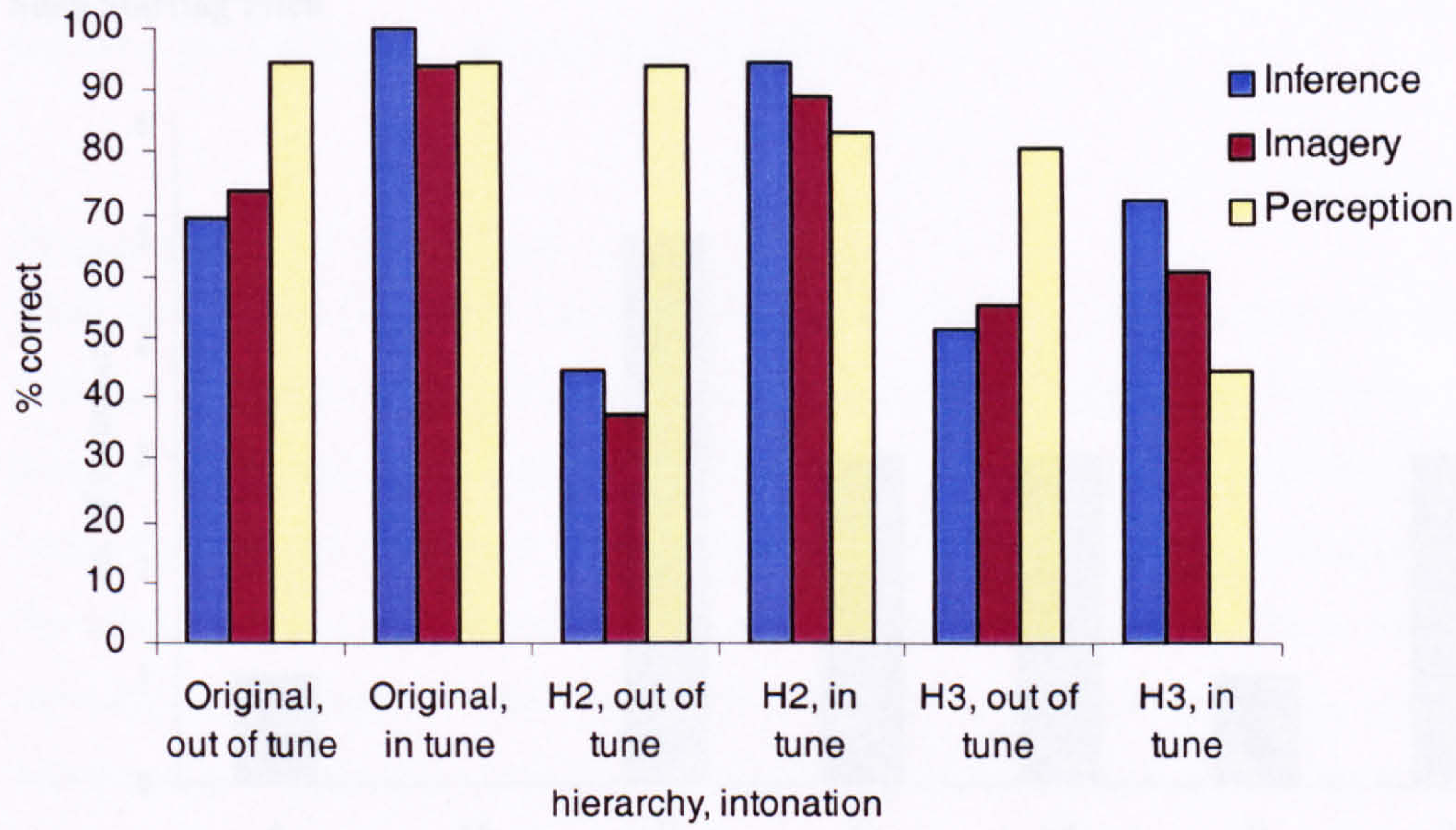
Note 1 Condition*Hierarchy*Intonation: Mean RT (ms)



Though not statistically robust, the tendency for the now familiar inversion pattern of perception and imagery RT can be seen (at original and hierarchically weak levels). Figure 4.23 for accuracy at Note One is also indicative of the anticipated pattern.

Figure 4.23

Note 1 – Condition*Hierarchy*Intonation: % accuracy



Most and least accurate

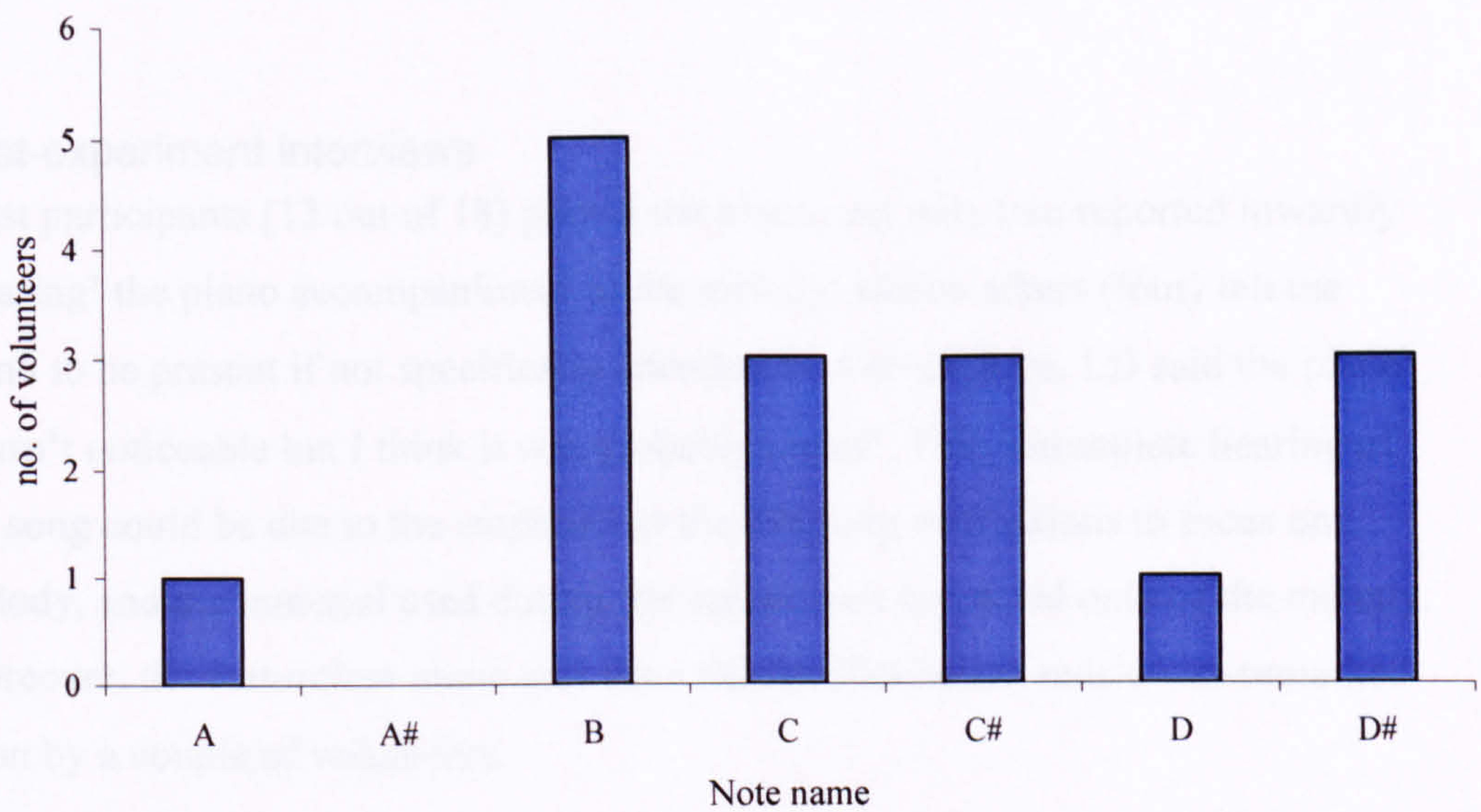
The most accurate results in all three conditions were from the one participant who had perfect pitch. Her data fit the hypothesis in that her perception task results (96%) were better than inference and imagery task data (which were equally accurate at 85%). The least accurate participant across all conditions was nevertheless the most accurate participant in the perception task. Interestingly this participant reported having 'relative pitch', which would account for a good ability to relate perceived pitches to each other, but a loss of reference leading to confusion under inference and apparently imagery tasks.

It should be noted that the most and least accurate participants both rated their image of the song as being good.

Starting pitch

Participants sang back the music before the main experiment session as an indicator of successful internalisation. D4 was the correct starting pitch, and only one participant spontaneously sang back on this tone (not the volunteer with perfect pitch who began on C#4).

Figure 4.24
Sung Starting Pitch



As shown in the above graph, most participants sang flat in relation to the original pitch. There is no apparent reason for this trend towards flat image production. Furthermore, there is no obvious link between voice type and chosen starting pitch.

4.4.6 Discussion

Experiment Two has confirmed the effect of condition found in the previous experiment, whereby perception tasks are performed faster and more accurately than imagery tasks. Condition as a factor in reaction time was more significant than in the previous experiment because of the addition of an inference task in which response was at its slowest. Interestingly, accuracy was no better in the imagery task than in the inference condition. The overall effect of tonal hierarchy on accuracy data (with lower levels producing more errors) from Experiment One was confirmed by Experiment Two after separation of data from the three target notes. As in Experiment One, this significance was not apparent for reaction time. Intonation was important for results in both experiments: a feature of both sets of data was that imagined 'in tune' targets led to fast response times, unlike perceived 'in tune' targets for which the 'correctness' of the target might have caused a delay while participants confirmed their judgement. This interaction of condition with intonation is confirmed to be important as a source of qualitative differences between perception and imagery task response.

Post-experiment interviews

Most participants (13 out of 18) played the piano, yet only two reported inwardly 'hearing' the piano accompaniment to the melody, whilst others (four) felt the piano to be present if not specifically attended to. For instance, LD said the piano 'wasn't noticeable but I think it was probably under'. This incomplete hearing of the song could be due to the emphasis in the listening instructions to focus on melody, and the material used during the test session consisted only of the melody. Moreover, the featureless piano part from the familiarisation music was remarked upon by a couple of volunteers.

When asked to elaborate on the dimensions of their imagery, some participants spoke of the mind as being a source of music. It was as if their imagery was truly felt to come from the mind, and to be played from the brain, functioning similarly to a 'real' sound source. For instance, AE said that 'it was just from in my head'. CA provided an interesting account of her imagery experience, likening the sound to distant music[1].

> It was like I was listening to it from a long way away . . . . At first I was just trying to imagine the pitch, but then I tried to remember the voice of the person singing it. I found that easier to remember.

[1] Verbatim evidence in this thesis has been edited to clarify the text, removing hesitations and stuttering where they occur.

Here she indicates that imaging the timbre of the singer's voice was an aid to her memory of the song. This points the way to an aspect of musical imagery about which very little is known, namely the veridicality of tone-colour in inner hearing.

4.5 General Discussion

Employing imagined melodic primes is an unprecedented experimental technique. Krumhansl and Kessler (1982) did examine the internal representation of the key development of chord sequences, but these were artificially contrived stimuli remote from 'normal' music listening conditions. The analysis of these results would be helped by a clearer notion of what exactly constitutes the experimental prime. Unfortunately, as sequences rather than chords were used, no direct means of pinpointing a priming moment are possible. For example, either the last note heard, the last note imagined, the last implied tonal centre, or some other salient feature of the music could be responsible for listener expectancies.

Certain anomalies in the experiments are not easy to account for. For instance, occasions have been described in which the local harmony has seemed to influence a target's perception more than the global hierarchy of the piece. An alternative explanation relates the role of melodic proximity in melodic perception observed by Deutsch and Feroe (1981). Contour and the striking nature of widely separated pitches may have occasionally taken precedence over the influence of a purely tonal hierarchy, as in the variety of response exhibited to the original note 2 in Experiment Two. This particular target followed the upward leap of a sixth, as illustrated in figure 4.25.

Figure 4.25

Target note 2 ('B') follows the leap of a sixth in the original

Another factor to consider is that the analysis from both of these experiments compares data from diatonic targets (root, fifth, submediant) with data from non-diatonic targets (tritone). As Krumhansl and Kessler (1982) observe, the perception of diatonic notes may be susceptible to confusion with other diatonic elements, due to the strength and interchangeable nature of notes from a tonic triad. The tritone might have been so different harmonically as to elicit disproportionately different data to targets at higher levels of the tonal hierarchy.

Most people's daily experience of musical imagery in Western culture involves the unintentional or involuntary 'singing' of music in the mind, often with the inclusion of song lyrics. Issues of cross-modal processing of verbal and non-verbal information are therefore often central to work in the field. For example, researchers address whether lyrics aid image generation, slow image generation or aid connections with musical imagery through kinaesthetic articulation. Weber and Brown were particularly interested in verbal musical imagery, and in one experiment that they undertook state that 'The finding that songs take less processing time than melodies indicates that the words aid in the generation of the tonal relationship' (1986: 418). Nevertheless, findings on cross-modal imagery remain equivocal, and results of imagery research may be difficult to interpret in any modality-specific fashion when verbal information is simultaneously processed. The use of lyrics in the current study was to provide a common reference point for labelling target moments. However, the following chapter will present an alternative method of labelling target notes, without the potentially confusing dimension of words.

The participants in both of these studies were all musically trained, yet imagery for these participants was not equivalent to actual perception. Intuitively this is not a surprising finding: other than eidetic forms, imagery is rarely considered to be an exact replica of perceptual experience given that it is an abstraction from that experience. A number of the seemingly contrary findings from the imagery and perception tasks could be attributable to the very specific demands of the experiment. For instance the active comparison to be made between a sounded target note and an imagined note may involve mental processes quite different from the simple confirmation required to judge the intonation and timing of a target in a perception condition. Because the tasks are not directly comparable, it is hard to be sure what the results mean. Nevertheless, the evidence still suggests that to view musical imagery as the weak remnants of musical perception would be an oversimplification. It may be that the two demonstrate functional similarities but not structural equivalence, but this data is equivocal. It is of interest to explore the imagery/perception relationship further, as the implications of any structural difference between the two potentially affect musical practice as regards the deliberate use of imagery in musical activity. By exploring another musical dimension in a similar manner, more may be learned about the qualitative difference in task type. Little is known about the explicit mental representation of timbre in musical imagery. The following chapter will adapt the method outlined in these experiments in order to test the relationship of imagery to perception further, and to explore a musical aspect reported to be less veridical in 'tune on the brain' imagery than melody and lyrics (see Chapter Three).

CHAPTER FIVE -

IMAGING TIMBRE: EXPERIMENTS

The previous chapter described controlled experiments used to test the theoretical concern of this thesis, namely the relationship of musical imagery to perception. Clear differences in the facilitatory influence of imaged and perceived musical contexts on performance in discrimination tasks were found, though less clear qualitative differences between imagery and perception performance necessitate further testing. While timing and pitch were the focus of the experiments, it is of interest to explore other musical dimensions. Data from the experience sampling study of Chapter Three suggest that music students rate timbre as a less veridical aspect of their tune on the brain imagery than melody (comprising elements such as timing and pitch). Perhaps the controlled investigation of timbral imagery could shed light on some of the differences between imaging and perceiving music. As in Chapter Four, this chapter will continue to focus on the intentional use of imagery in a task which is related to both general music listening, but also the more specific capabilities of music student subjects.

Intuitively, it is possible to bring to mind the timbral, and perhaps vocal, qualities of a particular piece or fragment of music. It seems that certain tone-colours are particularly vivid in their recollection. New instrumental arrangements of familiar pieces of music are easily recognised as such based on memory for timbre. Composers and orchestrators claim to be able to auralise different timbres: while some of their knowledge is declarative, the remainder is presumably based on inner hearing. Yet evidence that musicians, or indeed non-musicians, are able to inwardly 'hear' aspects of timbre is largely anecdotal. Asking people to introspect and report on their musical imagery tends to produce somewhat vague description of general sound colour, such as 'dark' or 'light'. Even musicians with the training to distinguish particular instrument sounds rarely describe their timbre for imagery in instrument-specific detail (see Bailes, 1999). However, Auhagen and Schoner (2001) demonstrated that timbral detail could be an important part of the mental representation of music. Their research investigated the control of timbre by musicians through the communication and use of various verbal attributes. They found a certain agreement between the timbral properties expressed and the common metaphors used to qualify sound.

5.1 Research Findings

Known as 'the psychoacoustician's multidimensional wastebasket category' (see Toivianen, 1996: 1), timbre is a notoriously complex aspect of music to explore (Hajda, Kendall, Carterette and Harshberger, 1997). While the relationship between frequency and pitch is relatively well understood, this is not the case for timbre (Slawson, 1985). This chapter does not detail psychoacoustical research findings, or issues of steady state and transient portions of a tone, but draws on the perceptual categorisation of timbre in an attempt to compare the experiences of perception and imagery. The definition of timbre adopted for the purposes of the present study is that provided by Plomp in 1976: '"that attribute of sensation in terms of which a listener can judge that two steady complex tones having the same loudness, pitch and duration are dissimilar"' (Giannakis and Smith, 2001: 162).

As discussed in Chapter Two, Crowder has undertaken pioneering research into imagery for timbre (see Repp, 2000). In a paper with Pitt (Pitt and Crowder, 1992), imagery for timbre was found to be stronger for spectral rather than time-varying properties of timbre. These studies (see also Melara and Marks, 1990) do not examine timbre in a musical context, but focus on isolated tones. Wolpert (1990) realised the importance of context for perception, and used musical sequences in a study of the relative salience of various musical dimensions for musicians and nonmusicians. Although not primarily an exploration of timbre or imagery, results from her experiment are interesting because nonmusicians responded more strongly to timbre than melody or harmony. This result is surprising: in the Western classical tradition, timbre has a cosmetic value, acting as a carrier for melody and harmony. 'Instrumentation provides color and can be altered without changing the essence of the excerpt' (Wolpert, 1990: 96). However, Pitt writes that

> For nonmusicians, timbre is probably a more salient dimension than pitch because the former is generally more informative about environmental

> events, and these listeners have not been trained to analyze pitch closely. (1994: 977).

These studies should not be taken to suggest that musicians are incompetent at attending to timbre. Musicians outperformed nonmusicians in a chord recognition task designed by Beal (1985) in which instrumentation was either held constant or altered. As Singh and Hirsh observe:

> Musicians are generally expected to be able to equate F0 across spectral differences, in the act of tuning instruments with different timbres to a common pitch (1992: 2658).

As discussed in Chapter Two, Intons-Peterson (1980) suggests that certain auditory properties, including, timbre may be optionally important to musical perception and imagery. By contrast, *Klangfarbenmelodie* (a term coined by Schoenberg meaning 'tone colour melody') and electroacoustic musical forms work on the premise that timbre is the musical object rather than a melodic carrier, and consequently the focus of musical interest.

Attitudes toward the relatedness and therefore the structural potential of different timbres are mixed (McAdams, 1989). Krumhansl and Iverson (1992) conducted an experiment exploring the perceptual interaction of timbre and pitch, both in single tones and musical sequences. One of their main findings can be summarised as follows:

> The relative perception of timbre was weak and was found only when pitch was constant. These results suggest that timbre is perceived more in absolute than in relative terms. (Krumhansl and Iverson, 1992: 739)

By way of contrast, studies (for example Ehresman and Wessel, 1978) have indicated that timbres can be perceptually related to each other. Subjects successfully selected the appropriate timbre to fit the vector 'tone A is to B, as tone C is to '?". Multidimensional scaling and timbre space models are the products of studies asking subjects to rate the dissimilarity of pairs of sounds. The ability to perform such tasks implies that timbre can be related and even transposed in a manner analogous to pitch. A geometrical space representing the perceptual proximity of different instrumental tones can be generated (Grey, 1977; Wessel, 1979). This has led theorists such as Lerdahl (1987) to postulate that timbre may be organised in a hierarchical fashion to provide musical structure, although Cohen and Inbar (2001) disagree, stating that 'timbre . . . does not lend itself to clear hierarchical organization' (142).

The comparative lack of timbral imagery research has necessitated the development of new techniques. Hajda *et al.* 'reiterate that methods and techniques must be guided by the research question(s), rather than the converse' (1997: 264). Building on the work of Crowder and Pitt, two experiments have been devised to test both the perception and imagery for timbre of groups of music students. They test memory for timbre and the ability to use imagined timbre as the contextual cue to a discrimination task. The experiments presented here are an extension of the already tested techniques, with timbre rather than pitch or timing as the parameter under investigation.

5.2 Experiment One

5.2.1 Aims

- To test imagery for the timbral qualities of a familiar musical sequence
- To compare timbral discrimination in imagery and perception tasks
- To explore the experience of timbral imagery

5.2.2 Hypotheses

Following on from the results of the experiments described in Chapter Four, it was again hypothesised that participants will perform better in a discrimination task under perception rather than imagery conditions. A new prediction was made. This was based on the findings from previous research that timbre for imagery can be generated, and that timbre can be perceptually important for musicians. The new hypothesis stated that the music students participating in this experiment would be able to internalise and image timbral aspects of music.

5.2.3 Method

Participants learned an instrumentally varied musical sequence. Following this familiarisation phase, participants hearing or imagining the sequence were asked to judge whether the instrumentation of one of its notes was the same or different from the original sequence.

5.2.3.1 Participants

Sixteen university music students were each paid three pounds to take part in the study. Four of these had previously volunteered and participated in an imagery experiment, but it was not anticipated that this would affect their performance.

5.2.3.2 Material

An attempt was made to use stimuli similar to existing music composed with timbral change as a prominent feature, such as the first movement of Webern's *Symphony opus 21* (1928), but with an appropriate degree of experimental control. In constructing the materials, the following five considerations were made:

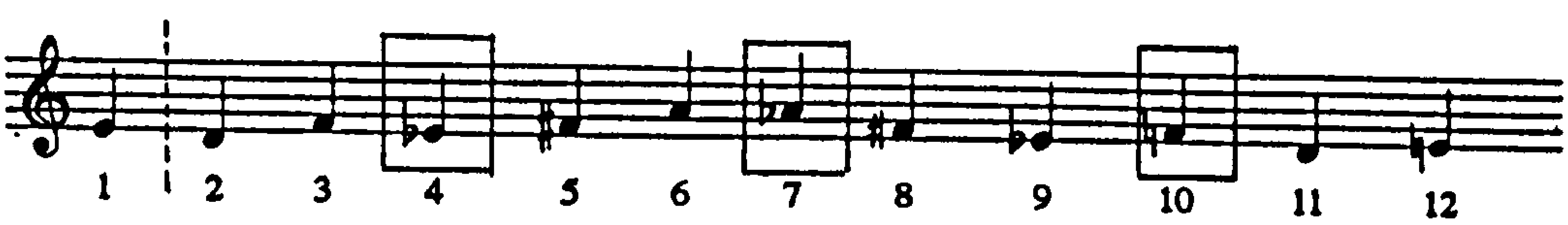
1) Facility of sound substitution. To create a 'same'/'different' discrimination task, sampled orchestral instrument sounds were used, as they are simple to substitute at the appropriate target moment.

2) Timbral contrast. It was decided to contrast each target note with its immediate context, rather than to aim for transitions of overlapping timbre, since this would ensure distinct and hopefully memorable target sounds.
3) Timbral texture. Paired instrument sounds were employed for each pitch. More sounds than this would have created an overly fused and homogenous texture, while using just one instrument sound per pitch was too sparse.
4) Register. The range of pitches was chosen to be within a comfortable vocal range, as it was thought that being able to sing the music might help in its learning.
5) Rate of sequence. A fairly slow speed was intuitively chosen on the basis that time would be required to fully register each new timbre pair.

A MIDI file was generated in MAX (Opcode), consisting of the twelve pitches shown in figure 5.1, with isochronous inter-onset intervals of 2 seconds. The sequence was sent to an EMU (ES14000) sampler, programmed to produce paired instrumental sounds for each pitch. Two independent listeners who were informed of the experimental aims confirmed that the choice of tempo and instrumentation was appropriate.

Figure 5.1

Timbre sequence with boxed target notes (dotted line marks the start of the imagery zone)



Sounds for each note were as follows:

Note 1 - Bassoon & oboe	Note 5 - Fr. horn & oboe	Note 9 - Clarinet x2(oct.)
Note 2 - Trombone & trumpet	Note 6 - Trumpet & flute	Note 10 - Fr. horn x2(oct.)
Note 3 - Clarinet & flute	Note 7 - Clarinet & oboe	Note 11 - Cello & clarinet
Note 4 - Cello & violin	Note 8 - Bassoon & Fr. horn	Note 12 - Bassoon & oboe

An initial attempt was made to juxtapose timbres according to their spatial proximity in multi-dimensional scaling (MDS) representations of timbre (see for example Grey, 1977, and Wessel, 1979). This was to maximise the perceptual sense of the sequence through assuring some form of timbral continuity from event to event. However, the choice of instrument sound was ultimately based on the perceptual criteria of the investigator, as the particular samples involved did not relate well to each other according to MDS models.

An effort was made to maintain octave equivalence in the transition from one pair of instruments to the next. However, the normal instrument range of each sampled sound was such that this was not always possible. For example, the high flute of note 3 did not lead to an equivalent octave for either the 'cello or violin of note 4. In perceptual terms, such moments were not outstanding or problematic. A sound example of this sequence can be found on track 4 of the CD.

Once created, this sequence was recorded onto audiocassette, so that participants could use this to familiarise themselves with the experiment material. A score of the music was distributed at the same time, with each note numbered. Participants were instructed to consult this score while listening, as it was hoped that the numbers might be learnt simultaneously, facilitating referencing target notes by number during the experiment. Focusing on the score whilst listening was also intended to ensure that the music was thoroughly attended to.

Notes 4, 7 and 10 were selected as target notes for timbral discrimination because of their distance into the sequence and from each other. Moreover, they represented distinct pitches to ensure minimal confusion between the targets based on pitch similarity. Indeed, these targets were at least two semitones distant from each other in pitch height. The three target notes were either presented with the original timbral quality, or an alternative in which one note of the paired instruments was replaced by a different instrumental sound. Figure 5.2 shows 'same' and 'different' instrumentation for the pre-selected target notes.

Figure 5.2

Original instrumentation at target notes and substitution

Target no.	Note no.	Same instrumentation	Different instrumentation
1	4	Cello & violin	Cello & trumpet
2	7	Clarinet & oboe	Cello & oboe
3	10	French horn x 2 (oct.)	Flute and French horn

These substitutions were based purely on perceptual criteria but agreed by two independent listeners. They were felt to be neither too obvious nor too subtle for perceptual discrimination.

Counterpart sequences for the imagery task borrowed those created for the perception task and 'silenced' all but the target note and opening note of the sequence (the start of the imagery zone is marked by a dotted line in figure 5.1). As in previous experiments, the music was discontinued after the onset of the target note. A flashing light on a computer monitor provided a visual anchor to the imagery task, blinking in time to the onset of each perceived or imaged note. The light was also present in the perception condition, in order to maintain a maximal equivalence between imagery and perception conditions.

5.2.3.3 Procedure

Participants first took part in an instrument identification pre-test lasting ten minutes, the purpose of which was to establish a basic competence in instrument identification. This asked them to select from a list the instrumental sound and pairs of sounds they believed to be playing isolated tones. These tones were the same sampled sounds as were used in the main experiment, transferred from computer to audiocassette. Participants listened individually to this over headphones.

Following the pre-test, cassettes of the experiment sequence were distributed to participants with instructions to pay particular attention to the timbre of the music. Internalising the experiment sequence demanded listening to the cassette a minimum of fifteen times, over a minimum of five days. The experiment session could then take place, during which participants were asked to attend to a score of the music that was placed below the computer monitor.

Participants listened to the music over headphones. Instructions were then given as to the task requirements, and the keys to press in response to target notes ('S' for same, 'D' for different). It was requested that subjects respond as quickly, but as accurately, as possible.

Participants were tested individually, but to test for order effects between conditions, condition order was reversed for half of the listeners:
Group A - (n=8) pre-test, perception, imagery
Group B - (n=8) pre-test, imagery, perception

Testing was grouped by condition (perception/imagery) and test block. Each block comprised the six trials (three target notes x two variations) presented in random order. Each block was presented three times per condition, and interspersed with a replay of the original music, followed by a 35 seconds gap. Distributing a questionnaire that asked for basic information about musical background separated perception and imagery halves of the experiment. Following the final experimental block, each participant was briefly interviewed to find out more qualitative information about the experience. The interview was recorded onto DAT for subsequent analysis.

5.2.4 Results

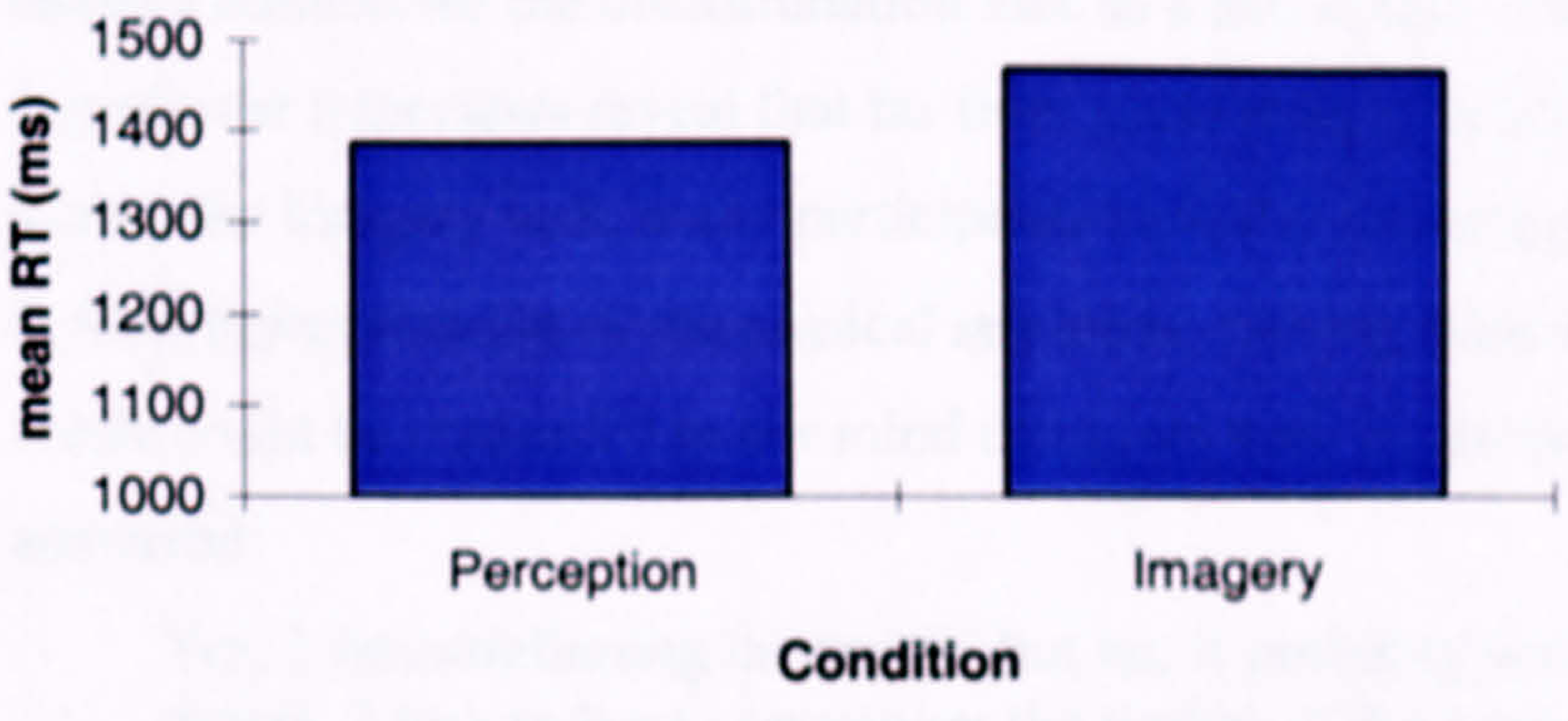
Response time and accuracy rates provide an indicator of performance under perceptual and imagery conditions for timbral discrimination. RT were analysed using a multifactorial ANOVA, with order as the between-subjects factor, and three within-subjects factors of condition, target number, and target type (i.e. 'same' or 'different' instrumentation). Discrimination data were analysed using a generalised chi-square. Post-experiment interviews were analysed thematically, and are discussed both in relation to quantitative findings, and as a source of new issues arising during the course of the study.

Pre-test data were examined. Most participants scored highly in the identification of single instrument sounds (mean score of 8 out of 9), but less well on the paired sound test (mean score of 5.5 out of 8). The ability to identify the single instruments was taken to be the most important baseline, as sound discrimination rather than the identification of paired instruments formed the basis of the main experiment tasks.

Condition

The anticipated effect of condition (imagery/perception) was significant for accuracy data ($\chi^2 = 7.31$; $p < 0.005$) with a value of 87.5% correct in the perception task and 79.1% in the imagery task. This finding supports the hypothesis that participants perform better in a timbral discrimination task under perception rather than imagery conditions. There was no significant effect of condition for RT, although as figure 5.3 illustrates, times were marginally longer for imagery cues than perceived cues.

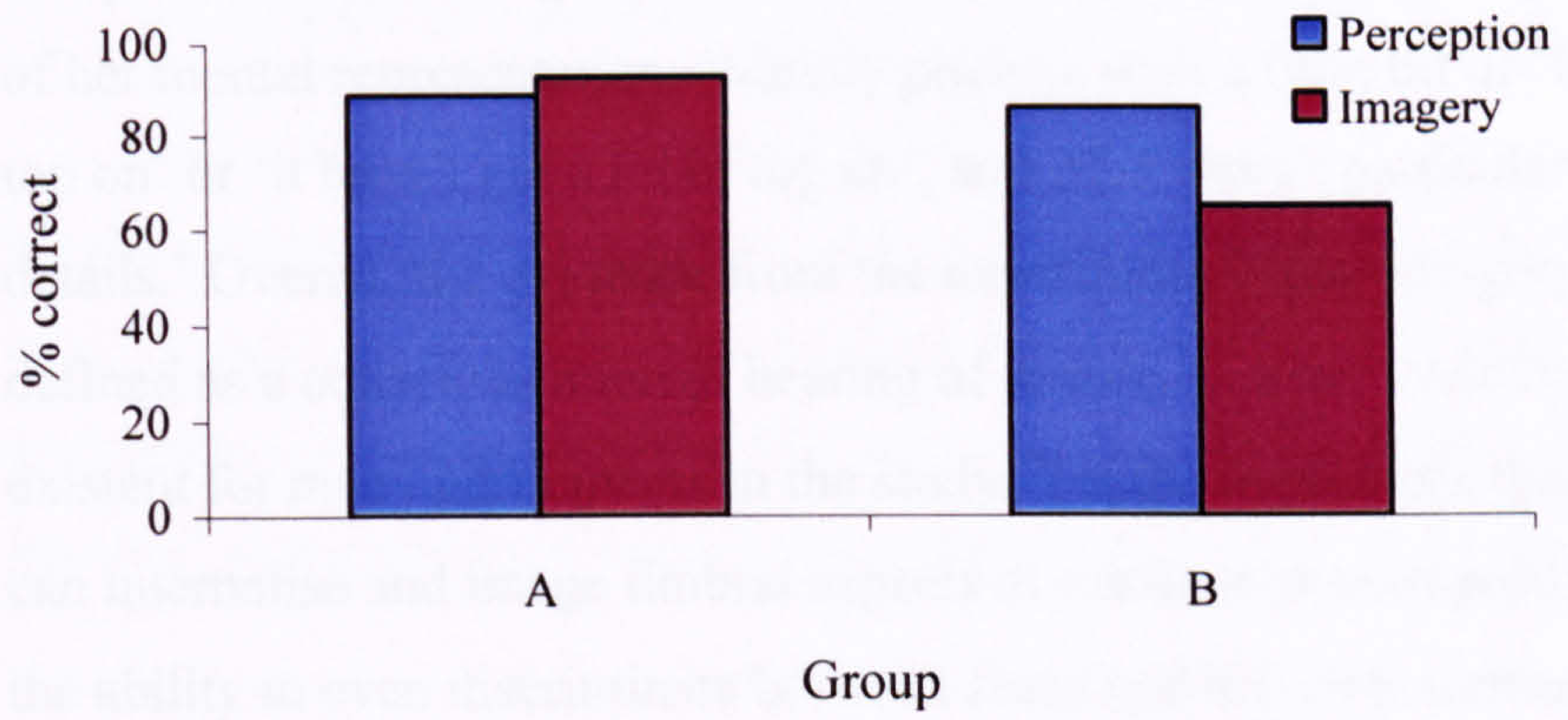
Figure 5.3
Condition: Mean RT (ms)



A closer examination of condition data reveals that the significant difference in accuracy is attributable to the performance of Group B ($\chi^2 = 17.28$; $p < 0.0005$) (those who did the imagery before the perception task). As their performance was significantly more accurate in the second of their two tasks (see figure 5.4), it seems likely that practice effects led to an improved performance at this later stage of the experiment.

Figure 5.4

Condition*Group: % Accuracy



Accuracy data for Group A did not indicate that performance on the perception task was any better than on the imagery task. Does this indicate that perception of the musical sequence was unhelpful as a cue to the correct target timbre? Could it be that the imagery of group A was particularly accurate, providing as stable a context for the discrimination task as a perceptual context? Post-experiment interviews reveal that far from generating a veridical timbral image during the imagery task, many participants lacked a conscious timbral awareness in their representation of the musical sequence. Having been asked whether the music could be continued in her mind complete with its timbre, one respondent answered:

> Yes, I was continuing the music, but no, it probably wasn't complete with timbre. I was trying to remember the timbre of the note that I was listening for, but I was sort of generally listening to approximately the notes in my head but no, in terms of timbre no, I wasn't really listening.

In the light of this comment, it is even more surprising to see undifferentiated accuracy and RT performance by Group A. It runs counter to the original hypothesis that the imagery condition would elicit less accurate response than perception, and indicates that perceptual cues were not particularly helpful to the timbre discrimination task, perhaps because the timbre events were not perceptually related so as to form a coherent musical context. The question 'Was your mental image of the music fully timbral, or simply melodic?' was asked. Five participants could not report that timbre was an integral part of their image.

Other participants do describe being able to hear elements of timbre when imaging the musical sequence. For example, here is one participant's response to the question concerning whether timbre as well as pitch and melody formed part of her mental representation: 'Mainly pitches, with a little bit of 'it's got a lot of top on' or 'it hasn't got a lot of top on', sort of. I wasn't particularly hearing details.' Overall, the evidence from the experiment is that imagery for timbre, defined as a conscious internal hearing of timbre, was not veridical, nor even existent for many participants in the study. Yet the hypothesis that participants can internalise and image timbral aspects of music is at least partly borne out by the ability to even discriminate between same and different timbral targets.

Group effects

Group A performed with 91% accuracy, while group B was 75.6% accurate. The difference is significant ($\chi^2 = 24.38$; $p < 0.001$), though no difference in RT was found. This result is not surprising as those in Group A began with a perception task that exposed them to the stimuli eighteen times more than those who began with the imagery task (Group B). Still, Group B would be expected to approach the perception task with equally accurate performance to Group A, although fatigue might have an effect on concentration by that stage.

For Group B, but not for Group A, 'target note' was a significant variable ($\chi^2 = 9.21$; $p < 0.01$), with accuracy decreasing for the later notes in the sequence. In designing the experiment, equivalence had not been sought between targets, which apart from being perceptually different also occurred at different times in the sequence. The ease or difficulty of detecting timbral change was expected to differ markedly, as it was impossible to maintain a uniform rate of change for all targets. Any comparison between target note data must take into account the necessarily different nature of each note. Moreover, as each trial was presented, the sequence cut off after the onset of the target note. Consequently, target one occurred in all trials, and target three in only a third of trials. It might be expected that the greater familiarity with target one would enhance performance, and this is the case for group B. The effect is one of practice, and this was seemingly important for most participants as expressed in the post-experiment interviews.

> The more we did this, the easier it got, because I knew which notes were going to be changed . . . . because you've heard it a lot of times in succession, and generally if it was different, you knew which different one it was going to be as well, 'cause there was only one or two changes in each one. So it was kind of a practice thing.

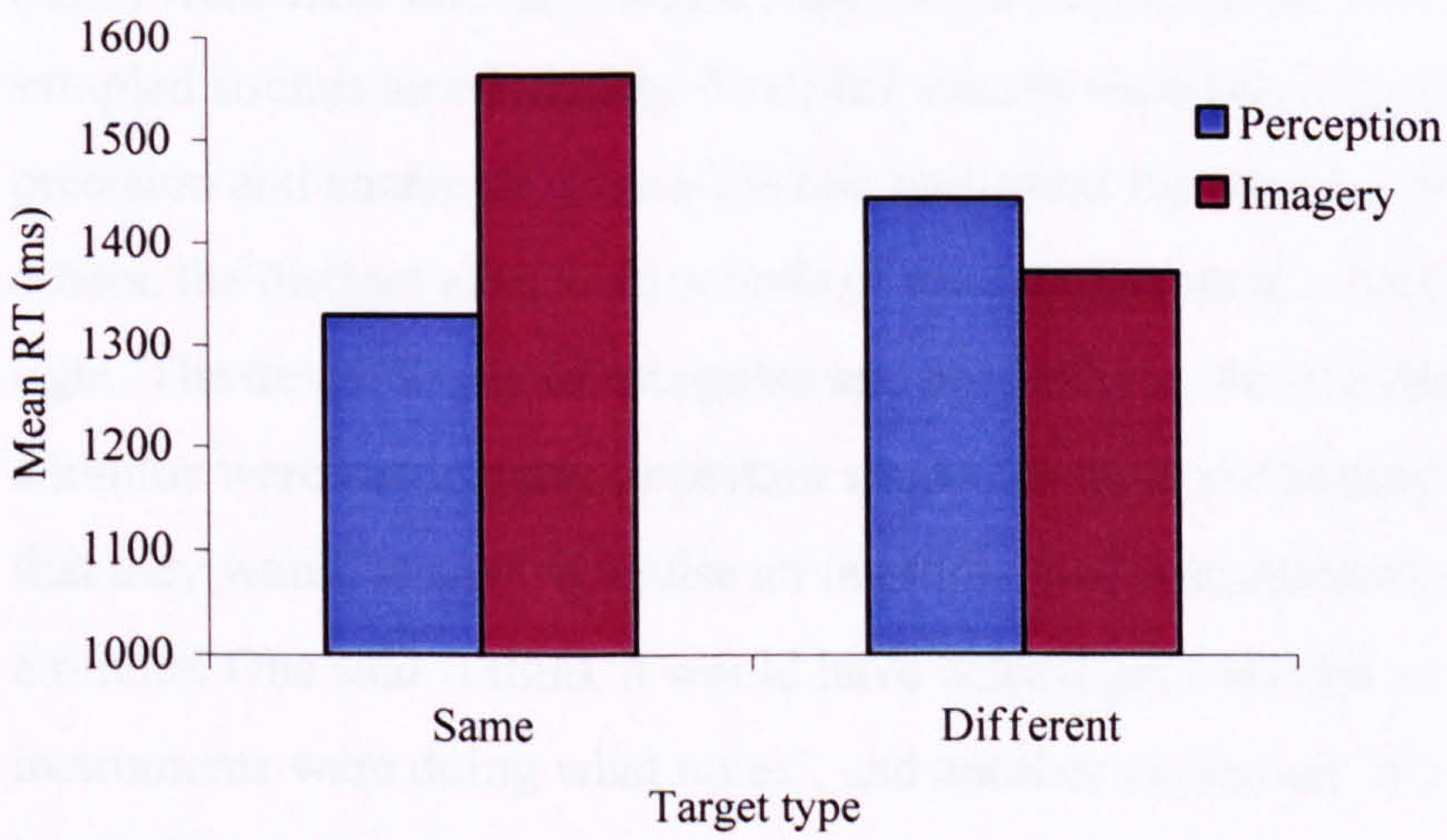
As each trial was presented three times in all, it might be expected that the third trial for each target would be completed more accurately than the first. This was not shown to be a significant effect, demonstrated by the absence of 'trial number' as a significant factor in the analysis of both accuracy and RT.

Target type

The significant interaction of condition with target type (same or different) found in the experiments of Chapter Four was not replicated. Indeed, a different pattern emerged for RT, as illustrated in the following graph:

Figure 5.5

Condition*Target type: Mean RT (ms)



Data for same targets show that perception conditions elicited significantly shorter RT than imagery conditions ($p < 0.05$). This finding is the reverse of that found in previous experiments.

Self-Report

Before the experiment session began, participants were asked how well they felt they knew the music they had been asked to listen to. Responses were largely negative and uncertain, perhaps partly as a defence for their predicted performance in an as yet unknown task, but perhaps also because it is difficult to judge familiarity with the music. Participants generally doubted the extent to which they had internalised the music, yet overall accuracy was above chance. This represents a more tacit awareness of timbre than has been supposed. On being asked *after* the experiment about the ease or difficulty of familiarisation with the music, some respondents said that they had expected it to be more difficult than it was. Ignorance of the future use for the music may have contributed to the perceived difficulty of the task.

In learning a traditional piece of music, the melody is primarily attended to. For most people, relative rather than absolute pitch is the useful skill in doing so: there is no need to identify the exact pitches heard, as long as they can be related to an overall contour. Repeatedly however, participants in this study expressed a desire to identify the sounds they heard, stressing that this would have helped them to learn the music. Recognition of the instrument was deemed important to image formation. It was mainly for this reason that the majority of respondents (nine) were clear that they would have found the use of acoustic rather than sampled sounds an advantage. Sampled sounds were often found to lack the precision and character of an authentic orchestral instrument, although for others, the distinct electronic sounds of the samples were a timbre in their own right. The desire firstly to recognise and secondly to identify the sounds in the stimulus were particularly important stages for three participants who explained that they would tend to visualise an instrument or instrumentalist when imaging a timbre. One said 'I think it would have helped get a mental picture of what instruments were doing what notes', and another explained 'if I've got a visual image it's easier to remember'.

Two participants pointed out that the sequence was not easy to internalise due to its atonal nature. The lack of obvious melody-line led to problems for some in correctly pitching the sequence during the imagery task: 'The notes weren't necessarily the pitch I expected to hear, which then threw me because I wasn't expecting that sound'. Participants were asked to sing the first few notes of the sequence before the start of the experiment session, and few pitched the intervals between the notes correctly, implying that the correct music was not in fact being auralised. While a sense of tonality was deliberately avoided to focus attention on timbre rather than a pitch pattern, it is possible that a monotone or tonal sequence might have produced different results. Krumhansl and Iverson (1992) found in their research that timbre patterns were perceived only when pitch variations were highly controlled.

Strategy - Perception

It is interesting to analyse how easy or difficult participants reportedly found performing the perception and imagery tasks. On the whole, the perception task was viewed as being moderately difficult to easy. Only two respondents framed their experiences of the perception task as being wholly problematic. For both, the difficulty was an effect of a sensory overload when perceiving the full timbral sequence. One said that:

> When you're just hearing it played it's very difficult, because of course you've got all the different instruments which are playing it. So it's slightly off-putting I think. Just hearing a note inside your head it's a bit easier.

Another reasoned that 'I found it more difficult than the other one. Maybe I had more to deal with'. Contrary to the hypothesis that timbre discrimination would be facilitated by a perceived timbral context, these respondents felt they required silence in order to focus on hearing and judging the timbral target. It is far from clear from the varied testimonies whether timbre is genuinely perceived and imagined in an absolute or a relative way. More important to an investigation of imagery is the finding that many participants focused attention exclusively on the target notes without drawing on the context to help in any conscious way.

Strategy - Imagery

Responses to the question 'How would you describe the ease or difficulty of doing the imagery task?' were evenly distributed between both ends of the difficulty spectrum. Some participants found the task difficult as they were focusing their attention on synchronising their image with the target moment.

> I think I was trying to concentrate on keeping the timing right, in my head. Or trying to follow the light, but not look too much. I was concentrating more on that than the actual notes I think.

As with the perception task, practice effects were apparent, expressed in terms of confidence in knowing which target notes were expected. Once again, some participants chose to divorce target notes from their musical context as expressed by one participant, who subsequently found the imagery task easier than the perception task: 'I found the second one easier because in my mind I could repress all the other sounds'.

Timbre in Everyday Imagery

It was recognised that the experimental task required the learning of music that would not otherwise form part of the participants' normal listening behaviour. This was one reason for the inclusion of the following question in the post-experiment interview: 'Are you aware of knowing or inwardly hearing the timbre in your imagery of any other music?'. The response to this was largely affirmative, with only two volunteers considering timbre to be largely absent from their mental imagery. The population sampled in the experiment (music students) is not representative of the general population, and it is not surprising that imagery for timbre was frequently, and sometimes exclusively, associated with performance. One clarinettist says that the type of music she would normally imagine with timbre would be:

> Things like orchestral music or concertos, and things like that, especially if it's something that you know the solo part. Because then you hear the clarinet, or whatever the solo instrument is, as being separate, as it's a whole different thing to the orchestral accompaniment. Especially if it's something that you've played.

This participant expresses a further idea that a solo melody line may lend itself to timbral imagery.

Those who did experience timbral imagery agreed that a high degree of familiarity with the music was a pre-requisite. For instance, one participant said that:

> I think I would hear the vague timbre. I wouldn't necessarily hear exactly what it should be. But I think it has to be stuff that I've heard a lot, or something that has impact like if an advert came on with music in the advert.

A declarative knowledge of the music was also mentioned as helpful to the imaging of timbre. As an example, one participant was a student of performance and world music, involving focused attention on the timbre of less familiar instruments. She made a link between detailed perceiving and corresponding imagery:

> I listen to a lot of world music. And I'm quite often listening to music on instruments that I'm not familiar with. . . . Or it's on an instrument that I am familiar with but the player is getting quite a different sort of a timbre to the one. . . you know, say I'm asking how they're doing it.

Another participant also explained that, for her, a timbral effect that captured her attention would be likely to stay as a musical image. Speaking of a particular recording of Holst's *Jupiter*, she said:

> It has a very nostalgic tone to it. It has this main melody which makes you think "ah, this is very very interesting", that captures my attention, and automatically that melody glues in my mind.

Veridicality of the Image

The important question for the purposes of the current study was 'How true to the real piece do you feel your image of the music to have been?'. Respondents were variously confident as to the clarity of their mental representation. The most common qualification was that while the pitches and the general timbre of a few key notes were in place, there existed no detailed replica of the music in their minds. For example, one participant said of his imagery that 'in terms of melody contour I think it was quite close, and if I wanted to think of timbre as well I could get a bit closer to the timbre as well but not as close'. It is interesting that he said that he could, and by implication did not, get close to a timbral image. Task instructions particularly asked for attention to be paid to timbre, yet this did not occur naturally for this respondent.

Flaws in the material chosen for the experiment are perhaps revealed by one participant's difficulty in learning the music. She explains that:

> It was so hard to remember, because each individual note was different, I could never remember it. I couldn't learn it. . . . I think it was too hard for me to have a very good image of it.

Likewise, that the music needed more listening sessions in order to be reliably 'heard' is corroborated by some respondents who claimed that their image improved as a result of the task sessions. The response of other participants demonstrates a common psychological trait in memory retention in which imagery occurred only for the earlier notes in the sequence.

It should be pointed out that the experiment design meant that same and different targets were sounded an equal number of times throughout the experiment. The investigator noted that any initial uncertainty with the material was confounded by hearing the different target note sequence played as many times as the original during the session. This difficulty applied to both perception and imagery tasks.

5.2.5 Discussion

The ability to perform the discrimination task is testimony to the ability to internalise timbre. This timbral knowledge appears to be largely tacit, given the few reports of any ability to inwardly hear it. That accuracy rates provided a statistically significant result while overall RT data did not is of interest. As timbre was rarely acknowledged to be part of the mental image, timbre was not readily open to conscious introspection, but formed part of a sub-conscious knowledge. Does the definition of imagery as a process that is open to conscious introspection require modification in view of these findings? Perhaps timbre is not easily incorporated into a musical image, despite being an implicit musical memory. Erickson (1975) quotes Schouten writing in 1968 on the subject of the conscious perception of sound subtleties, and the contribution that unobserved details nevertheless play in identifying sound:

> "Evidently our auditory system does carry out an extremely subtle and multi-varied analysis of . . . elements, but our perception is cued to the resulting overall pattern. Acute observers may bring some of these elements to conscious perception, like intonation patterns, onsets, harshness, etc., even so, minute differences may remain unobservable in terms of their auditory quality and yet be highly distinctive in terms of recognising one out of a multitude of potential sound sources." (Schouten, cited in Erickson, 1975: 9).

According to participants, it is possible to internally 'hear' timbre of particularly well-known and well-loved music. However, as will be seen in the following chapter, trying to internalise timbre is not a skill that is encouraged in music training. Perhaps familiarity is the key to our mind's capacity to replay music with an integral timbral element.

As predicted, participants were better able to perform the discrimination task under perceptual rather than imagery context conditions, though this result is reflected only in accuracy rates, and not in response times. The overall finding is not hard to account for given the lack of reported timbre 'heard' during the imagery task. A mental representation of music without a conscious awareness of timbre cannot be described as equivalent to perception of that music. It should be remembered, however, that effect is entirely due to the performance of Group B, and may be largely due to the impact of practice. This experiment would therefore be improved by ensuring greater familiarity with the musical material beforehand, so that such group differences could be discounted as a contributing factor.

Two participants in the study reported having absolute pitch. One also commented that the sampled tones were irritating to her. It has been suggested in the literature that the correct identification of pitch and key by both possessors and non-possessors of absolute pitch may be intimately linked to timbre (see Reynolds, 1997). Timbre research has a history of using synthesised sounds, but that does not necessarily validate the practice. Hajda *et al.* (1997) report that Kendall, Carterette and Hajda (1994, 1995) have compared different tone generating methods such as commercial synthesisers and digital samplers. The current experiment used sampled sounds, and these are believed to relate fairly well perceptually to acoustic instrumental sound. Yet when asked whether the experiment might have been helped by the use of actual acoustic musical instruments, the majority of respondents believed so. Erickson writes '...there are fewer musically different electronically generated sounds than one would have expected. Listeners tend to hear electronic sounds as a class – "ah, electronic" – just as they might hear "ah, a violin".' (1975: 8)[1]. Not only might sound recognition and consequent categorisation ease the perception and imagery of timbre, but also the more natural aspects of timbre might be fundamental to their meaning. Boulez observes that in order to use timbre effectively in composition, it must be integral to the musical context. Indeed

[1] Of course, electronic sounds and digital synthesis have increased considerably in sophistication in the intervening years.

'Instrumentation is not learned by a systematic study of timbre, but by picking out here and there examples, chosen as models, which work particularly well' (Boulez, 1987: 162). The stimulus sequence used in this experiment did not conform to a model of meaningful timbre for the listener.

This study acted as an exploratory experiment. Not only did it explore new questions, but it also tested untried methods. A couple of fundamental experimental flaws were revealed - most notably, the repetition of same and different target notes throughout the course of the experiment. This allowed some participants to focus on the anticipated target note sounds to the exclusion of a more complete and general hearing of the music. For others, the equal occurrence of original and altered targets meant that the altered version was reinforced, leading to confusion as to the correct version. Avoiding the repetition and consequent learning of target notes by employing more than three target notes, or providing more different responses might stop these effects. Secondly, an insufficient familiarity with the stimulus was commonly reported. Either more hearings of the music should have been demanded, or the use of a less forgettable piece. Perhaps a tonal sequence would lead to a more familiar and memorable sequence, whilst reducing insecure pitch internalisation. Ideally, an enjoyable piece of music, or one that engages the interest of the listener, would be employed. Moreover, a couple of participants in this experiment explained that they found the rate of timbral change both unrealistic and difficult, preferring instead a more progressive or slow-paced transition from event to event. In the remainder of this chapter a more refined experiment is outlined, designed to eliminate some of the problems of Experiment One, and to employ more ecologically valid materials.

5.3 Experiment Two

A second study explored a different facet of timbre: rather than focusing on the discrimination of individual instruments, there was an investigation into whether participants could discriminate between target moments of music that had been artificially filtered, and those that had been left unfiltered (the original) in familiar pop music. Instead of replacing an instrument, the entirety of a continuous, pre-existing timbral texture was channelled through different forms of sound filter. In order to build on and support the findings from the previous experiment, an inference condition was added. This would provide a control, in which participants would hear a fragment of a pop song, silence, then hear more of the same song (either filtered or unfiltered). The task was to decide whether the second extract of song material seemed to have a filtered sound or not. This condition was closely equivalent to the imagery condition, without instructions to image through the 'silence', and before the pop songs had been learned by the participants.

5.3.1 Aims

- To test participant accuracy of imagery for timbre using familiar popular music
- To compare timbral discrimination in inference, imagery and perception contexts
- To explore the experience of timbral imagery

5.3.2 Hypotheses

- Participants can internalise and image timbral aspects of music
- Participants will better detect timbral identity under perception rather than imagery conditions
- Participants will better detect timbral identity under imagery rather than inference conditions

The final two hypotheses are based on data from all the previous experiments showing that hearing music up to the discrimination moment will provide a generally more useful context to the task than imaging. Imaging the music would still facilitate the task, while hearing only an extract of the music followed by silence (inference) would facilitate the task less well.

5.3.3 Method

Participants were asked to familiarise themselves with two timbrally varied pop songs. Before the learning or familiarisation phase, an inference condition aimed to test how well participants could judge the filtered status ('filtered'/'unfiltered') of the as yet unknown music at target moments. Following the familiarisation phase, participants hearing or imagining the musical context were asked to judge whether a sounded target moment was filtered or unfiltered (original).

5.3.3.1 Participants

Seventeen university music students (aged 18-37 years) volunteered to take part in the study. Some of these had previously participated in imagery experiments, but their prior experience was not judged to affect the study. All claimed to have normal hearing.

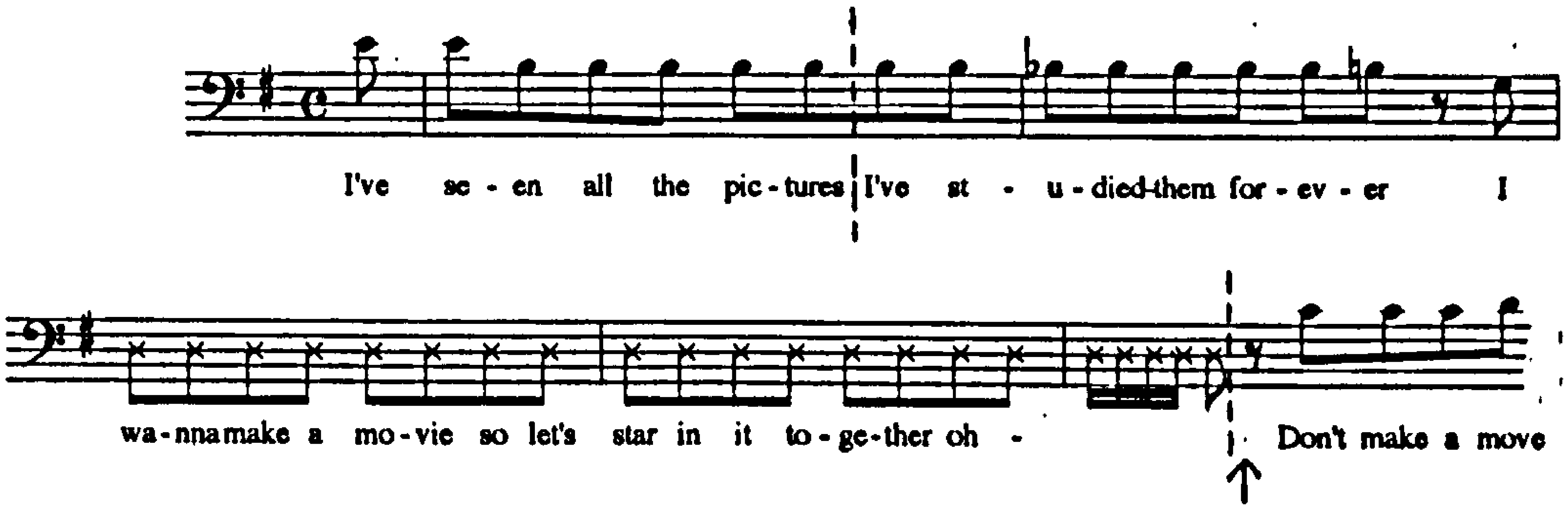
5.3.3.2 Material

Pulp *This is Hardcore* was chosen as music comprising clear blocks of instrumentally varied music. Björk *Scatterheart* was chosen as music comprising sounds varied in filtered quality. Each track was passed through a pre-determined filter from the target moment onwards. Soundfiles of the music were created by transferring each track to a Macintosh G3 computer. To avoid the problem of Experiment One, in which participants re-heard target moments one and two to arrive at target three, sections of each track rather than the entire piece were presented. Score samples[1] of the sections that were used are shown in figure 5.6 (see Appendix F for the score of all six targets in this experiment). The arrows pointing upwards indicate the onset of the target moment.

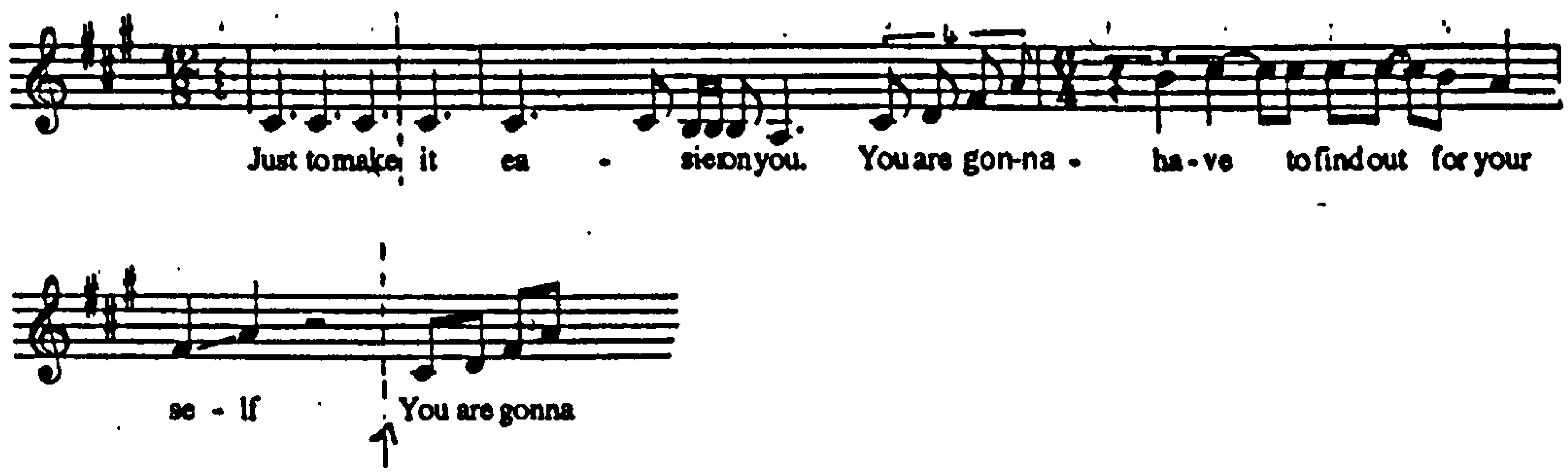
[1] For copyright reasons it has not been possible to supply sound examples from this experiment.

Figure 5.6

Pulp – target one



Björk – target three



Max MSP software (Opcode) enabled the manipulation of the music and the creation of a separate music file for each target and its variations.

Either bandstop or bandpass filters of different bandwidths around a selected centre frequency provided a contrast to the original timbre. These were set to output after a delay appropriate to the relevant target moment. The perceptual effect of filtering the sound was to make it sound more 'hollow' through removing partials in the sound spectrum. 'Bandpass' filters out partials at the extremes of the sound spectrum for a softer sound, while 'bandstop' has the opposite effect, blocking all partials in the middle. It was important to ensure that altered target moments (filtered) were relatively subtle to avoid a ceiling effect. Consequently, perceptual effectiveness rather than parametric equivalence was the guiding principle in choosing filters. Three independent listeners, who were aware of the experiment aims, listened to the sequences and confirmed the appropriateness of the degree of filtering applied.

Initially sequences for the perception condition of the task were created. Three target moments in each track were selected for timbral discrimination. These were allocated three variations of timbre: the original timbral quality, bandpass filtered sound, and bandstop filtered sound. Counterpart sequences for the imagery and inference tasks made use of the materials created for the perception task and 'silenced' all but the opening few seconds of each sequence and the target moment music (the imagery zone is marked by a dotted line in figure 5.6). This experiment differs from the previous experiments as the music continued after the onset of the target moment. For filtered trials this meant that all of the music from the target moment onwards was affected.

During the imagery condition a visual metronome (a blinking spot) on the computer screen served to keep participants in time when imaging music.

5.3.3.3 Procedure

An 'inference' condition was introduced in the place of the pre-test of Experiment One. In this, participants heard the first few seconds of music, followed by a period of silence, then more music (the target moment). At the onset of this second music they were instructed to decide if it seemed to be filtered or unfiltered. They were asked to indicate their decision by a computer key press (key 'S' labelled unfiltered and 'K' labelled filtered) as quickly but as accurately as possible.

Testing in this inference session was grouped by piece. Each piece comprised nine trials (three target notes x three variations) which were presented once and in random order. Participants listened individually over headphones. A number of trial attempts were allowed, so participants could learn what was understood by a filtered sound.

Having completed the inference condition, a CD of each track was distributed with instructions to pay particular attention to the timbre of the music. Participants were again provided with skeleton scores of the target moments of each track. They were also given song lyric sheets. They were told that they could look at these while familiarising themselves with the music, though this was portrayed as being optional only, to discourage an over-reliance on a visual rather than an aural representation of the music. After the 3rd, 10th and final listening participants were asked to rate how well they liked the music on a scale of 1 to 7 (really dislike to really like) on a sheet that they took away for their home listening. This was to monitor any link between liking, familiarity and subsequent task performance.

Having internalised the experiment tracks (participants were instructed to listened to each a minimum of ten, but preferably at least twenty times, over an average of seven days) participants were tested individually. The score relevant to the trial (the same skeleton scores provided for the familiarisation phase) was positioned below the computer monitor. As in the inference condition, key press indicated response. Filling out a questionnaire asking for background information separated the imagery and perception blocks of this main experiment session. Once again, participants were recorded on DAT in a short post-experiment interview.

Participants were allocated into two groups according to the order of performing the perception and imagery tasks.
Group A - (n=8) inference, perception, imagery
Group B - (n=9) inference, imagery, perception
The main experiment session comprised a series of two condition blocks, which in turn comprised separate blocks for each of the two pieces, made up of nine trials each (3 x 3 targets per piece). Trials within each block were presented once and in random order.

5.3.4 Results

In choosing the stimuli no equivalence had been sought between the Pulp and Björk songs. For this reason the results for each track will be presented separately, though evidence in favour of the experimental hypotheses should hold true for any piece of music, so that a pooling of the findings from both pieces will be presented where relevant.

As in previous experiments, response time and accuracy rates provide an indicator of performance. Response times were analysed using a 5-factor ANOVA (factors comprising 'group', 'piece order', 'condition', 'target' and 'filter'), and accuracy rates were analysed using a generalised chi-square. Post-experiment interviews were again analysed thematically, and are discussed both in relation to quantitative findings, and as a source of new issues arising during the course of the study.

As neither 'group' (representing order of condition) nor 'piece order' were statistically significant factors in RT or discrimination data, these between-subject variables have been collapsed to focus on the within-subjects factors of condition, target number and filter type. Figure 5.7 provides a summary of the main effects.

Figure 5.7

Summary table of significant findings per variable

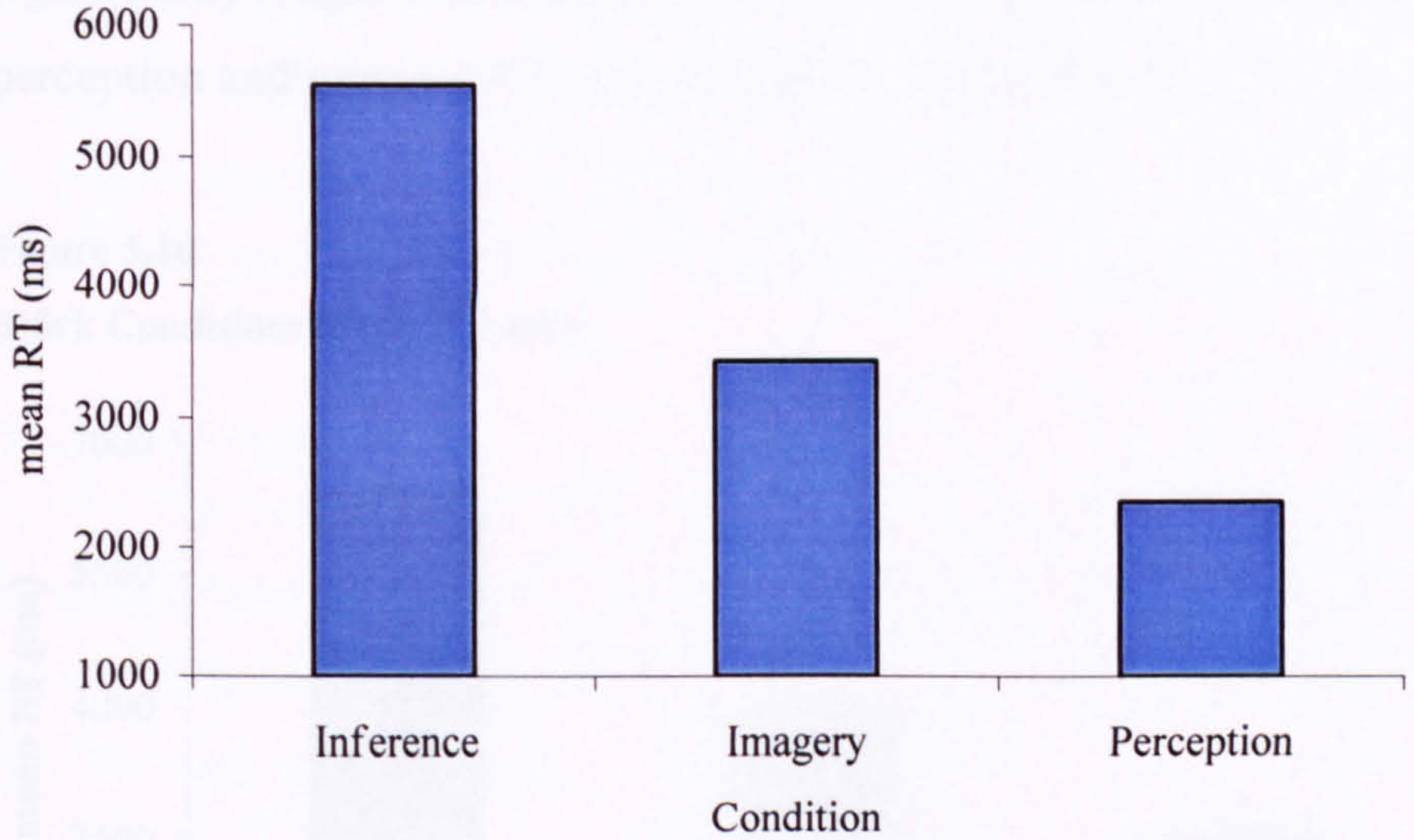
	Response time (ANOVA)	**Discrimination data (chi square)**
Condition		
Pulp	$F_{2,32} = 13.2, p = 0.0001$	not significant
Björk	$F_{2,30} = 12.7, p = 0.0001$	$\chi^2 > 10.8, p < 0.001$
Target		
Pulp	$F_{2,32} = 6.3, p < 0.005$	not significant
Björk	$F_{2,30} = 11.2, p < 0.0005$	$\chi^2 > 13.8, p < 0.001$
Filter		
Pulp	not significant	not significant
Björk	not significant	$\chi^2 > 5.99, p < 0.05$

Condition

Pulp *This is Hardcore*

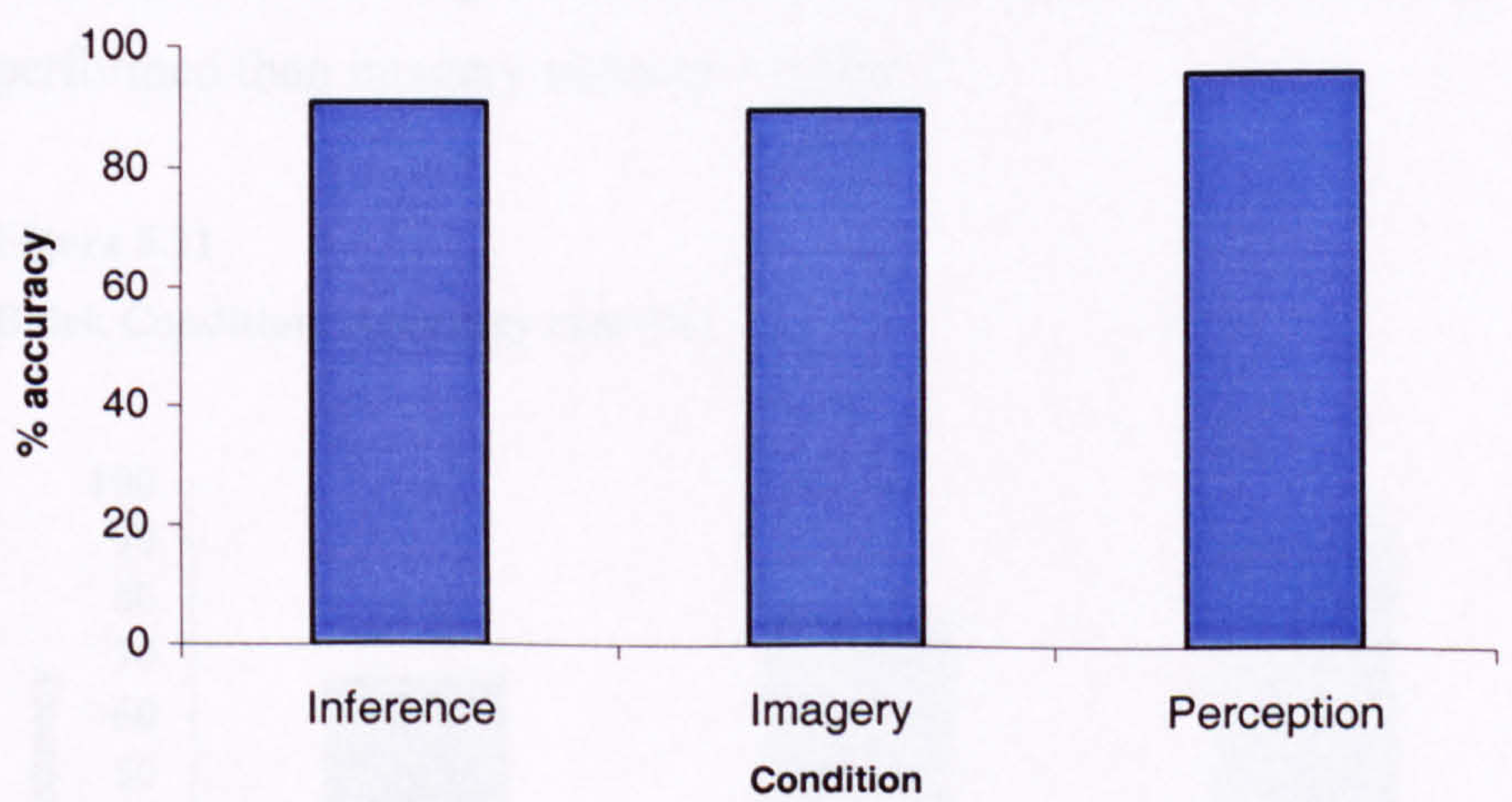
The anticipated effect of condition (inference/imagery/perception) was highly significant for RT [$F_{2,32} = 13.2, p = 0.0001$]. Inference tasks took the longest time, with imagery tasks taking significantly less time to perform ($p < 0.005$). Perception tasks elicited the shortest response times, though it is important to note that perception and imagery RT were not statistically different. Figure 5.8 illustrates this result. Overall, this finding would seem to support the hypothesis that participants are facilitated in their judgement of timbre under imagery more than inference conditions.

Figure 5.8
Pulp Condition: Mean RT (ms)



Accuracy rates showed no significant overall effect of condition (see figure 5.9), though perception tasks led to significantly more accurate performance than imagery tasks ($p < 0.05$).

Figure 5.9
Pulp Condition: Accuracy rate (%)



Björk *Scatterheart*

For the Björk track, both response time [$F_{2, 32} = 12.7$, $p = 0.0001$) and accuracy data ($\chi^2 > 10.8$, $p < 0.001$) confirmed the experimental hypothesis: The perception task was faster and more accurate than imagery task performance, which in turn was faster and more accurate than the inference condition. As for the Pulp, while inference conditions produced RT that were significantly longer than imagery RT ($p < 0.005$), the difference between perception and imagery RT was not significant (see figure 5.10).

Figure 5.10

Björk Condition: Mean RT (ms)

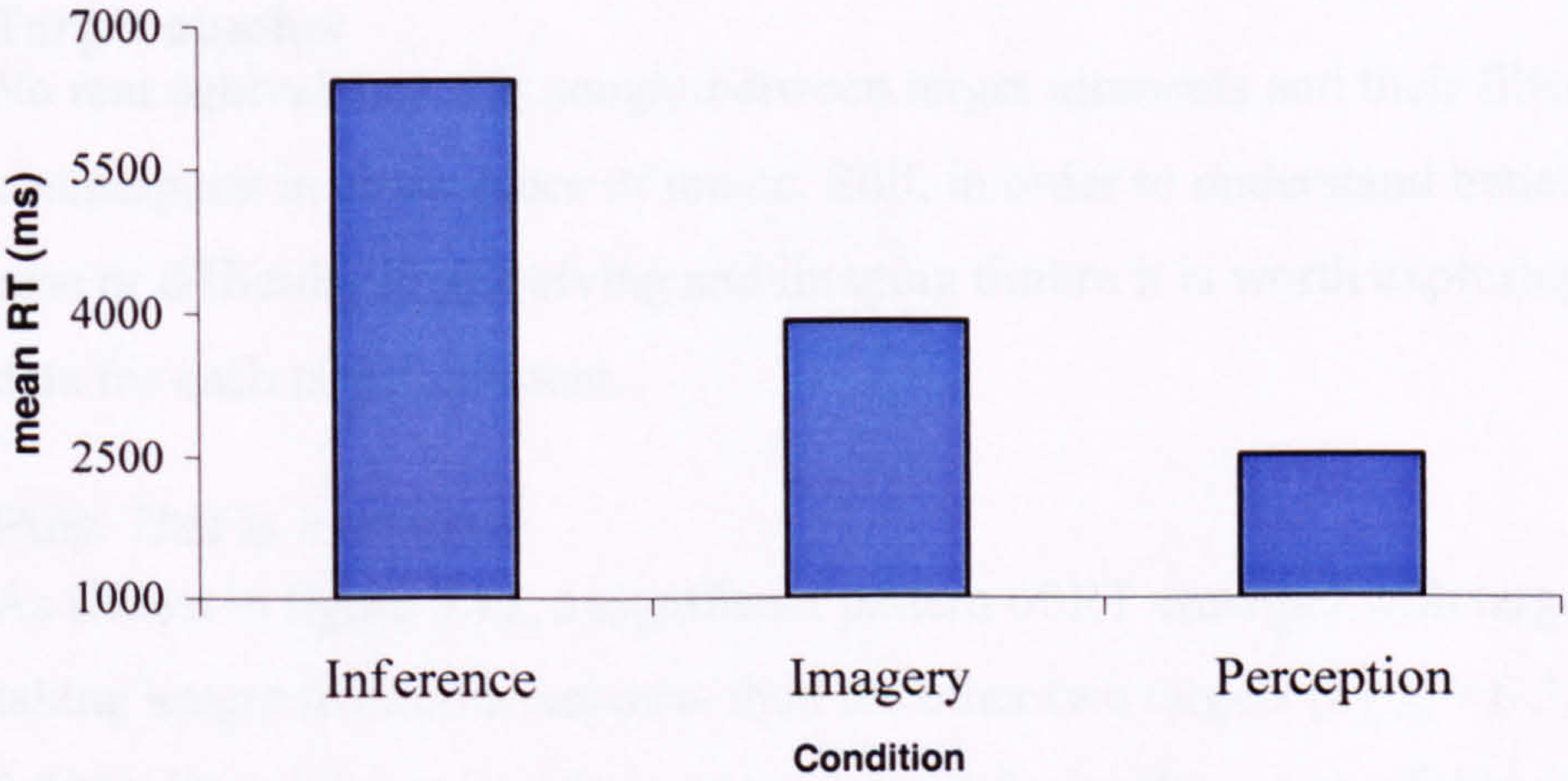
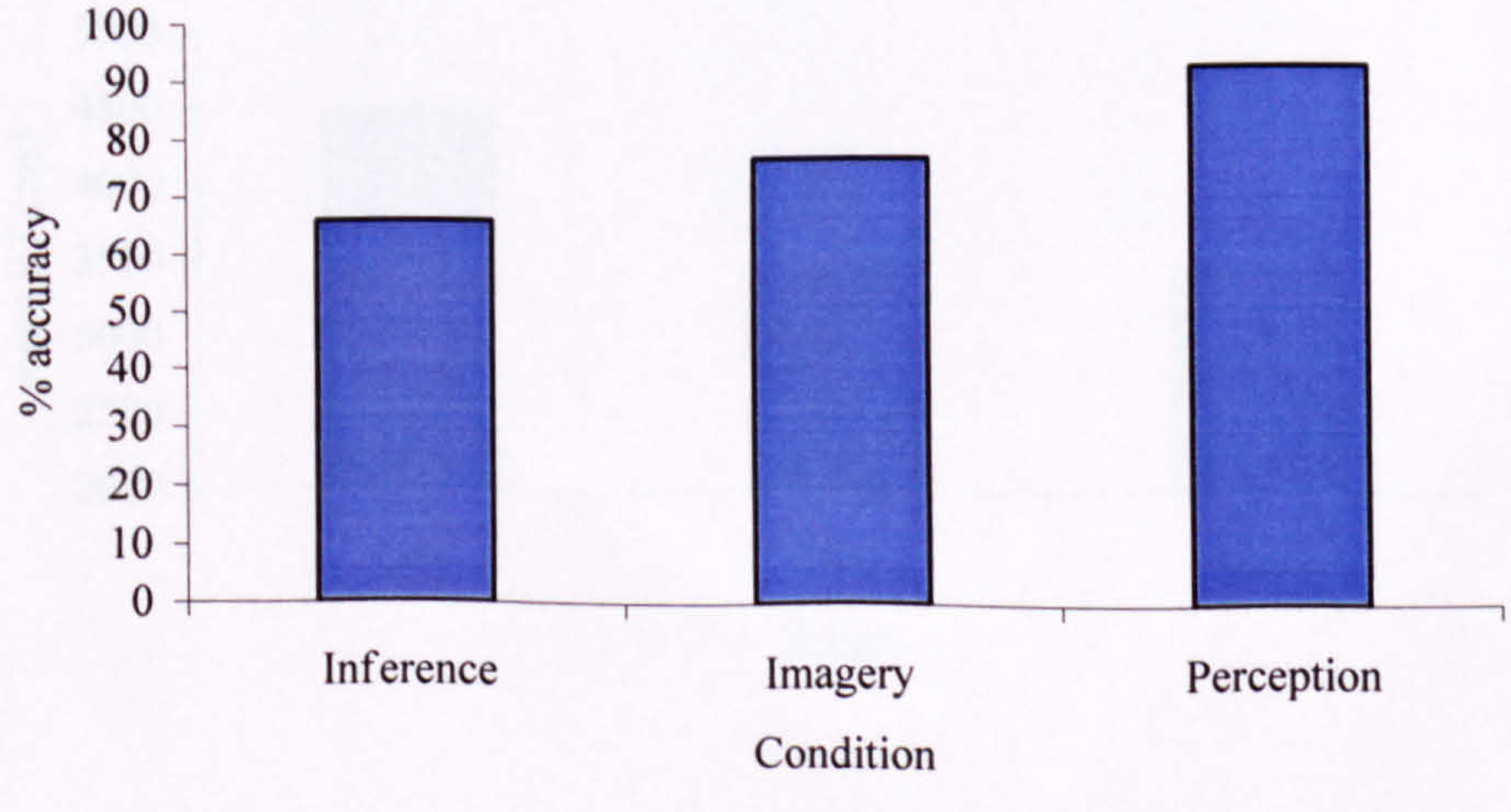


Figure 5.11 illustrates that imagery tasks were performed more accurately than inference trials ($p < 0.05$), and perception tasks were more accurately performed than imagery tasks ($p = 0.0001$).

Figure 5.11

Björk Condition: Accuracy rate (%)



The accuracy rates and RT are similar to those for Pulp, supporting the experimental hypotheses, but with a lack of significant difference between perception and imagery RT suggesting that participants found their mental image adequate to respond quickly. Different to the accuracy rate 'condition' patterns for Pulp, accuracy was significantly different between inference, imagery and perception conditions. All participants reported having found the perception task easier than the imagery task. Only two respondents spoke of their experience of the inference test. Both claimed that it was more difficult than the two tasks of the main experiment session. One explicitly volunteered that having an image of the music helped her to complete the tasks.

Target number

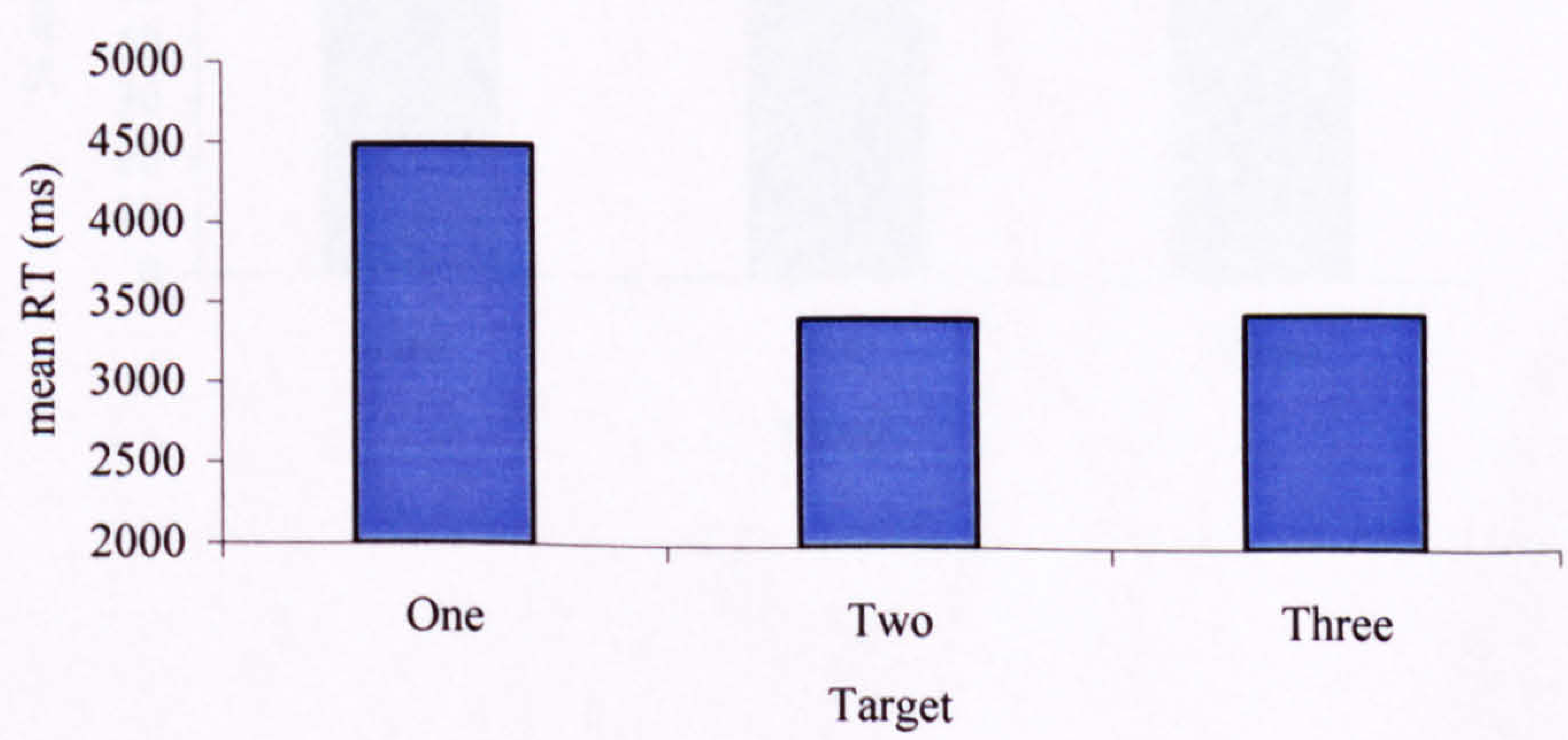
No real equivalence was sought between target moments and their filtered counterparts in either piece of music. Still, in order to understand better the ease or difficulty in perceiving and imaging timbre it is worth exploring the data for each target moment.

Pulp *This is Hardcore*

As shown in figure 5.12, a significant pattern of RT emerged with target one taking longer to elicit a response than the other two targets [$F_{2, 32} = 6.3$, $p < 0.005$]. This delay can perhaps be accounted for by the nature of this target: it is possible that participants held back until the salient re-entry of the bass guitar approximately six seconds into the target music to make a judgement. The effect was not matched by an important difference in accuracy for the three targets.

Figure 5.12

Pulp target: Mean RT (ms)



Target number is important considered alongside condition. While accuracy rates were not significant for condition, a significant pattern of condition does emerge for target number 2 ($p < 0.05$). Here perception performance is 100% accurate, but inference is surprisingly more accurate than imagery task performance.

Björk *Scatterheart*

Target number was a significant factor for Björk 's song, both in terms of RT [$F_{2, 32} = 11.2$, $p < 0.0005$] and accuracy data ($\chi^2 > 13.8$, $p < 0.001$).

Figure 5.13

Björk target: Mean RT (ms)

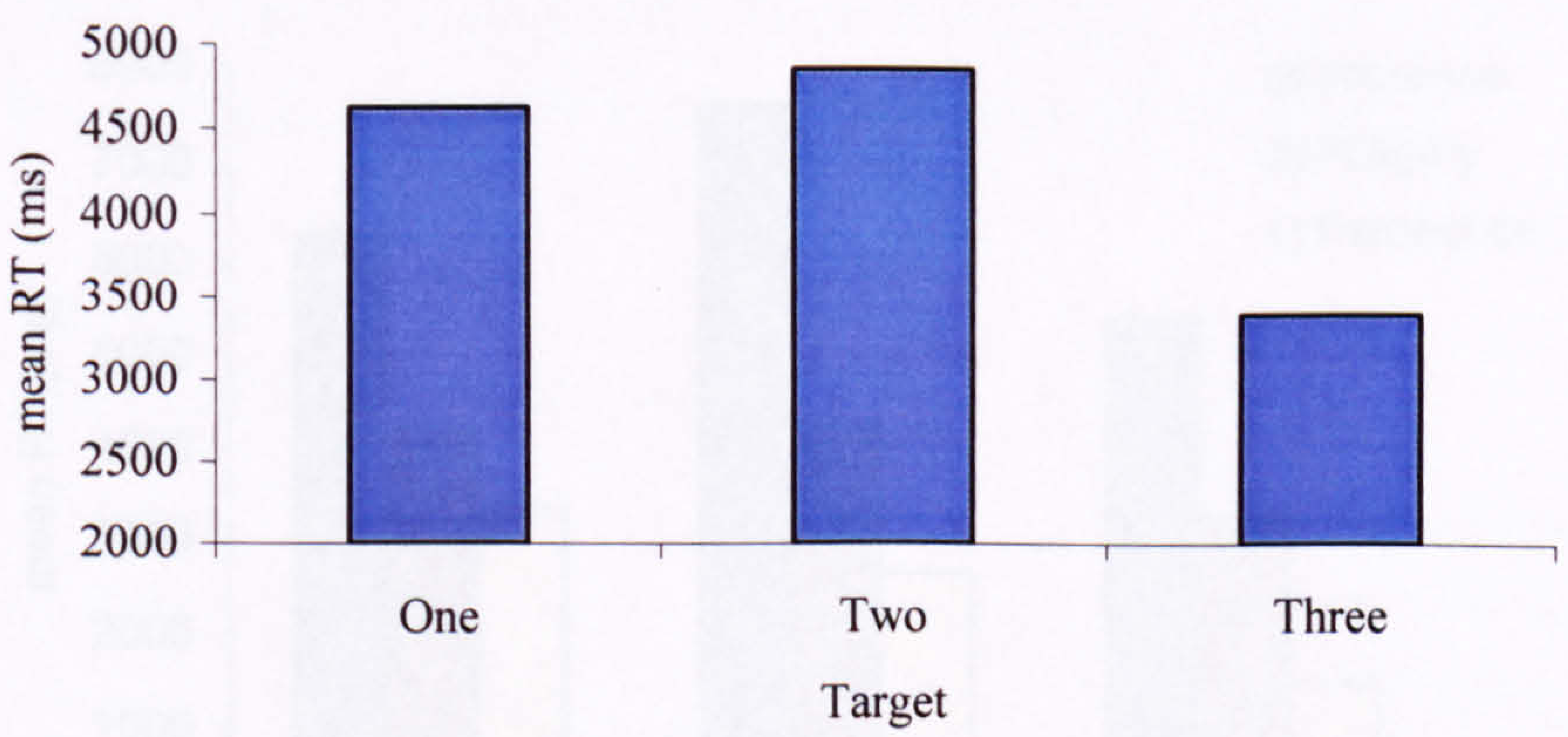
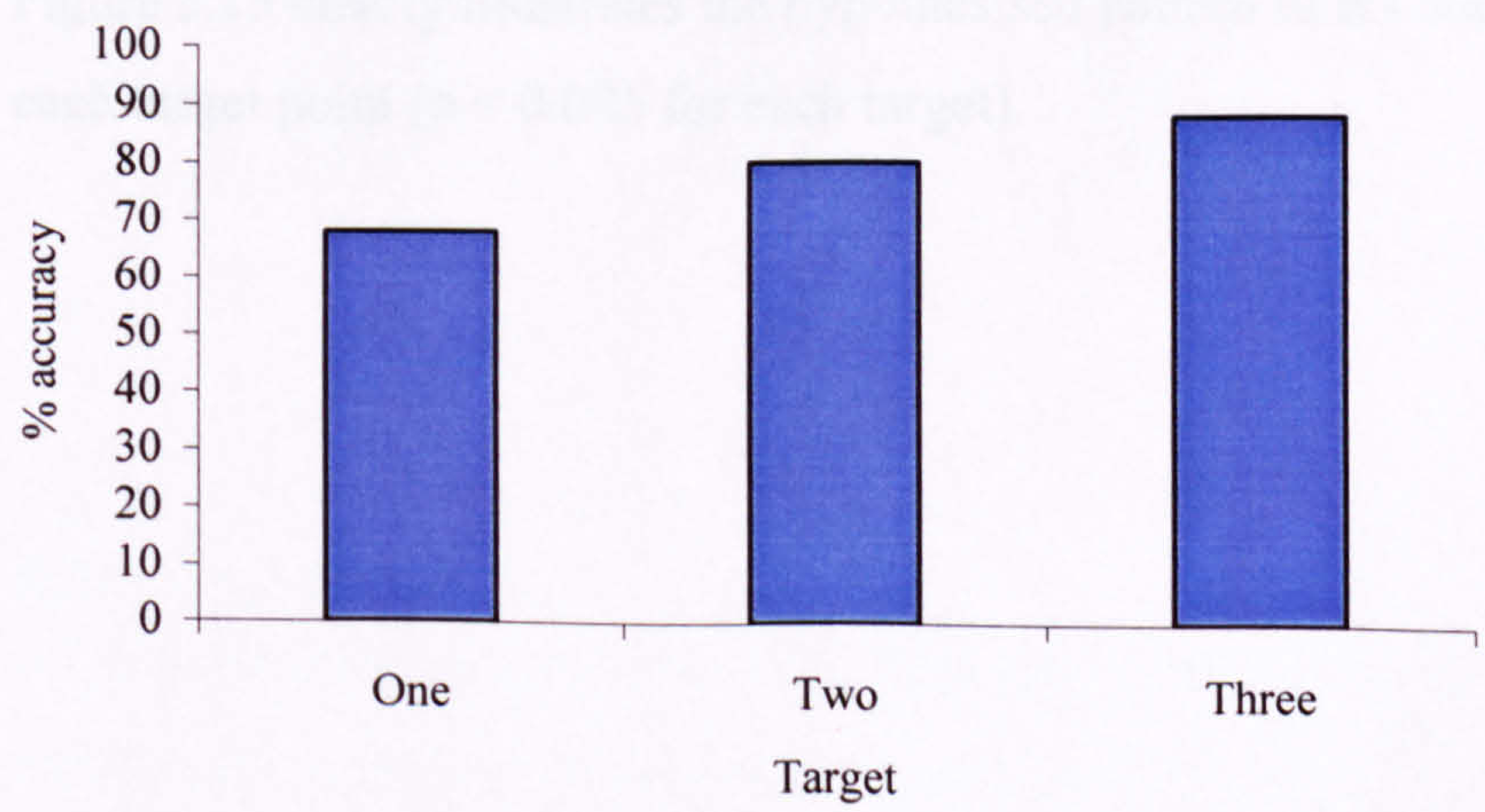


Figure 5.14

Björk target: Accuracy rate (%)



As illustrated in figure 5.13, target 3 elicited faster responses than the other two targets. Moreover, target 3 was performed most accurately, with target one the least accurate. These results imply a hierarchy of difficulty experienced by participants in responding to the three targets.

It is worth mentioning that condition and target number interact significantly for RT [interaction $F_{4, 60} = 3.72$, $p < 0.01$]. The root of this interaction lies in the fast response to target 3 under perception conditions, compared to target 2 perception ($p < 0.01$), as well as target 1 (see figure 5.15). The reason for this pattern is not clear.

Figure 5.15

Björk condition*target: Mean RT (ms)

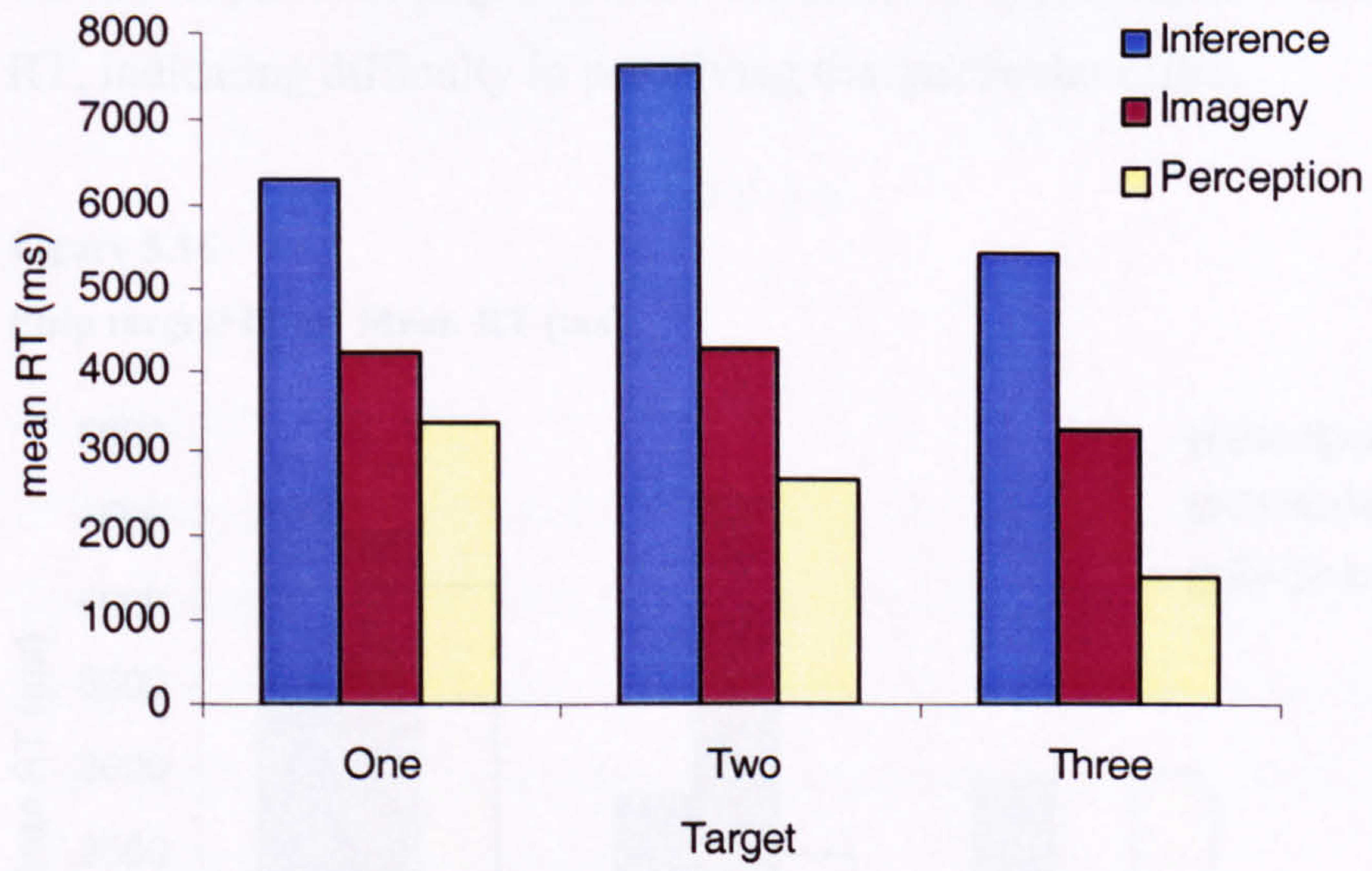


Figure 5.15 clearly illustrates the hypothesised pattern of RT for condition, at each target point ($p < 0.005$ for each target).

Filter type

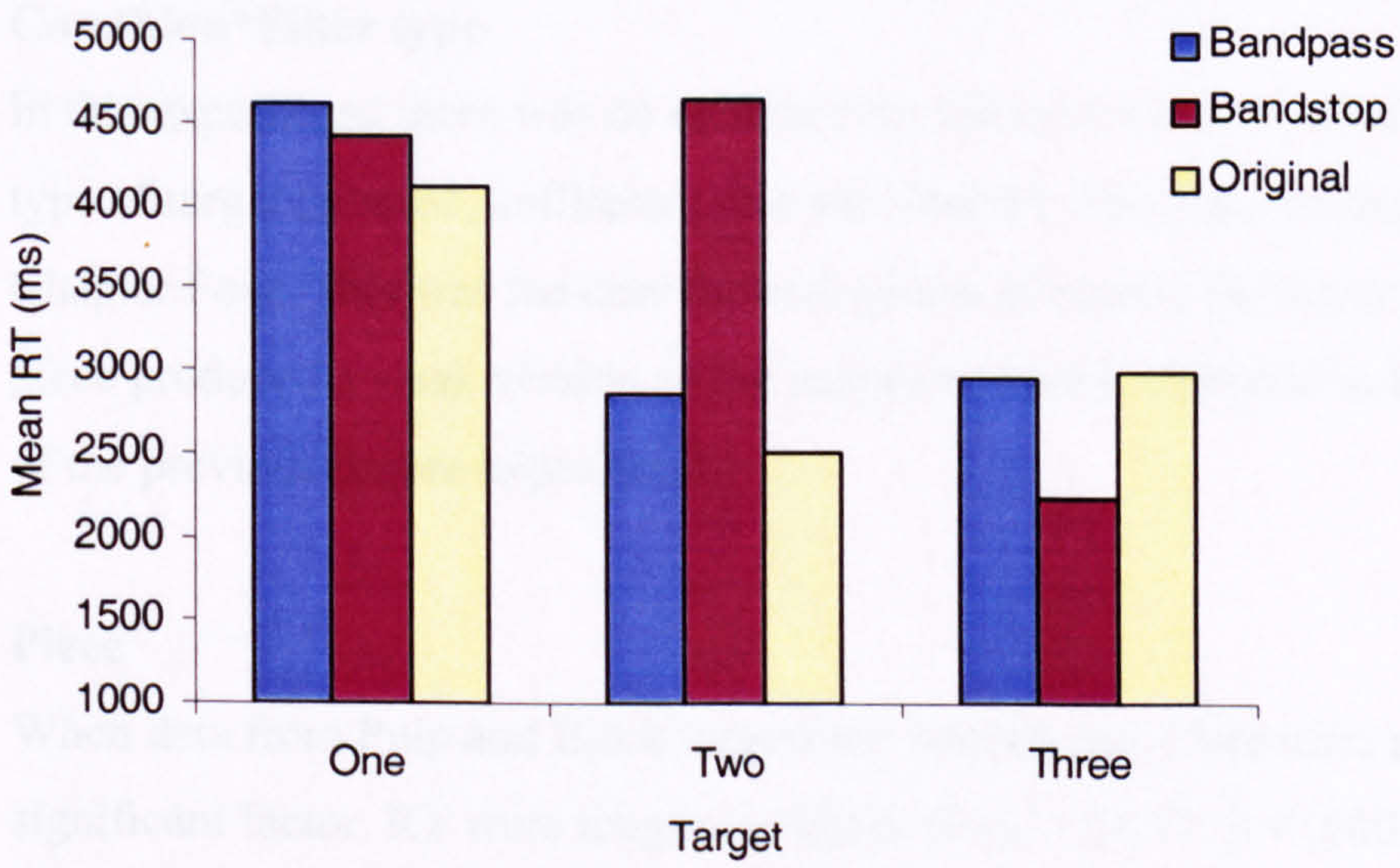
It has been explained that no physical equivalence was sought between the filter parameters applied to each target. Nevertheless, separating data according to filter type ('bandstop', 'bandpass', 'original') can provide an indication of the relative difficulties of perceiving and imaging the different types of sound employed in this experiment.

Pulp *This is Hardcore*

There was no overall difference between performance on bandstop, bandpass and original targets during Pulp. However, filter type and target number interact significantly for RT [interaction $F_{4, 64} = 3.3$, $p < 0.05$]. Figure 5.16 illustrates the pattern, which is of interest mainly as an indication of the level of difficulty of each trial. For instance, while all forms of filter elicited similar response at target one, the bandstop filter at target two led to slow RT, indicating difficulty in perceiving that particular effect.

Figure 5.16

Pulp target*filter: Mean RT (ms)

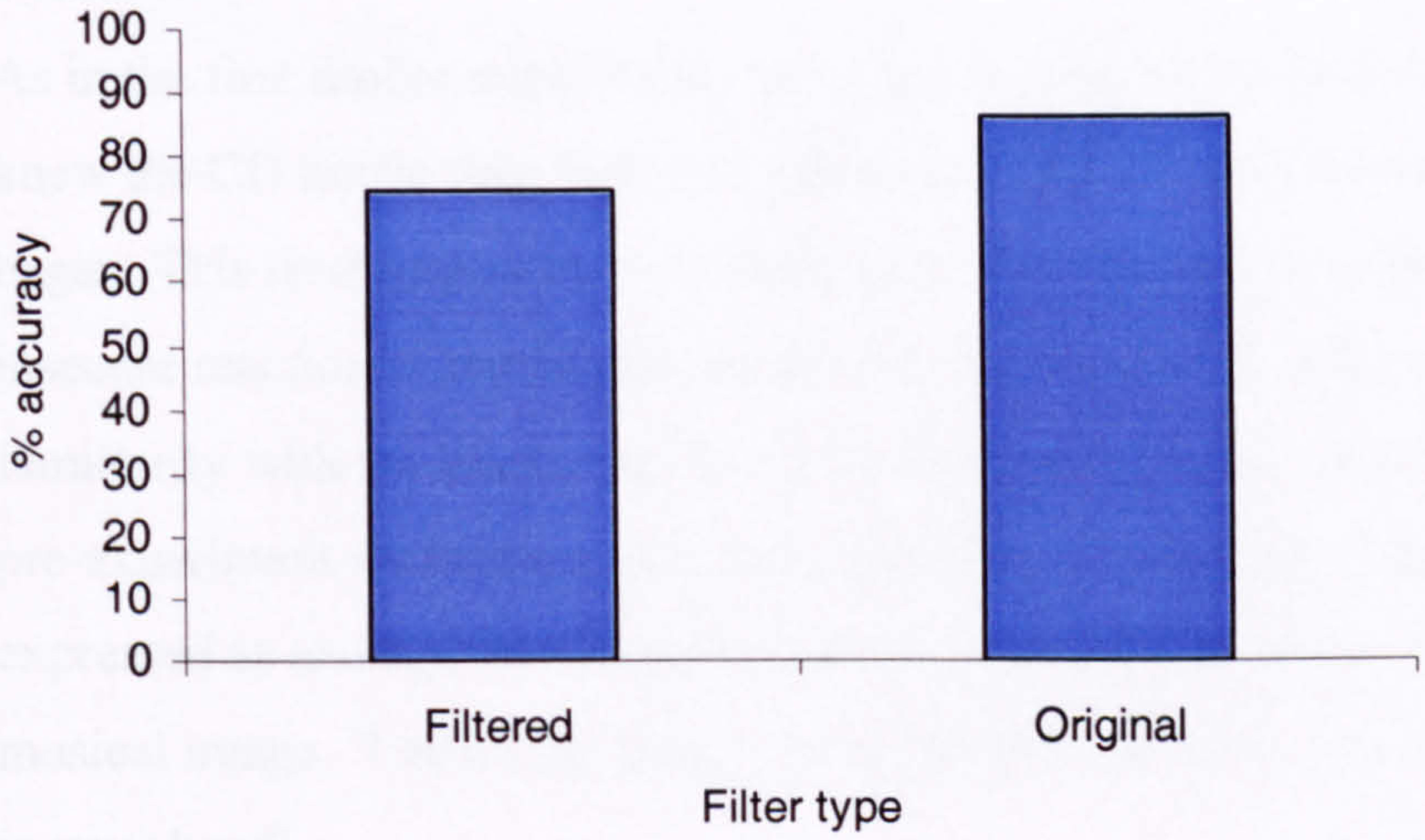


Björk *Scatterheart*

RT are not significantly different for filter type in the Björk, but there is a statistically important pattern for accuracy rate ($\chi^2 > 5.99$, $p < 0.05$). Figure 5.17 shows that filtered targets produced less accurate responses than original target moments. The nature of the music is largely responsible for this result. As explained on page131, *Scatterheart* makes use of filter effects as an integral part of the musical interest. It would not be surprising to find that participants judged additionally filtered targets to be part of the original musical fabric, thus lowering their accuracy rates.

Figure 5.17

Björk Filter: Accuracy rate (%)



Condition*Filter type

In this experiment there was no evidence for the interaction of condition with type of target (filtered, unfiltered) that was found in the experiments of Chapter Four. This was the case for both pieces of music. However, Björk's piece produced a weak version of the pattern (which is opposite to the result of the previous timbre experiment).

Piece

When data from Pulp and Björk targets are pooled, piece becomes a highly significant factor. RT were longer for Björk [$F_{1,15} = 24.13$, $p < .0005$], and accuracy was higher for Pulp ($p < 0.0001$). The differences found between the Björk and Pulp results are largely attributable to the perceived complexity of each piece. The Björk track was commonly reported to contain many changes, and to be complicated in terms of texture and timbre. The increased demands that extra detail in the sound place on memory will affect the conscious recollection, or imagery, of that music. One participant explained that:

> I found the Pulp to be more complete because it was more consistent as it went through, whereas Björk, the track has quite a lot more detail in the way it plays with its elements, and so that's a little bit more in and out. So it's harder to predict what's going to happen in the Björk. So it seemed harder.

Familiarity

As in the first timbre experiment, participants were asked how well they felt they knew the CD music they had been asked to listen to before the main session began. This time responses were fairly positive, contrasting with the more insecure reaction of participants in the last experiment. It will be seen that familiarity with the tracks was felt to be fairly high, surely contributing to this pre-experiment assessment. It is not surprising that in general familiarity was expressed as an important contributing factor in the generation of a secure musical image. 'I mean the more you're familiar the more you can see it actually in your head'.

As already mentioned, a commonly shared view about the Björk was that this was difficult to get to know. One participant said that 'Björk I found quite difficult to get used to because, . . . however many times I listened to it it wasn't really becoming any more familiar'. In light of this impression, poorer performance on the Björk than the Pulp track fits with a general feeling of greater familiarity with the latter.

Sound source

In the last experiment the issue of electronic versus acoustic instruments was raised. This time a similar subject was introduced by some participants who expressed a difficulty with the electronic sounds forming the basis of the Björk track. For example, one said that:

> The Pulp is slightly easier because it's usually more real noises, as opposed to synthesised noises. And so when you've got the idea of what the horns and things should sound like, whereas the Björk is, because when there's an electric noise to start with, it kind of doesn't change much.

It is certain that the use of filtered sounds by Björk made the task of identifying additional filtered effects a difficult one: 'I think I had to concentrate a little bit more in the Björk, but I was aware that there were certain effects on the track already so I was making sure I was in touch with that'. The filtered effects in the Björk track had been a primary reason for this choice of music, so that the sensitivity to timbral change could be tested. Another participant said:

> Sometimes the music was not filtered, and then there was a kind of silence after the piece of music was different, was sometimes filtered or not filtered in the original, so it was hard to imagine which degree of filtering was after the silence period.

Nature of the imagery task

The above quotation is potentially revealing about the true experience of performing imagery tasks. Note the use of the words 'silence period' to describe what should essentially be filled with a vivid timbral image. Others speak of a gap to be crossed, and one which is not always adequately filled, with perhaps the first few moments of image only in place, or 'piecing it together in the gaps'. Asked how vivid her mental image of the Björk was after the experiment session, one participant said that: 'I still don't think I'd be able to sing it back freely, I'd have to listen to it and then maybe could continue if it stopped, but I couldn't sing straight off I don't think'.

These testimonies support the previous experiment findings suggesting that imagery and perception tasks are approached quite differently. Imagery tasks involve an element of recalling music against which to match the heard stimulus, while perception tasks call for a more instinctive and immediate comparison of adjacent musical moments. For instance, one participant found the perception task easier to perform for this reason, saying 'that was easier because you had the direct, the two things next to each other'.

Only one participant explicitly linked difficulties in performing the imagery task to the lack of perceptual feedback against which she could 'check' her judgement. For her, weaker imagery performance may not be due to inferior imagery, but to self-doubt and hesitation. When asked why she found imagery tasks 'much harder', she explained that:

> I just suppose when you listen to it the whole way through you can tell when there's a change whereas when you're imagining it I suppose it's easy not to trust yourself, and what you're hearing in your head, and whether it's right or not.

Timbral Imagery

The purpose of the present experiment was to focus on imagery for timbre. Nevertheless, many participants say they were unable to image sound quality, or that timbre only occasionally featured in a patchy fashion. When asked how complete her mental imagery was, one participant thought 'I don't think it was really the full spectrum of timbre in it. It was more or less the melody that I imagined, and maybe a bit of timbre but I had no representation of the complete piece I have to say'. As the selected music comprised songs with lyrics, and song lyrics were provided for reference, it is not surprising that participants seemed to conceptualise the music as 'songs' (melody and lyrics) separate from their background (comprising textures, harmonies, and timbre).

There is certainly a link between the importance of a particular musical feature for a listener and its subsequent incorporation in their musical image. Some participants in this study identified timbre as an important focus of the music they listened to in their everyday lives, and as such a core component of their imagery. As in the previous experiment, respondents were asked if they were aware of knowing or inwardly hearing the timbre in their imagery of any music. When asked whether he tended to image timbre in his everyday imagery, one participant replied that 'I think so, yeah. Because it's the actual sound really. It's how you hear it rather than what you hear'. Another explains that detailed timbre is important to the perceptual experience of music, in turn transferring to imagery:

> It contributes to the whole sound you listen to, and that's why you've chosen to listen to that certain piece of music as opposed to another piece of music that's different timbre.

Perceiving and Imagining

Familiarity with the stimuli, meaning attributed to sound quality, ease of identifying sounds, and degree of filtering have been discussed as factors shaping the nature of timbral imagery. Another factor mentioned by respondents is the degree of concentration and conscious attention paid to the music in listening. For one participant, 'taking in' music is to concentrate on music. She also mentions trying to concentrate hard as her primary strategy in performing the experiment tasks. Some participants reported having paid particular attention to aspects of the music. One pointed out that she had not always attended fully to the music during the familiarisation phase, feeling this to have a bearing upon her imagery. Interestingly to a consideration of timbre, another respondent speaks of it saying, 'you know it's there, but you don't really pay attention to it'. This final point reiterates the artificiality of the experimental tasks. The experiment session required a degree of attending to the music which would not otherwise be required (although music students are used to analysing music as part of their work). As in previously described experiments, the interviews called for introspection on musical imagery, in addition to the key press task. These different requirements made on participants are reflected in response to the question 'Were you aware of a strategy or technique when doing the task(s)?'. Some respondents seemed bemused by the question, perhaps reflecting a more instinctive, non-reflecting approach to the tasks. Others were able to verbalise their approach in a way that suggests they had consciously reflected on it. One participant described their strategy to task performance as 'Instinctively knowing whether is sounded filtered or not.' The idea of instinctively feeling the answer fits with the findings of the previous in which a more implicit than explicit timbral image was shown to be operative.

Experiment Design

As in previous experiments, respondents were asked to comment on issues raised by the experiment. Some of these provided important feedback concerning the experiment design. For instance, one respondent pointed out that the sound quality of the music through the computer during the experiment was higher than that of the CD when played on his hi-fi system at home. The familiarisation for many may not have provided an adequate level of timbral clarity. This is particularly important in the current experiment, as it differs from the others in its use of relative degrees of filter change, rather than absolute changes in instrumentation, pitch or rhythm.

Another problem, and one that was anticipated but unavoidable, was one of following the visual metronome on screen during the imagery task.

Finally, participants reported occasionally waiting for the onset of particular cues in the music before attempting a response. This was possible because unlike the previous experiments, the target music continued to play until a key was pressed. Talking about his experiences of performing the perception task, a respondent said:

> I noticed that, I think it was a Björk one, I had to kind of wait for the bass to come in before I could tell whether it was filtered or not, because that's the way the tune is anyway.

Another is also talking about the perception task when she says that:

> I could either tell immediately . . . in the Pulp, . . . 'don't make a move 'till I say action', that bit... all other places I could tell when it had kicked in, so I could be immediately responsive, but with the others I just waited until the stuff was going on so I could properly tell.

This indicates that response time could be more meaningfully related to the particular cue being used, rather than the onset of the selected target moment. This helps to explain the different results per target moment, as the musical context seems to have determined when respondents would press a key, more than the simple arrival of the designated target.

5.3.5 Discussion

The hypotheses tested by this experiment have been supported by both the quantitative and the qualitative data collected. Significant global response time patterns for both pieces indicate that the imagery condition was sufficient to facilitate task performance as compared to the inference condition. Perception and imagery tasks did not produce statistically different RT, suggesting that imagery in this case was approaching perception as a contextual aid to discrimination. Differences in the accuracy rates were also significant for Björk but not Pulp. Here though, perception and imagery responses *were* statistically different showing that imagery was less effective than perception as a prime.

Examining perception, imagery and inference data separately, some patterns emerge which are consistent with previous experiment findings. Firstly, the trend of longer response times for perceiving 'original' targets than altered targets has been replicated, with the exception of data for target one. That this pattern is the same for both pieces is striking. Secondly, in this experiment it is clear that imagery data are generally slower than perception, and faster than inference data, but that no significant patterns within those results are discernible. Finally, inference data are seemingly erratic for both pieces, as might be expected of a task largely based on guesswork. As with previous experiments, interview data suggest that participants approach imagery and perception tasks differently, tackling the first as an active comparison of musical events, with the latter more of an instantaneous decision. In imagery tasks the lack of sensory input denies the participant the auditory feedback and checking mechanism that might lend them confidence to perform the task (regardless of the true veridicality of their imagery).

No group or order effects emerged in the second experiment, and familiarity with the experiment stimuli seemed to be fairly assured. It should be noted that the practice effects of the last experiment were not replicated, indicating that the choice of music and increased number of suggested hearings for stimuli produced the desired improvement in experimental design. The length of the songs may have necessitated a broad appreciation of the music as a whole rather than a detailed analysis. This is in keeping with the sort of listening exposure and attention that might naturally be paid to music absorbed as a mental image. As it is true of vision that a distant overview of a scene leads to a general view with distant landmarks, so aural imagery for little known, 'distant' music may feature only occasional, striking timbral features.

The Björk track proved more challenging than the Pulp. Interview data show that this music was felt to change a lot, and to contain a lot of detail. While the music was an ecologically valid choice, participants often felt they could not imagine the degree of filtering already present in the music, and as a result their performance may have depended on more tacit timbral awareness than a conscious image. The meaning attributed to timbre by the individual during the listening process is probably responsible for its place or otherwise in a corresponding mental image. Interview data tend to support this assertion. For example, imagery was explained as an incomplete train of musical thought with occasional, more complete, snapshots along the way. These moments clearly had more resonance than others for the individual. A complicated mix of conscious and unconscious attending during the listening process underpins such imagery.

Hajda *et al.* rightly observe that 'at this time, it is unknown to what extent pitch, duration and loudness confound timbre judgements' (1997: 262). The current experiment did not consider imagery for any musical element other than timbre, because the theoretical focus was not one of perceptual equivalence across trials, but of comparing same trials across musical conditions (inference, imagery, and perception). The task was meaningful for all participants insofar as they understood what was meant by filtered and unfiltered, and respondents were invited to discuss important features of imagery and the experiment, to touch on any faults in the experiment design. Balancing the use of real music with the need to control variables inevitably calls for an imperfect solution. But as Hajda *et al.* observe:

> Variability among listeners means that stimuli *never* will be perceptually equal for every subject. . . . The results of equalisation paradigms are misconstrued; actually researchers *minimise* pitch, loudness and duration variability, not *equalise*. (Hajda *et al.*, 1997: 263)

However, while a rigid control of all parameters was sacrificed, a methodical approach to balancing imagery and perception conditions was not.

It has become apparent in this experiment that participants wait for cues in trying to decide upon the filtered status of the stimulus, in spite of being instructed to respond quickly to the target moment. Though this affects the response times, it is not a problem as long as target moments are considered to be unique and compared across condition. Indeed, this knowledge helps to explain some individual target response patterns, such as the anomaly of target 2 in Pulp.

5.4 General Discussion

The studies reported in this chapter demonstrate that music students can internalise timbre sufficiently to aid performance on a forced-choice timbre discrimination task. The question arises as to whether a conscious image of timbre facilitated task performance. Both sets of post-experiment interview data indicate that where timbre is considered to be integral to the music, or noteworthy in some way for an individual, such timbral moments are more likely to feature in recollection or imagery of that music. A key difference between the first and second experiments is the progression to the use of 'real' music. While participants struggled to listen, learn and recall the timbral sequence in Experiment One, results in Experiment Two are the result of greater familiarity with the musical stimuli, providing more consequential data. In Experiment One there was a greater dependence on tacit timbral knowledge rather than explicit timbral imagery. Results were noticeably poor even under perception conditions. By contrast, Experiment Two was still dependent on tacit knowledge, but to a lesser extent, with greater familiarity and thus image veridicality being reported. The more meaningful nature of the music seems to have led to greater knowledge of the timbral content on implicit and explicit levels of consciousness.

Related to familiarity is the effect of musical complexity on the formation of timbral imagery. The sequence used in Experiment One was difficult to internalise, and participants listed its length and timbral detail as an obstacle. Indeed, some participants found its heard presence in the perception task to be a distraction to their concentration. In Experiment Two, the Björk track was found to include too many changes and too much detail for participants to feel confident in performing the experiment task. Clearly such stimuli presented too heavy a burden on memory, leading to inadequate conscious familiarity with the music.

It will be remembered that, in Chapter Four, the experiments produced longer RT for different targets than same targets when imaging music. In this chapter, this pattern was not significant in Experiment Two, and reversed in Experiment One. It seems plausible that this interaction of condition by target type reflects the difficulty of the experimental task. The relative importance of response times over accuracy rates in each experiment differs dramatically. While the main hypothesis was supported by accuracy rates and not response times in Experiment One, both RT and discrimination data are useful in Experiment Two. Yet again, this difference reflects participant confidence and image veridicality: while confidence was low and performance dependent on tacit timbral knowledge in Experiment One, response time was facilitated by greater conscious awareness of the music employed in Experiment Two.

Finally, it should not be forgotten that the participants in this study were music students. At the start of this chapter some empirical differences between the timbral perception of musicians and nonmusicians were discussed. The current experiments demonstrate that musicians are capable of perceiving and learning timbre, but that their imagery for timbre is dependent on familiarity with the music, liking for the music, the attention paid to timbre, and the meaning attributed to timbre. Consequently, for most participants timbre was viewed as a secondary musical dimension to melody, featuring only when it was originally perceived as significant to the music.

Data from this chapter have shown that a conscious mental image is not required in order to perform a related musical task. The tendency to image various musical properties and the ability to do so are not the same. This distinction relates to the intentional nature of mental representations. While timbral imagery was strongly encouraged in these experiments (the intentional generation of a musical image for a musical task), the experimental focus from the participant's perspective was the perceptual discrimination judgement. As a result, the image took on qualities relating to its function as a context for the task in hand. This tells us little about the actual ability of a music student to form an explicit timbral image. The following chapter explores the importance placed on the development of inner hearing for musicians, to further understand the relationship of imagery to perception in different musical contexts. It explores various approaches taken to aural training, and considers why some musical dimensions, such as timbre, have been comparatively neglected in traditional teaching.

CHAPTER SIX –

DEVELOPING THE MIND'S EAR

6.1 Introduction

Chapter One outlined three distinct categories of musical imagery. The last of these was the intentional imaging of music as in the 'silent' reading and analysis of musical score, or the imaging of sound in harmony and counterpoint exercises. It is clear that this particular imagery function concerns musicians, and calls for a set of auralisation skills. Even the second category of imagery as an unintentional corollary of a musical activity might depend on the ability of an individual to hear in the 'mind's ear'. It has been suggested that intentionality and the nature of musical activity might impact on the experience of musical imagery and its relationship with perception. Having presented a controlled, theory-driven investigation of musical imagery in Chapters Four and Five, the purpose of this and the following chapter is to look at musical imagery in its practical application to musical activity.

The results from previous chapters, which use music students as participants, highlight a need to explore why dimensions such as pitch and timing were seemingly more stable in their mental imagery than timbre. What is the inner hearing training provided for these students, and what is the prevailing attitude as regards the functional importance of imagery in musical activity? This chapter aims to explore the attitudes to musical imagery of those involved in music education, and specifically aural training, so as to reveal the implicit beliefs regarding the potential to develop inner hearing skills, and the extent to which these are valued as part of a student's musical training. The original intention was to investigate how inner hearing is developed, but as will be seen, only one of the three institutions forming the focus of this research had this as an explicit aim of their aural programme.

Of interest to musicians is whether inner hearing skills are innate or can be developed, either as an integral part of musical activity, or as a separate area for training. There is little information concerning the way in which musicians develop their imaging skills to perform musical mental tasks. Nevertheless, the more generic domain of aural training is a long-established educational practice in music that has taken the role of developing both aural perception and strengthening the 'mind's ear'. Aural courses exist for beginner instrumentalists (for example the Associated Board of the Royal Schools of Music examination syllabus) GCSE and A-level students, and those at Music College. It is therefore surprising that so little research into the development of imagery skills has been undertaken.

Why might musicians need musical imagery? Neisser (1976) argued that musical imagery is a form of perceptual readiness. Perceptual readiness can benefit a musician during performance by both mentally and physically priming the production of the sound being evoked by the musician's mental image. Another way in which musical imagery is important, is in the reading of musical notation. Notated score is useful as a means of communication precisely because the reader is presumed to be able to translate the written symbols to an auralisation, or mental image of sound. However, the extent to which a clear mental image is formed in score reading should not be taken for granted, according to research by Brodsky *et al.* (1998). They provide an ingenious example of an experimental procedure, 'embedded melodies', for assessing the inner hearing ability of sight-reading musicians. Their series of experiments provided participants with visual score cues to generate an auditory image, taking familiar melodies and arranging them such that only an internal realisation of the score would reveal the identity of the modified and disguised original tune. Participants matched sounded melodies with the notation-based internal melody, providing evidence that professional orchestral musicians varied greatly in their ability to inwardly hear notated music.

It is helpful to consider what dimensions of traditional aural training relate to musical imagery. For example dictation tasks of different elements of music require perception before the sound is 'heard' as a short-term image. This image can then be translated to notation. Singing or playing back different elements of aurally presented music involves all these processes, except that rather than representing the sound in notation it is produced in a physical manner. Sight-singing and sight-reading music require imagery: the music is read and translated into an aural image before production. More advanced score-reading involves the auralisation of not just pitch and rhythm, but instrumentation, texture, dynamics, and articulation. Even aural skills that appear to be more concerned with perception require a representation of sound in the mind. For instance, tracking a piece of music in order to name a chord progression involves short-term aural memory for preceding events. The whole range of aural skills seems to implicate imagery, and as such, aural training directly involves the development of inner hearing.

The first year of higher education in music is generally the highest level of formal aural training provided, and consequently a particularly interesting stage to examine. Institutions of higher music education differ greatly from each other in their educational focus, and have consequently adopted various approaches to the development of aural skills. A selection of education programmes will be discussed in this chapter, following an examination of the scant literature on the development of musical imagery and a look at some specific aural training methods and their approach to inner hearing skills.

6.2 Literature on the development of musical imagery

Godøy and Jørgensen (2001) have edited the most recent collection of writings on the subject of musical imagery, yet this does not address developmental issues or musical education. Even in the field of visual imagery, developmental research is scarce (see Paivio, 1971, and Denis, 1989, for a review). For an understanding of imagery development it is necessary to look at the less specific literature concerning aural training and music perception.

Aural skills are fundamental to all music, and for this reason their inclusion as a separate subject in music education is controversial: Priest (1993) points out that an artist does not expect to have lessons in 'visual training'. If aural is an integral part of musical activity, why is it separated out into a set of more or less agreed upon exercises? Priest (1993) argues that musical literacy is largely responsible for this trend, claiming that it forces attention away from sound itself to its symbolic representation. Reading music requires the translation of symbol to sound, and of sound to symbol, in varying degrees of difficulty. While dealing in sound directly undoubtedly requires high skills of perception, reading music is a specialised addition to simply hearing music. Aural training as a discipline has arisen from these needs.

Psychology has uncovered certain facets of musical memory and learning that could be applicable to aural training and the development of imagery. For example, Davies and Yelland (1977) asked subjects to produce the melodic contour of tonal sequences following two different training procedures. These were either silent rehearsal of familiar music, or an immediate retrieval of the presented sequences. Those subjects in the silent rehearsal group were the only ones to significantly improve in their post-training performance. Consequently the authors found that 'the ability to form stable, accurate internal representations is amenable to practice, and can be improved at least in the short term' (Davies and Yelland, 1977: 8). This very specific imagery task, at least, is open to development through training, although only short-term effects were monitored here.

Lapidaki (2000) has contributed developmental knowledge of tempo stability in musical imagery. Age was a factor in her experiment, which examined the consistency of tempo perception in music listening with participants of different backgrounds. Participants were required to decide whether music they were hearing should be played faster or slower, a task necessitating a mental image of the desired tempo. She found that adults were the most consistent in tempo judgements, with adolescents being more consistent than preadolescents. She points out (2000: 39) that this finding does not fit with Imberty's 1981 assertion that the perception of various musical parameters reaches a plateau after the age of 10 years. 'It is therefore likely, though not essentially certain, that only when the representation of music has stabilised in the mind through maturation, is the corresponding temporal consistency noticeable' (Lapidaki, 2000: 39). Lapidaki's work suggests that imagery for tempo is naturally prone to stabilise through time. Note that her findings concern chronological development rather than the effects of training.

Developmental considerations in musical imagery are not limited to the auditory, but also to the kinaesthetic, visual and spatial modalities. With so many properties of musical imagery and multi-modal memory to consider, the picture of the potential development of imagery is complex. To the author's knowledge there is only limited literature addressing the beginning of musical image formation, either at a pre-natal stage or in the early years of life. For musical imagery, as with the development of any knowledge structure, issues of nature and nurture play a role. Farnsworth (1958) proposes that 'the early appearance of strong auditory imagery in the child may serve as a predisposing factor to subsequent ability with, and interest in, tonal materials' (196). It would however be imprudent to address such questions directly within the scope of this thesis, given the scope of the task, and the sparseness of existing knowledge.

Literature does exist concerning the development of musical imagery in children. Priest (1993) recognises the importance of developing the 'inner ear' for children. He argues that not enough music educators 'have been . . . aware of the need to develop perception and imagery and "auditory feeling" in order to avoid a mechanical approach to reading' (Priest, 1993: 105). According to Priest, aural ability should bypass the score, being replaced instead with an auditory image: an auditory image of sound would provide the musician with an alternative point of reference to the written page. Priest proposes that kinaesthesia should support musical learning, through the perception and imaging of psychomotor aspects of music such as the feel of the instrument and the body tension needed to produce the desired sound. Nevertheless, he stresses that the aural image must come first. Thus the title of his paper, *Putting Listening First* proposes the perception and imaging of sound as the pre-requisite for the development of aural skills.

> 'Aural', in the experience of those we teach, should be concerned with sounds in the head and responding to them practically. These can be remembered sound patterns or new, imagined ones. . . . If such imaging of sounds is considered to be an essential part of behaving like a musician, it should be integrated with other aspects (Priest, 1993: 105).

Jacques-Dalcroze is also concerned with musical imagery in his writings on music education (1967).

> The essential is . . . that musical training should develop inner hearing – that is, the capacity for hearing music as distinctly mentally as physically. Every method of teaching should aim, before anything else, at awakening this capacity. (98)

For him, rhythm is fundamental to musical sense, and the whole musical being should be based on a multi-modal amalgamation of experience. He stresses that 'Musical consciousness is the result of physical experience' (Ibid.: 39), and that 'It is only through experience, be it remembered, that the inner ear can be formed and trained' (Ibid.: 55). In particular, Jacques-Dalcroze promotes singing as essential to the development of a 'good ear': 'There is so intimate a connection between the vocal and the aural processes that the development of the one virtually involves the development of the other'. (Ibid.: 21). The flux of perceived physical experience and perceived mental representation is at the centre of Jacques-Dalcroze's pedagogical approach. He describes specific activities to encourage the 'creation of mental hearing of sounds', such as asking students to sing a melody, stop at a certain word, and then image the continuation of the song.

Sakata is influenced by Jacques-Dalcroze in her work on the formation of inner hearing (1993). Based on her own introspection as a performer and on the observation of young children in their music learning she proposes a model of inner hearing development that depends on the interaction of experience with imagery for motion. The model takes the form of a spiral in which experience and consciousness unite in musical activities of increasing sophistication, culminating in a developed 'mind's ear' and heightened powers of perceptual appreciation. For her, imagery is an integral part of perception; any conceptual distinction between the two being the external or internal origin of the experiences.

As individuals learn music in an increasingly specialised way, superior aural skills are presumed to be of increasing importance. Institutions of higher education in music exemplify this specialised level of musical activity. McKenzie-Gray (2000) designed a study to examine how aural perception was taught in the music department of one particular university. She aimed to determine why some music students outperformed others in aural tests when they first began their university course, and to work out how those with lower marks could do better. Her study was not specifically about inner hearing, but does address the issue of what she terms 'audiation'. She asked students to give possible reasons for improving aural perception. Interestingly for the current study, answers concerning the internal representation of music were offered, such as being able to do analysis, playing by ear, improvising and being able to do music dictation. Thus students themselves confirmed a link between aural training and musical activities dependent on musical imagery.

A summary of the limited literature on the development of inner hearing skills suggests that imagery and aural are mutually important. The theoretical work of Jacques-Dalcroze might be useful in its proposition of an alternation between physical and mental forms of musical perception in order to train the mind's ear. Psychological research has contributed some useful knowledge of imagery development, namely the stability of mental representations of tempo related to age, and the possibility of learning short-term tonal images through practice. Multi-modal musical imagery has also been mentioned in the context of development, though this is a complex area that has received inadequate attention. None of this literature has satisfactorily explained or monitored the development of the mind's ear. The following section will explore instead some examples of aural training methods.

6.3 Development in Practice

There have been various publications advising both students and teachers how to develop aural skills in an effective way. In 1978, Thackray published a book entitled *Aural Awakening* which calls into question the traditionally narrow approach to aural development. In addition to the chapters on dictation and sight-singing, it seeks to include a more comprehensive and inter-disciplinary range of exercises that go beyond the confines of simply testing ability. The book is primarily aimed at first year students of music in higher education. Imagery is occasionally mentioned as important to aural development:

> One of the secrets of good instrumental reading is to be able to hear the music inwardly before playing and not rely entirely on the mechanism of the instrument; many instrumental teachers rightly stress the importance of singing as a preliminary or complement to playing. It is regrettable, however, that many do not. (Thackray, 1978: 183)

Thackray writes that the term aural training 'is of course a misnomer. We are concerned not just with "training the ear", but with the whole mental process' (1978: 4). His methods intentionally adopt 'a multi-sensory approach in which ear, voice, eye and finger are all involved' (Ibid.: 7).

Pratt has been a leading figure in aural training practice. His book *Aural Awareness: Principles and Practice* (1990) is very similar to Thackray's volume of twelve years previously, as it tackles aural training from a needs-based perspective. The exercises and advice are aimed primarily at A-level music students. A distinction is normally made between hearing and listening, with the latter an active process requiring a conscious focus. Pratt (1990) aims to develop just such a conscious, active awareness of different musical elements. The method proposed essentially draws attention to the detail of sound. The reader is encouraged to concentrate on different instrument sounds, as this will have a bearing on the ability to image timbre:

> A week spent concentrating on violins and violinists, oboes and oboists, pop vocalists, or jazz pianists will extend your repertoire of sound and enhance your ability to 'image' it. Then, in turn, it is available for you to use. (Pratt, 1990: 85/6)

Imaging sound is featured as an important aspect of aural awareness, and as a means of dealing with sound. An entire chapter is devoted to the subject. Pratt observes that auralising a score is a useful way to focus on dimensions other than pitch, such as texture, dynamics, timbre, density, and rhythm. His idea is that such imaging allows a musician to by-pass the constraints of physical performance skill and listening to recordings.

> A great deal can be learnt about a piece of music by *not* performing it but, instead, sitting away from your instrument and reading through it in your head. Accuracy of notes recedes into the background – if you already know the piece, they are, anyway, easily 'thought' correctly – and instead you can pay attention to the other elements, in great detail and with great clarity. (86).

Pratt is unusual in writing about one neglected dimension of the musical image, that of the spatial location of sound:

> We frequently ignore the placing of music in space as we use our 'inner hearing', as we *imagine* sound. Think to yourself the opening two bars of Beethoven's *Fifth Symphony*... Did you hear the *breadth* of the sound as well as the familiar rhythm and the falling third? ... When reading music silently, we tend to miss its expansiveness. Do you read a full orchestral chord simply as a pillar of vertical sound, or does your imagination have horns on the left and trombones on the right? (Pratt, 1990: 23)

The extent to which 'expansiveness' is a property that can be imaged in music is not known, as this is an area that has been overlooked in music research. Pratt is demanding in his imagery exercises. One asks his readers to imagine their way through the horn part of the *Prologue* from Britten's *Serenade for Tenor, Horn and Strings*. They are then asked whether a horn had been 'heard', whether a specific performer had been 'playing it', how close or distant the image was, how firmly the first note was 'tongued', how smooth certain slurred notes were.

> Most people engaging in such an exercise hear a kind of vocalized sound or a barely audible whistle made by pitching within their mouths but without using vocal chords. Identifying pitches can often totally obscure every other notated element, let alone the un-notated qualities (Pratt, 1990: 85).

While Pratt's observations and exercises are intuitively sound, he provides no empirical evidence to suggest that imagery is commonly experienced in such a way, or that it is even open to development.

Memorising music for performance is the process of creating an image of that music. Pratt acknowledges the multi-modal form that such a memory image can take. His chapter on playing for memory is divided into 'aural memory', 'visual memory', 'kinaesthetic memory' and 'analytical memory'. In particular he discusses the Suzuki method of learning for its reliance on playing by ear and consequently memory (see also Lester, 1987). Pratt recommends the following kinaesthetic exercise in imaging:

> A revealing experience, once a piece of music is thoroughly memorised, is to play it in the dark. All visual distractions except a mental picture of the score are put aside; nothing impinges on the senses other than sound and touch. (Pratt, 1990: 113).

Freymuth (1999) has published a guide for musicians to encourage the use of mental practice and imagery to optimise practice time and enhance performance. It is intended not for use in a class setting, but as a personal aid for performing musicians. As such it emphasises the application of imaging rather than its development as a skill. The varieties of mental practice covered by the volume are imagining an ideal sound; recalling the sensation of performing; performing mentally to a recording; miming music; and dance. It is underlined that mental practice can clarify musical goals, and also prepare the body for response. Freymuth observes an important interaction between perception, imaging, and performance:

> Effective mental practice depends upon a high level of sensory awareness. The more conscious you are of sensory feedback *while playing*, the more clearly you can imagine playing. In turn, the more vivid the mental work becomes, the more powerfully it can influence playing and performance. (Freymuth, 1999: 33).

The book is largely based on the Freymuth's own experience, and is lacking in adequate empirical support for her ideas. Nevertheless, the approach is practical, aiming to develop visual, aural, kinaesthetic, smell and taste senses in mental practice. She endorses deliberate manipulation of musical mental images, and takes it for granted that imagery can be as vivid as real experience. The way to achieve such veridicality is to use imagery alongside perception:

> Alternating continually between mental and physical playing is the key to building a strong musical memory, where aural representations are as clearly perceived as their physical counterparts (Freymuth, 1999: 38).

In common with Pratt, the importance of multi-modal musical dimensions is recognised by Freymuth to be important to imagery.

'Harmony and counterpoint' is an area of musical training that ideally involves the imaging of sound. For example, in an examination situation a student does not have access to a keyboard to hear their work. An e-mail discussion among representatives from institutions of higher education in the UK, co-ordinated by PALATINE (Performing Arts Learning and Teaching Innovation Network), surveyed the teaching of harmony and counterpoint at the transitional stage from A-level music to an undergraduate degree. One of the questions posed by PALATINE was whether the completion of A-level technical tests as coursework rather than exam still meant that it is important for music students to develop the capacity to 'hear' internally. If so, should they develop the skill for themselves or should it be taught somehow? An overview of responses shows an agreement as to the importance of inner hearing for both harmony and counterpoint and other music activities. There was also a consensus that students should be helped to develop the skill, and aural training was mentioned as the primary means to achieve this.

Hurry (1997) surveyed the views of twenty-five music lecturers about A-level music syllabuses. She found that while some boards allowed the use of keyboards in exams, 'several lecturers expressed relief that "silent" harmony and counterpoint was included in some syllabuses' (Hurry, 1997: 30). This same survey of music lecturers highlights the placement of 'aural ability' as the second most important area of past study for prospective music students (94%). Thus aural skills, including inner hearing, were prized by respondents in the survey. There is an apparent mismatch between the value placed on aural, and the time devoted to its teaching. For example, McKenzie-Gray (2000) asked peripatetic music teachers in her study about their teaching priorities. She found that technical fluency and repertoire were given most time in a lesson, with improvisation and 'aural' the least.

How is aural taught? An established method is the use of computer assisted learning (CAL). Examples include TLTP3 (Teaching and Learning Technology Programme 3) and CALMA (Computer Assisted Learning for Musical Awareness). These packages allow for the playback of music for specific aural exercises. Either an individual can use them to target particular areas of skill, or a teacher can use them as part of their aural teaching. As McKenzie-Gray points out (2000), one of the drawbacks of CAL can be the lack of support in the face of decreased motivation for an individual working alone. Of interest to the current research, CAL is more inclined to encourage practice in perception than imagery, given that music can be played repeatedly, minimising on aural memory. Working at a computer encourages the hands-on manipulation of sound, and not a removed musical image.

By addressing the purpose of aural training, various music educators have challenged the still prevalent traditions of certain core aural exercises such as dictation and interval recognition. Pratt and the team at RAMP (Research into Applied Musical Perception) in particular are a rare example of the promotion of inner hearing, including the detailed awareness and imaging of aspects of sound additional to pitch and rhythm, such as timbre and articulation. They also stress the importance of attentive, focused listening as a means to improve aural ability, and that aural should be fully integrated within a teaching programme, rather than occupying separate lessons. Others have stressed the importance of action and invention in improving aural abilities (Clarke, 1987). Multi-dimensional memory-images are encouraged by Pratt and by Freymuth, and both suggest that the combination of perception and imagery is important to aural development.

6.4 Observation and Interview

The limited amount of literature and pedagogical guidance to develop imaging does not give a comprehensive picture of current aural teaching practice in higher education. Particularly lacking is the perspective of aural tutors, who might hold specific views about the relevance of imagery to aural, and the possible ways of developing the skill. The existing literature does not distinguish adequately between different institutional aims. While a music college might be expected to focus on practical aural skills, a university music department might be geared towards more academic, notation-driven exercises. Consequently, aural classes at three different institutions of higher education were observed. Students filled out a questionnaire at the start of their aural course to gather their views about their past aural training and the importance of inner hearing skills. Tutors were asked about their methods of teaching and about their own experiences of developing inner hearing. Finally, extra discussions were held with students at the end of their course to determine how they felt about their training.

6.4.1 Aims

- To determine whether inner hearing is viewed as an important skill
- To explore how inner hearing can be developed
- To explore the relationship of hearing to inner hearing in aural training

6.4.2 Participating Institutions

Three institutions were informed of the aims of the project, and gave their consent to take part. All three were in the North of England.

1) 'Traditional' music department

A university music department offering a traditionally academic degree in music was selected. Aural training was worth 20% of a general 'Instrumental studies and Aural' module, which was compulsory for all level 1 music students. Aural classes took place on a fortnightly basis. The module director had previously taught the aural component, but no longer did so, the work being contracted to an external tutor. One of the course aims for the aural content was 'to cultivate the inner ear by developing aural awareness and extending musical memory'.

2) 'Practical' music department

A university music department offering a fairly practice-based degree in music was contacted. There was no aural class as such, rather a 'Ways of Listening' module stemming largely from the work of Pratt who had been professor in the department. The module combined improvisation classes with classes in aural perception and approaches to listening. This department was home to CALMA, though the programme was not in use during the time the study was conducted.

3) Music College

A music college offering practical training for students who intend to pursue a career in music performance was selected. Students attended weekly classes, and took aural training for the first two years of their study. They could additionally opt to take aural in their third and final year.

6.4.3 Questionnaire and Interview Material

Identical questionnaires were devised for students at each institution to complete (see Appendix G). In addition to gathering information about age, gender, and musical background, the following questions were asked:

> Q. Please list any musical situations in which you believe the ability to imagine or have a mental image of sound is an asset
>
> Q. Please list any aspects of your current or past musical training which were designed to improve or did improve your inner hearing skills

Respondents were also asked whether they believed inner hearing to be an innate ability, and whether they felt the skill related to musical talent. They rated, on a scale of 1 to 7, various beliefs about their aural ability, as well as the frequency of their 'tune on the brain' experiences. The final two questions invited information about any patterns that the respondents could see to the types of music imaged, and the times they might image music. Though there is no reason to believe that experiencing 'tune on the brain' phenomena is linked to the functional imagery involved in musical activity, such data were collected in the eventuality that a relationship between the two existed. Finally, respondents were required to indicate whether they would be willing to take part in a follow-up. Those that responded positively were invited to take part in a discussion group at the end of the module.

Semi-structured interview schedules were tailored for course tutors, directors, and in one case, the originator of the course material (see Appendix H for a sample interview schedule). Core questions addressed how inner hearing could be developed, how it could be measured, the changing needs of aural training, and the respondent's past aural training experience. As in Chapter Three, the semi-structured interview format was preferred to allow the respondent to discuss issues relevant to them within the thematic framework of inner hearing.

6.4.4 Data collection and presentation

An aural class was observed at each of the institutions towards the start of each module. The purpose was to gather information about the educational emphasis on the course and the material used. At this point the questionnaire was distributed to students. Questionnaires were returned collectively via each institution.

A course tutor was invited to take part in an interview from each of the institutions. Their participation was agreed at the start of the module, with interviews taking place at the end. Where possible, an extra class was observed towards the end of the course (at the two university departments). Those students who had volunteered on the returned questionnaires to take part in a follow-up were contacted and invited to participate in a group discussion about 'tune on the brain' experiences (see Appendix I for discussion group questions). Due to practical considerations outside of the investigator's control[1], only one

[1] This was due to a combination of extraneous factors at each of the institutions, ranging from unreliable communication of time and venue to the students, to timetable changes (after which point students had left to study for their exams without the possibility of arranging a later session).

group discussion took place (at the 'practical' music department), while an interview with just one volunteer student took place at another[2] (the more traditional music department). No follow-up with the students took place at the Music College. At the 'traditional' music department, there was an opportunity to interview an additional member of staff. Although she no longer taught on the aural course, she had written the course material. This interview also took place towards the end of the module's duration.

A summary of findings across all three institutions will be presented first, including a presentation of the questionnaire data. Following this, two main themes that emerged from the study will be described in detail, and these structure the remainder of the chapter, in which an examination of the data per institution from observation, interview and student discussion will be included.

6.4.5 Summary of study findings

Overall, course tutors and students either believed or worked on the premise that musical imagery could be developed. However, some course tutors struggled to describe techniques to help those with the weakest skills, seeing this as a particular challenge to the teaching of aural. An apparent divide was seen to occur between those with good inner hearing, and those without. When probed, participants in this study unanimously found inner hearing to be an important ability. However, observation and student discussion revealed that inner hearing was rarely, if ever, conceptualised as a separate skill to be trained. Instead, the development of musical imagery was approached in a more holistic fashion, frequently inextricable from the activities of music listening and music performance. These two domains of musical activity form the two methods found to be of most importance to inner hearing: auditory experience through listening, or a more physical experience through performance. Different institutions favoured a different balance of either listening or performance, though some form of heightened perceptual experience was always reported to underpin the improvement of inner hearing. These two themes will be developed later with respect to data from each of the institutions.

[2] NB. Only one of the volunteers attended

6.4.6 Questionnaire data

Response rates from the two university music departments were disappointing, with only eight completed questionnaires from the first institution and eleven from the second. However, the course tutor at the Music College incorporated the questionnaire into her lesson time, so that students both completed and returned a total of fifty-six responses. It follows that data from the Music College are potentially more representative than those from the universities where only students motivated to complete and return the form took part. The mean age of respondents was 18 years. A total of 36 male and 39 female students responded.

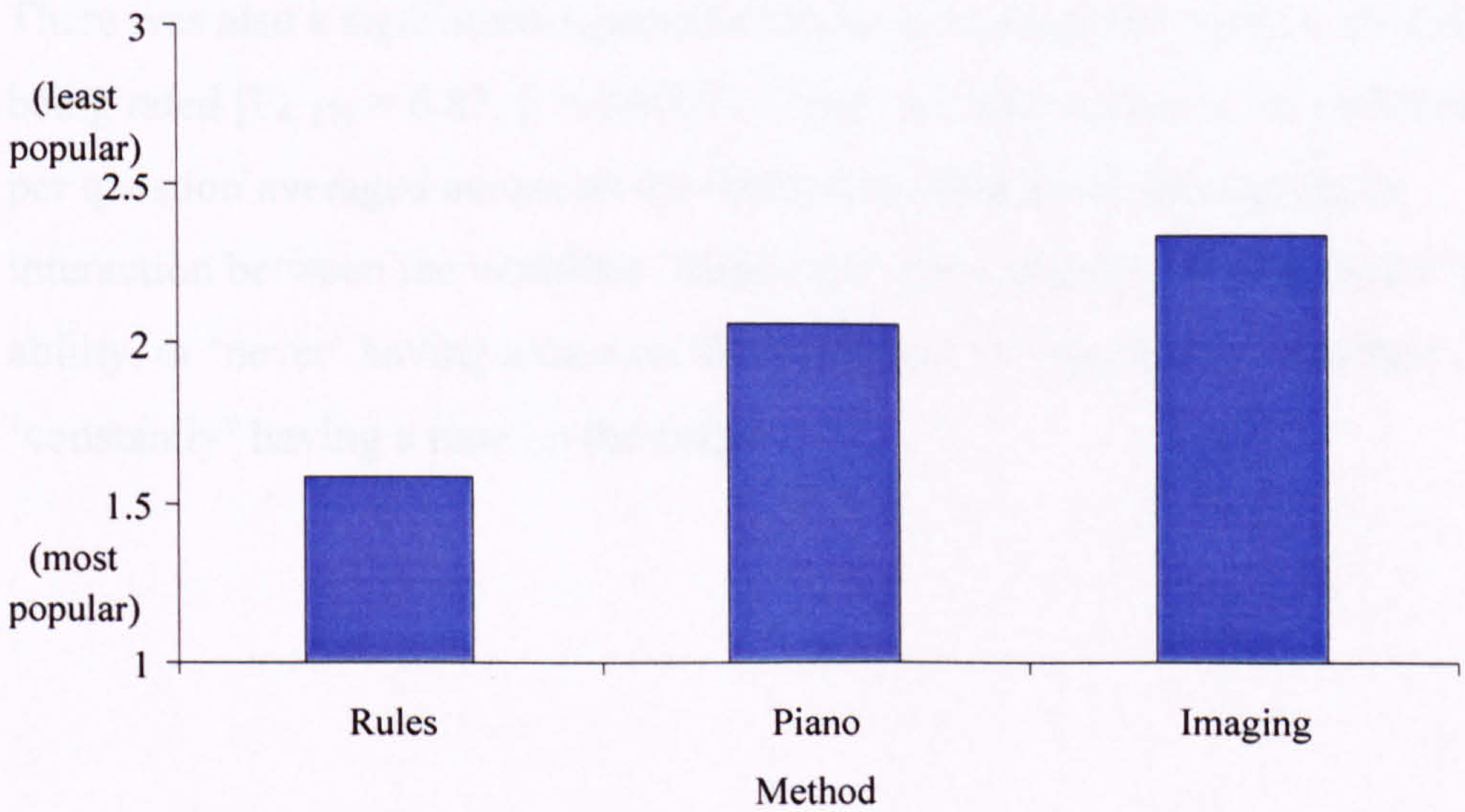
Respondents were asked to list the instruments they played, estimating the length of time they had been learning. A variety of instruments were represented, with piano the most frequently represented for students at all of the institutions. At the traditional university music department, all but one of the respondents had taken an aural skills component as part of their A-level or Scottish Higher music course. All of those at the practical university department had previously studied aural at this level, while 7 of the 56 respondents at Music College had not. One of the respondents at the traditional university had perfect pitch, as did 10 of those at the Music College, while none at the practical university did. A couple of respondents reported some hearing loss (one each at the traditional music department and the Music College).

One of the aims of the research was to determine whether inner hearing was seen to be an important skill. The first open question asked students to name situations in which they could see that imaging sound might be an asset. Responses to this were comprehensive: many students simply wrote 'all' musical situations, while specific categories (see Appendix J for list of coded answers) included group performance, composing, conducting, arranging, teaching, harmony exercises, aural tests, improvisation, practising, memorising, sight reading, analysis, performing, anticipating sound, and imaging a narrative or programme. Students were then asked to list any aspects of their current or past musical training that were designed to improve inner hearing skills. Many different aural training techniques were named (see Appendix K), including dictation. Harmony classes, improvisation, aspects of instrument lessons, group singing and composition were also listed. A few respondents mentioned pitching notes as a way to develop inner hearing, and music listening was also mentioned.

The 74% of respondents who had been taught harmony at A-level were asked to number from 1 to 3 their most frequently used method of doing harmony exercises from the following list: application of abstract rules, imagining the sound, playing at the piano. A two-way ANOVA indicated that while the institution attended was not a factor in these data, the ratings were significantly different for each of the three methods [$F_{2, 100} = 8.67$, $p < 0.0005$]. Figure 6.1 illustrates the overall reliance on rules above use of the piano. Imaging the sound was the least employed method.

Figure 6.1

Mean rating for method of doing harmony exercises (at A-level)



Respondents were asked whether they believed inner hearing to be an innate ability. A generalised chi-square examined the distribution of 'yes', 'no' and 'unsure' answers between the institutions, finding no significant pattern. Overall, respondents were 'unsure' (51%), with 33% believing it to be the case.

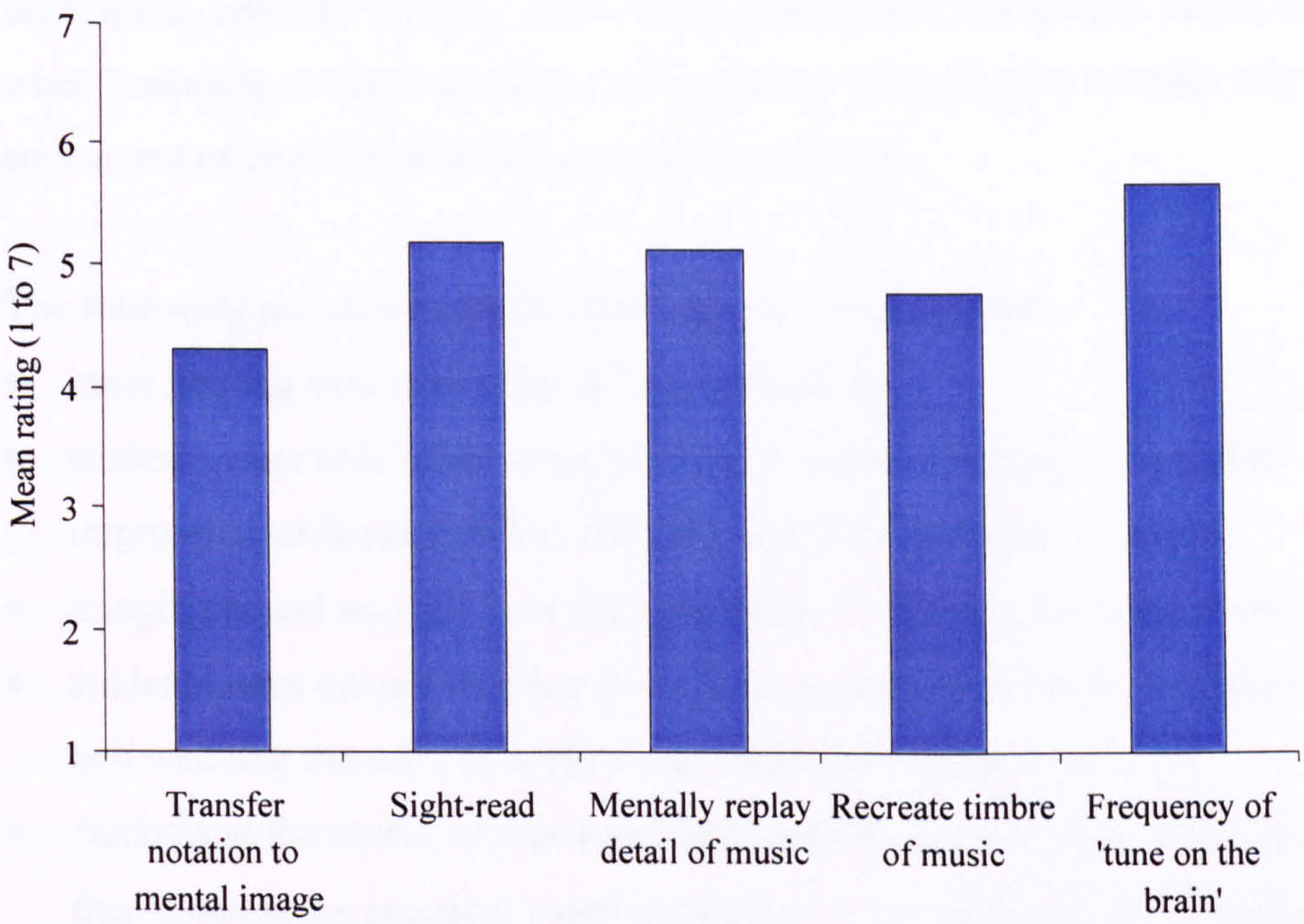
A subsequent question asked whether most 'talented' musicians had good inner hearing. The majority of respondents believed this to so (67%), with only 5% saying otherwise. A chi-square found no significant pattern of answers between institutions for this question.

Respondents rated their ability to perform various imagery-based tasks, and also the frequency with which they experienced 'tune on the brain' phenomena. These data were analysed together in a two-way ANOVA to determine whether the variable 'institution' had a bearing on ratings. 'Institution' was a significant factor [$F_{2,69} = 3.25$, $p < 0.05$], with a higher mean at the Music College for all questions. The practical university department had a slightly lower mean rating than the Music College, and the academic university department represented the lowest mean rating. It is not surprising that students at the music college rated their inner hearing skills more highly than those at university music departments: access to music college is highly competitive, and belonging to such an institution is testimony to high levels of musical skill. The high ratings could be either a result of genuinely superior skills, or of increased confidence through belonging to the college.

There was also a significant reported difference between the various abilities being rated [$F_{4,276} = 6.81$, $p = 0.0001$]. Figure 6.2 demonstrates the mean rating per question averaged across all the institutions (there was no significant interaction between the variables 'institution' and 'rating'). '1' represents 'poor' ability, or 'never' having a tune on the brain, and '7' represents 'excellent', or 'constantly' having a tune on the brain.

Figure 6.2

Mean rating of ability to perform imagery tasks, and mean frequency of experiencing 'tune on the brain'



Data for 'tune on the brain' questions were extensive. The pattern of interest to the development of inner hearing was that a large number of respondents mentioned imaging music that they had performed or were working on at the moment. Many students mentioned imaging music with which they were generally familiar, liked, or had studied. Most common was the inner hearing of easily identifiable melodic music, perhaps the solo line of a concerto or sonata or vocal music. Imagery for harmony was also mentioned, though normally as secondary to melody. Less common features include one participant who claimed to image mostly chromatic and atonal music, and another imaged 'Eastern sounding' music. Style, timbre and articulation were named as image features by only one individual.

Students at all three institutions were prone to answer that their musical imagery was constant. Otherwise, there was an interesting pattern of students claiming to image music when waking up or last thing at night. This is in contrast to the ESM finding of Chapter Three (though it should be remembered that it was not possible in that study to sample early and late moments in the day). Other students linked their imagery to times when they were either preparing mentally to play (for practice or a performance) or had just played. A couple of participants reported imaging music when playing and listening to music, or when humming or singing: their answers did not make it clear whether this was concurrent or chronological imaging and perceiving.

The following points summarise data from the questionnaire:

- inner hearing was seen to be an important skill,
- students were able to list some aspects of musical training designed to improve inner hearing skills, including actually listening to music
- imaging sound was the least common method of doing harmony exercises,
- students were unsure whether inner hearing is an innate skill, but largely believed that the most talented musicians have a good mind's ear,
- students at the music college rated their various inner hearing skills higher than those at the practical based institution, who rated their skills higher than those at the traditional institution
- respondents rated their ability to sight-read more highly than their ability to translate musical notation to a mental image of sound
- respondents rated their ability to recreate musical detail in a mental image more highly than the more specific ability to image timbre

6.4.7 'Traditional' music department

6.4.7.1 Teaching style

First year students at the 'traditional' music department were streamed into three groups of sixteen, following performance in an aural test in the first week of the university course. Two separate groups were observed on separate occasions (15th September 2001 and 23rd April 2002), though the same course tutor (CW) took both. The time was split according to the two types of aural activity found in the aural examination: the first portion of the lesson was spent on exercises of interval recognition, dictation, and identifying cadences; the second portion of the lesson involved answering questions related to a specific piece of music. This second exercise was taken directly from *Aural Analysis*, the course book by Dale (1994) which is described in greater detail below.

The content of the class observed at the start of the course differed greatly from the class at the end of the course, at which point teaching centred on the students' requests for specific help in preparation for their exam. This was given in the form of exercises such as rhythm dictation and SATB sight singing. The first class observed had a clear emphasis on inner hearing (the extent to which this was normally the case is unknown). For instance, students were told that singing is simply 'externalising' what is heard in the head. They were also encouraged to imagine chords while sustaining pitches. Sight singing was a particular focus of the class, both for the group as a whole, and for individuals. Students were frequently asked 'Did you hear it in your heads?'. In spite of the activity of sight singing, the emphasis of the class was on heightened music listening rather than the development of aural through practical means.

An informal conversation with CW at the end of the last class revealed his concerns that one particular group had low aural abilities because they had poor inner hearing. His theory was that such a skill needed to be present before the age of five or six years, otherwise its acquisition would be problematic. He also stressed that sight-singing was less common at schools than previously, thus students came to the university at a disadvantage.

6.4.7.2 Teaching material and its derivation

Dale's book comprises excerpts of seventeenth- to nineteenth-century Western music in score and on compact disc. Though it is primarily about aural perception, an aural memory is an advantage to completing tasks such as transcribing a melody or identifying a cadence. The book forms the basis for the course teaching, and is also the basis for the one-hour test at the end of the semester.

CD was interviewed about her book and her past experiences of aural training. Her view was that 'everybody can develop inner hearing'.

> Certainly in terms of just the old practice of 'take this rhythm down', 'take this melody down', taking intervals down, you really can improve on those I think, just by familiarity.

Implicit to her solution is that repeated music perception, or drilling, underlies the improvement of inner hearing skills. CD was asked about any aspects of her own inner hearing that she found more difficult than others. She described herself as 'an interesting case' as she had no problem auralising visually presented music, 'so I can pick up a score and I can hear a symphony in my head'. However, she admitted 'if you were to play just a very simple melody on the piano, I probably wouldn't be able to remember it'.

6.4.7.3 Course director

Though the module director, EG, no longer taught the aural component, she taught formal analysis, pointing out that this was a course involving an element of inner hearing. She described the aural course as being very traditional, in spite of changes she had instigated to make it less 'boring' for the students. These had included an active performance focus on rhythmic work and clapping as opposed to purely listening. EG endorsed the course's traditional approach, stating that it was driven by the 'unchanging needs of classical performers'. She saw little benefit in considering CAL approaches.

When asked how it was possible to measure and assess the development of the mind's ear, she replied the following:

> It's not just the aural classes which we're assessing their inner ear, we're assessing it in harmony and counterpoint and formal analysis, and in composition, because those subjects, I mean if you can't, if you're writing a piece of harmony, if you're completing a Bach chorale, you've got to rely to some extent on your inner hearing, . . . So that's . . . why I think that the people with the good ear tend to do well because it feeds into the other subjects, not just aural.

This implies that inner hearing is at the heart of successful musicianship, moreover, that success on the degree course could be directly related to auralisation skills. Rather than viewing the activities of harmony and counterpoint, formal analysis, and composition, as adequate aural training in themselves, her perspective is that those tasks must be approached from a firm foundation in aural skills, hence the provision of separate training.

EG was unusual in expressing her view that inner hearing is an innate gift, and that those without such skills would find it hard to develop them:

> You've either got it or you haven't. I mean some students are just hopeless, they really are hopeless, whereas the ones that obviously have got more innate ability seem to be fine with just general aural. And I do think that's the problem in that there's more of a divide in aural than any other subject, I think, because you really either can do it, or you just totally struggle.

This bleak view does not fit with the emphasis that continued to be placed on aural training in the institution. '... At this institution we do value it and we're really trying not to let it go.... You use your ear all the time, so we are going to keep it in the curriculum'. This emphasis would normally suggest a skill with the potential for development. Later EG said, 'having a good ear, and this ability to read a score in your mind is something that you're going to have to develop, but it's going to require a certain ability to develop that'. The separating out of aural teaching from other, more practical, musical activities implicitly relates aural ability to intense listening rather than performance. EG was asked about the use of singing to develop inner hearing for the students. Her response hinged on the difficulties involved in encouraging students to attend extra-curricular music groups such as choir. However, she agreed that 'to be a musician you have to be able to sing and you have to be able to develop those skills, because it's so closely linked'.

When asked what weaknesses she saw in her own imaging, EG explained that perfect pitch was a handicap to the teaching of aural. She also mentioned timbre as a musical element that was less conscious than others in score reading:

> I guess when I look at a score I just hear the whole sound but I'm not really aware of thinking about timbre.... But within that, obviously, I'll be looking at articulation marks to get the character of the music, so I will be imagining those sorts of things in my inner ear, and the more I probably look at a piece, the more the timbre will come.

It is noteworthy that there seemed to be very little explicit development of the imaging of timbre in the aural module, though this might have been covered be other courses.

6.4.7.4 A Student's view

One student on the aural course, AW, agreed to be interviewed about her experiences. When asked how useful imaging music might be for musical activities she replied:

> Really useful. . . . I hadn't done any harmony and counterpoint but coming here I was doing it for the first time . . . but when I'm writing the harmony I can just hear the tune as I write it down whereas other folk that have been doing it for A-level have learnt it with a keyboard and are now having to try and change and do it differently. . . . And sight singing's obviously good.

AW was asked whether the course had fulfilled its aim to develop inner hearing. Her view was that it depended on how good the mind's ear was to start with. Though she found aural to be a fairly easy module, scoring highly in her exam, she recognised that some students found it hard. 'The way they teach it here is where you just have to learn to hear it and I think they say you should go away and start, you know, hearing on a piano play yourself intervals and hear'. This emphasis on concentrated perception contrasted with her own method of 'just picking it up' or using the specific mental image of a mini keyboard in her mind to 'work out' scales and tricky intervals. She described any gains from the course as minimal in view of her previous abilities to perform various aural tasks.

In view of her seemingly exceptional ability and enthusiasm for aural, AW was asked whether she thought inner hearing was something that everybody could do. She was not sure, linking her own skills with the musical context in which she grew up:

> I always had a chance to develop it in some way. The kind of listening ability, and if you don't then it's never going to grow. . . . But I don't know if that's something you're born with. I think it's just more opportunity I'd have thought. I'm just lucky I think.

Moreover, AW was categorical that the most 'talented' musicians might not perform the best in aural tests, giving an example of a good saxophonist whose sense of intonation was poor. 'There must be folk who have a wonderful kind of musicality but just haven't had it developed or something'.

6.4.7.5 Balance of listening and performance

Developing the 'inner ear' (inner hearing) was an explicit aim of the aural training at this institution. The approach at this self-confessed traditional music department was to focus on listening experience and drilling as the means to accomplish this. The potential for the improvement of inner hearing through musical activity and performance was amply recognised, yet aside from clapping and sight singing, this never became the training focus. As a consequence of this balance in favour of listening, aural dimensions of music were emphasised over and above related modalities of vision and kinaesthesia.

6.4.8 'Practical' music department

6.4.8.1 Teaching style

No traditional aural training course existed at the 'practical' music department. Instead, first year students took a 'Ways of Listening' course aiming to develop listening and communication skills. This was done through a dual focus on listening, and on performance through improvisation, taught by two different module tutors on alternate weeks. Groups were not arranged according to ability, but instead the year was split into three in order to accommodate the large numbers of students.

Two different groups were observed during their first improvisation class of the module (17th October 2001). Students brought along their own instruments or sang. The session was chiefly concerned with social interaction and communication both through music and more general rhythmic games.

6.4.8.2 Teaching material

Students were given a reading list but no specific module material; instead they were encouraged to draw on environmental sounds. In previous years the CALMA programme played a role in the teaching of aural skills in the institution. The aim had been to allow students and teachers to use real music to develop aural skills either through class teaching or individual practice. The nature of the software was such that links could be made between otherwise segregated areas of musical development. It included the use of some traditional aural exercises such as dictation, and allowed an interactive manipulation of music. However, CALMA was not in use during the period of observation for the following reasons:

- The course director had become sceptical about CAL as the best solution for music students
- Technical problems had arisen within the institution

At the time of this research, course assessment took the form of three assignments, the first being a concert review, the second a group improvisation, and the third a portfolio of listening exercises. The latter were worksheets based on the activities promoted by Pratt, the originator of aural awareness work in the institution. Students were required to 1) survey a soundscape; 2) listen to the interaction of musical elements in a CD recording, creating a detailed blank score for each; 3) watch a television programme answering questions on the function of music; 4) compare recordings to live performance; and 5) to listen repeatedly to unfamiliar music, making notes on changes in perception. As with traditional aural, the focus was very much on 'real' perception rather than imaging sound.

6.4.8.3 Course director

The course director (JS) had originally studied music at the institution under Pratt, and was thus well acquainted with the less traditional approach to aural training. He had taught on the course for five years, though explained that a few changes had been introduced since Pratt's retirement in 1998. Notably, while the course had been about 'Musical Awareness' it had since changed to maintain a close fit with other elements of the degree. When asked how it was possible to assess aural skills, he said that it was difficult to measure musical imagery, and that the institution was 'more assessing the outcome of those skills'.

As a composer, JS said of inner hearing: 'It's something that's always been important to me'. He stressed that he would like to re-introduce some of the more traditional aural exercises into the course. 'What we're doing I hope is interesting and relevant but I still think that's, for a lot of students, an area which could do with being looked at'. It is clear that while an even balance of heightened listening and performance activities formed the basis for the aural awareness teaching, JS felt that the traditional aural training skills were no longer being trained to an adequate extent.

6.4.8.4 Students' views

Four first year students attended a group discussion with the researcher, volunteering information about their experiences of aural training, and 'tune on the brain' episodes. Towards the end of the two-hour discussion, a lecturer in the department also joined the group. Every student contributed to the conversation and the discussion was lengthy. Only those comments relevant to the development of inner hearing or to the imaging of timbre will be presented.

The group were asked whether they felt that the 'Ways of Listening' module had improved their aural awareness. The immediate response was that nothing 'new' had been learned, although one student said he had become more aware in music listening. Another student was adamant that some form of traditional aural training should be included in the degree programme. 'I think we should have dictation. I mean everyone hates it but I really think we should'. The main argument for dictation skills given by the students was an increased speed in writing down composition, an activity that all the students in the group were involved in.

Opinions differed as to the balance of perceiving and imaging sound in the composition process.

> Doing things at a keyboard, you're constantly wanting to change things 'cause you're hearing it as it is, in reality, you start doing things - you've got too much power. You start doing things that perhaps don't need doing, that you're not sure you want to do, whereas if you just do it in your mind, you know, you can hear it.

This student describes a situation in which having perceived composition might tempt the unnecessary alteration of sound, describing imagery, by way of contrast, as being more deliberate.

The music students were asked whether in imaging music, their mental representations might include the sound quality of different instruments. The general trend was for students to listen out for their own instrument. Indeed, it was felt that the imaging of sound related to what musical and instrumental parts had been attended to in actual perception. 'If you're imagining it, if you've heard a recording of it I think you're imagining it like you've heard it'. However, the lecturer differed by describing the experience of imaging his own voice over and above the original instrument perceived.

Students reported that A-level music aural teaching had been unhelpful. Nevertheless, they reported having been aware of its relevance to musical activity.

> It instils the musician within you, like sort of literally academic. But there is that musical quality within you and doing dictation and exams, it does instil it within you.

This comment implies that aural skills are an important part of being a musician. When asked whether this view reflected their own opinions, each student in the group agreed, listing ways in which musical activity depends on aural ability. Aural in ABRSM exams was discussed and students reported finding these difficult. Subsequent discussion centred on the usefulness of singing for imaging sound and aural skills. When asked how the students might design their own aural training course to develop inner hearing, all agreed that singing, preferably in a group, would be the most efficient method. It is noticeable that in spite of their previously expressed desire to do conventional aural dictation, their actual choice of singing as a method is a form of active musical performance rather than the more passive listening.

Towards the end of the discussion the group were asked how aural skills might be developed without a specific aural course. 'Playing with other people is quite important,' said one student who explained that 'you have to really listen and so that's helping your tuning'. Another student agreed that listening was paramount, and this is crucial in group music.

6.4.8.5 Balance of listening and performance

At this institution, an even balance of active music listening and performance were the primary methods of developing aural awareness. Inner hearing skills were not singled out, and a holistic programme incorporating the musical awareness of visual and kinaesthetic as well as auditory dimensions was in place. However, both students and the course director expressed a desire to separately train more traditional aural skills such as dictation.

6.4.9 Music College

6.4.9.1 Teaching style

Two different classes were observed towards the start of the college term (22nd November 2001). KH, who was one of two aural tutors teaching at the college, took both these of lessons. The classes however were of quite different standards, and it was explained that students were grouped into four different grades following their performance in an examination in the first week of term. Classes were weekly, lasting for an hour, in typically small groups of between six and twelve students.

The first class observed took the form of traditional dictation in pitch and rhythm, led by KH who played exercises on the piano and asked for individual student feedback. The second class comprised students who were stronger in ability. Here 'real' extracts of music were used, and students had to write down first and last chords heard, to describe whether the first or last note of an extract was higher or lower in pitch, and to count the number of occurrences of a certain note. Thus the exercises at this higher level placed a greater emphasis on aural memory, and imaging. Other exercises took the form of sight-singing in different clefs, and spotting errors in four-part music. As at the 'traditional' music department, listening was the primary means of developing aural training in these classes, though of course these took place within the context of an institution in which performance is the primary component of the degree.

6.4.9.2 Teaching material

KH told me that she might invent her own exercises, but found Thackray's (1978) *Aural Awakening* to provide valuable course material. The other course tutor, SP, did not use specific books, preferring to draw on musical repertoire as the basis for aural work.

Assessment was by examination at the end of the year, with different grade classes taking papers of different levels of difficulty.

6.4.9.3 Course director

SP was the course director, having taught aural for five years at the college. He was particularly forthcoming in interview about not only teaching methods but also more theoretical concerns with imagery. To begin with, he explained that the aural course at the institution was about to undergo major revision. Classes would become integrated with improvisation, keyboard skills, composition, arranging and harmony, under the banner of 'Musicianship'. The guiding principle behind the change was to integrate aural skills with practical music-making; 'the perception is supposed to go hand in hand with being able to actually produce the material'. This would also avoid what he described as the old way of not teaching aural but merely testing it. Interestingly for the notion of imagery, SP explained that it was desirable for students to actually hold their instruments in aural training, as:

> Simply having your instrument in your hand enhances aural perception because, certainly with experienced players, if you've got a violin you can physically imagine yourself fingering the interval that you're hearing, and even if you don't actually make a sound, your perception is much more accurate.

Implicit in this view is that a kinaesthetic and perhaps even haptic image of playing an instrument represents a form of perceptual readiness. In the above description, enacting the physical movements of playing an instrument is enough to trigger a corresponding aural image, though it should be noted that such an ability is mentioned as pertaining to only very experienced players.

SP made it clear that traditional skills such as dictation involved not only aural ability but also theoretical knowledge. Moreover, being skilled in aural tests should not be equated with musicality. On the contrary, SP pointed out that entry into music college in itself necessitates musical ability, but that some students nevertheless had a block with aural. In fact, he went so far as to suggest that 'people who are very good at aural tend to be rather dry or intellectual slightly nervy, twitchy players who aren't expressive but approach everything in a very intellectual and organised way'. It is difficult to know in what way such a view (or even such a trend should it turn out to be underwritten by empirical evidence) concerns imaging abilities as divorced from the theoretical demands of traditional aural exercises. It will be seen later on that SP does in fact regard the ability to create veridical or eidetic memory images an impediment to creative musical thought in some way.

Asked whether or not students saw the benefits of aural training, SP replied that 'it's tended to be considered fairly self-evident' and that 'no-one's ever . . . even questioned the relevance, even if the courses haven't been particularly helpful. It's had kind of diplomatic immunity'. Nevertheless, and in common with reports from the other institutions, SP reported that students have tended to conceptualise each module as separate from the others, even though 'aural is something that everyone uses in their teaching in any case, whether they're giving an instrumental lesson or even a history lesson. If you don't use aural then you're not in touch with what people are perceiving'. Musical imagery is particularly implied in this instance of the word 'aural', as an image of the music forms the basis of communication in music teaching.

As regards the question of whether inner hearing can be developed, and whether any person is capable of learning, SP explained that:

> I think it's inevitable that some people's inner hearing is much more precise than others. What's difficult to determine is how much of it is analytical ability and how much of it is actually aural imaging. . . . I think the view is a kind of very positive one, that everyone has a fairly strong potential for having an innate musical gift, but there are very often insurmountable blockages.

He goes on to explain that a minimum level of 'decent aural imaging skills' must be present in the students for them to have attained the standard to enter Music College. This implies that SP does view aural imaging as a fundamental aspect of musical ability. However, he believes that this is precisely what is lacking in some singers who are apparently admitted because of their voice rather than their musical abilities: 'it's a bit like admitting a pianist because they've got a Steinway at home'. He no longer used singing as a main technique in his aural training, seeing it more as a test which is useful at a fairly late stage of aural development.

As with the course tutors interviewed at the other institutions, SP was candid about his own inner hearing weakness. For him, perfect pitch made the perception of microtones difficult. Like EG, he found his perfect pitch to be an obstacle to teaching inner hearing skills, as those with perfect pitch 'tend not to analyse what they hear but just hear things as a series of separate notes which they then name'. He aimed to devise aural tests that would not advantage those with perfect pitch; exercises in which relative rather than absolute knowledge would be developed. SP also said of his weaknesses:

> It's mainly just a question of practice. Obviously things like the precise perception of orchestral timbres could always be developed, . . . it's a question of experience I think.

Clearly, aural is viewed as something that can be improved, not only for his students, but also at his own professional level. His speculations lead him to discuss the relationship he observed between composers with good aural skills and those without. Of those with good aural ability he hypothesised that they had a particular leaning towards pastiche given the accuracy of their perception and imagery of other music. Of those with less good aural skills he claimed: 'All the things that influence you get filtered through your aural misperceptions so you can come up with interesting new fuzzy harmonies that aren't like anyone else'. Here SP is associating poor perception and imagery abilities with the freedom to experiment with 'misperceived' sound, and to create new types of sound. Those with strong aural abilities are by implication saddled with sound that has been stored and processed in a more isomorphic fashion, becoming fixed in the mind as a fairly accurate 'copy' of the original perceptual experience. According to SP's argument, this makes the creation of new sound more difficult.

The question of assessing aural ability was raised. SP volunteered information about one particular piece of assessment in which students were asked to describe a performance to their peers, but he pointed out that it was hard to quantify the students' success in the task. When prompted he went on to say that quantification for the sake of marking was a problem in education, but especially in the teaching of harmony. SP drew a parallel between the difficulties of research into an intangible phenomenon such as imagery in its reliance on self-report, to the difficulties of teaching aural when the root of each individual's weakness is likewise intangible.

6.4.9.4 Balance of listening and performance

At the time of this research, the institution was about to undertake a transition from a primarily listening-based approach to aural improvement, to a primarily performance-based approach. Theoretically, a holistic method of developing musicianship was favoured, although a focus on the auditory dimensions of aural skills was still being practised. It was clear overall that inner hearing skills were viewed as being inextricably linked to perception, such that heightened aural awareness of some kind was the focus of training.

6.4.10 Summary of observations

The three institutions observed operated in quite different ways as regards aural development. These differences reflect different institutional goals. The traditions of the first institution were geared to the needs of classically trained musicians with a reliance on notation and tonal harmony. The very existence of aural training implied that aural skills could be developed, although paradoxically the course tutors here were sceptical about the true potential for development of those students who struggled the most. In all three institutions the development of inner hearing was said to be measured less by performance in the module assessment than by its transfer to other aspects of music. Inner hearing skills were felt to be important by tutors and students in all institutions, but the student's view at the 'traditional' institution was that the richness of her musical environment at home had provided more opportunity to develop her abilities than the course. At other institutions the prevailing view was that actual performance was a desirable way to improve aural skills, combining as it does concentrated, multi-modal forms of perception and imaging.

Although the 'practical' university music degree did not explicitly use traditional aural training, both the course director and the students expressed a desire to re-integrate this element. Similarly, while the Music College planned to merge aural training into a general musicianship class, there was no suggestion of dropping tasks such as dictation, singing back music and recognition of musical elements. The modularisation of degree courses has meant the nominal segregation of aural from other musical activities, but it is during such general music-making that inner hearing skills seemingly come into their own.

6.5 General Discussion

A confused picture has emerged as regards the belief that inner hearing skills can be developed. The general consensus is that improvement is possible, but it should be noted that the teaching of those who struggle with aural was expressed as a difficult challenge, with no obvious solutions. It is noteworthy that while imagery was unanimously spoken of as being essential to all musical endeavours, it was not addressed as the most important teaching goal at any of the institutions. One implication of this is that though inner hearing may be developed, the bulk of this development will occur in conjunction with other forms of musical development. Generally speaking, where development was deemed realistic, the approach taken was to encourage drilling, to encourage increased music listening, or to encourage an integrated kinaesthetic approach.

It is interesting to reconsider the different ratings given by students of their ability to sight-read and their ability to silently read musical score. That students considered themselves to be less able to read score than sight-read has interesting implications for the relationship of perception to imagery. Banton (1995) is writing about pianists when she observes that:

> Less competent pianists . . . tend initially to overestimate their performance during normal sight-reading. One possible explanation for this is that less skilled sight-readers are unable to formulate a clear mental representation of the performance prior to attempting the music, and so utilise auditory feedback in order to confirm the correctness of the proceedings. Banton (1995: 14)

Sight-reading is highly dependent on creating a mental image of the music, but also on physical production of sound. Having a physical crutch may strengthen the image through kinaesthesia. In some cases it may act as a substitute for the mental image, as where imagery is lacking, physical production of the written pitch can still occur. Silently reading score is a more difficult matter: not only might the score involve the imaging of more than one part, but there is no perceptual feedback mechanism to check the image.

The current study has established that aural training and imagery are mutually dependent areas of musical skill, hence discussion of the development of imagery has centred on different institutional approaches to aural training.

However a key issue in imagery development that reaches beyond classical notions of aural training is multi-modality. Asking individual students and course tutors to describe any weaknesses in their inner hearing highlighted this. For instance, a divide between those with and without perfect pitch emerged, and a different approach was also found with an individual who could image sound from a visual score but not from an aural cue. Similarly, one student explained her preference for using the visual image of a keyboard to help with aural tasks. More striking than these individual accounts of modal preference in mental imagery is the emphasis placed by many on physical performance to develop aural skills. These ranged from the music college's encouragement of students to hold their instruments to perceive music with acuity, to the promotion of improvisation and the naming of practical musical activities as a means of improving aural abilities. Such a tendency towards kinaesthetic as well as purely aural musical experience is in line with the writing of Jacques-Dalcroze (1967), Clarke (1987) and Freymuth (1999). Godøy (2001) has also argued that the internal representation of physical action is integral to musical imagery.

Inner hearing was unanimously considered to be important to musical activity. However, students describing the most useful development of inner hearing only rarely related to the formal aural training they had received or were currently receiving. Instead, those who described enriching imagery experiences related them to concentrated performance or listening situations. The findings in favour of both concentrated listening and kinaesthetic experience of music as a tool to development have an important bearing on considerations of the relationship of musical imagery to perception. Heightened perceptual awareness is seemingly correlated with heightened aural powers that include aural memory and imaging. These findings accord with the theories of Pratt (1990).

It is worth revisiting the inventory of aural activities outlined at the start of this chapter in order to reconsider the respective roles of imagery, perception and theoretical knowledge involved in each. Firstly, score reading requires the theoretical knowledge of musical notation, perceptual experience in matching symbol to sound, and ultimately skills of auralisation. Discussion about music may require theoretical knowledge of music, but preferably also the ability to mentally refer to the music, based on a memory image of having heard the music. Dictation tasks of different elements of music require aural acuity in listening, theoretical knowledge in transcribing, and the capacity to hold the music as a mental image. Singing or playing back different elements of aurally presented music involves all these processes, with the addition of practical skills to produce the sound physically. Sight-singing and sight-reading music require musical literacy, imagery, and performance skill, all based on a perceptual experience of music. Analysing music, be it interval recognition or large-scale sonata form analysis, will necessitate either acute listening skills or accurate auralisation skills with short-term aural memory for preceding and antecedent events.

Observations of aural awareness and aural training classes took into account all obvious manifestations of the development of musical imagery. However, it was rare to hear mention of the terms 'inner hearing', 'auralisation' or 'imagery'. This is to be expected, as imagery though central to music is not often discussed in its own right or emphasised as a separate skill for development. Therefore, rather than concluding that there is a dearth of direct methods to develop imagery, the current pedagogical approach might be more a reflection of a holistic conceptualisation of music than a disregard for training in inner hearing. This holistic conception has traditionally been called 'aural training', and has been shown by the present study to comprise the close interaction of auralisation with the 'external perception' skills of close listening and performance, the one enhancing the other.

As Priest (1993) points out, 'aural' is inappropriate when what is really at the core of such music training is the development of focused listening and good inner hearing. In general, it was felt that inner hearing could be developed. Perhaps a deliberate shift from aural training to considerations of the mind's ear would help to readdress some aspects of music education seen as ineffectual by students in this study (for instance, help in developing dictation skills for the particular purpose of composing). While the role of this study was not evaluative, certain findings do suggest that methods that favour enhanced listening through performance, improvisation, or listening in a multi-modal fashion, are likely to develop the mind's ear. As the above inventory of aural skills for musical activity highlights, a balance of listening and performance is a likely key to the development of inner hearing.

This study has been primarily exploratory, but with the continued goal to further understand the relationship of imagery with perception in music. This has been achieved with a particular focus on music-specific activity, highlighting a crucial role of perception for the development of inner hearing, both through listening and performance of music. What is not known from the research presented in this chapter is the views of expert musicians as regards the importance of inner hearing, and the role of perception and imagery in advanced music activity. The following chapter will continue the exploration of real-life, intentional, applied musical imagery by interviewing professional musicians about these and related imagery issues.

CHAPTER SEVEN –

EXPERT MUSICIANS, MUSICAL IMAGERY AND THE NATURE OF MUSICAL PERCEPTION: CASE STUDIES

The previous chapter explored different approaches to training inner hearing and aural awareness in students. It uncovered the attitudes to musical imagery of both students and tutors. As a final stage in the trajectory from general to specific musical activity, and from unintentional to intentional imaging, this chapter continues to probe the relationship of imagery to perception in an exploratory fashion. Imagery is arguably very important for professional musicians: examples of its assumed occurrence include a performer developing an interpretation in his or her head; a conductor doing silent score reading in the absence of any instrument; and a composer imaging new sounds, or new combinations of sound. What do professional musicians say about their imagery? For example, how important and how prevalent is musical imaging in expert musical activity, and what is its relationship to perception? This chapter is an investigation of these questions, with three professional musicians: a composer, a pianist, and a deaf organist. These musicians themselves discuss the relationship of their mental representations of music to the music they perceive.

7.1 Musical Imagery for Expert Musicians

There is no shortage of anecdotal report concerning the musical imagery of famous composers such as Beethoven, Stravinsky and Elgar. Mountain (2001) and Retra (1999) have attempted to undertake a more systematic understanding of the subject. Retra ran a study in which composers were asked to provide a verbal commentary on a composition task away from an instrument. The purpose was to investigate the nature of mental representation in the composition process. Mountain's approach draws on a number of anecdotal accounts of compositional imagery, as well as on her personal experience as a composer. She makes the important point that music is written to serve quite different functions, and that 'The intentions and objectives will necessarily condition the process and consequently the specific use of imagery' (272).

Inspiration in composition is often taken to be synonymous with musical imagery, and 'the myths that surround the one have confused investigation of the other' (Mountain, 2001: 273). One of these myths is that inspiration takes the form of a complete and pure auditory image to be translated in a sequential manner from the mind to paper. In reality, Mountain's evidence[1] suggests that composers are more likely to have been mentally working on music for a while, modifying and developing an image rather than transcribing one in virgin form. Harvey (1999) provides a comprehensive discussion on the subject of musical inspiration. Drawing on the reports of composers including Mahler, Dukas, Elgar, Boulez, Maxwell Davies, Schumann, Ligeti, Hindemith and Rubbra he writes that:

> The unconscious is clearly capable of reordering mental impressions to find solutions to compositional difficulties, without any need for conscious thought. (Harvey, 1999: 22)

On the subject of consciousness, Penrose (1999) formulates a theory that creative thinkers unconsciously put up ideas for contemplation but consciously eliminate those that are redundant. Retra's conclusions (1999) are similar to this. She found that the contemporary composers of her study seemed to use imagery as a means of holding information before the mind's ear in decision-making. Mountain describes a similar intermediary role of mental imagery in musical composition: 'The vividness of the auditory image is ... necessary during the encoding stage, so that it can be clearly maintained and referred to during the sometimes tedious procedure of notation' (Mountain, 2001: 275/6).

The alternation between unconscious and conscious thought seems to be at the root of many misconceptions regarding the role of inspiration and the role of assimilation. While inspiration may strike as a seemingly complete idea, it is likely to be based on the unconscious amalgamation of assimilated musical experience. Thus inspiration and assimilation are likely to be part of the same

[1] Gathered by questionnaires distributed to contemporary composers and based on self-observation and the accounts of others

experience, both originating in perception. A chronological dimension might mean that composing 'traces a path from the intangible imagination to the tangible reality of a created work' (Saxton, 1998: 6). Imagination is more than imaging, involving a degree of creativity over mere visualising or experiencing a ready-made copy. According to this, musical imagery might represent an intermediary point between imagination and what Saxton (1998) describes as the 'aural detection' stages of creation. The process of developing a compositional idea implies a musical imagination to hear the desired sound, musical memory, and the ability to alter and mentally rehearse an image.

In spite of the importance of imagery in creative thought, musical composition is not purely endogenous, requiring as it does the initial perception of constituent sound material. Mountain points out the direct link between the multi-dimensional content of musical imagery, and the corresponding dimensions of our physical environment:

> Even while attempting to restrict the discussion to 'purely' auditory or visual imagery, it becomes evident that there are often latent associations between such imagery and a more complete model which has all the attributes of an entity or phenomenon of our physical environment (2001: 278).

The basic contention of Mountain's chapter is that it is fundamental in human cognition to relate to our perceptions of the natural environment, meaning that while music might seem to be an abstract phenomenon, visual, kinaesthetic, auditory and visceral influences abound in imagination and consequently in compositional imagery. Harvey cites Brian Ferneyhough writing on the subject of his compositional experiences, where the compositional idea is far from being a purely auditory experience:

> The first sensation, the experience which begins to persuade me that I am actually going to write a piece, is very often a cross between a tactile, a visual, and an aural one. That is, I tend to perceive a mass, almost a tangible sculptural or sculpted mass, in some sort of imagined space, which is made up of these various elements. (Ferneyhough, quoted by Harvey, 1999: 30)

Musical imagery is not unique to composition. Performers are also presumed to experience a mental representation of music. It would be wrong to believe that, even in the tradition of Western classical music, notation is the sole carrier of musical information. Godøy and Jørgensen point out that 'Western art music is in fact dependent upon an 'oral' transmission of performance tradition' (2001: 182). For the greatest musical performers to teach others necessitates conveying information additional to the musical score through the shared communication of a detailed musical image. Yet relatively little research on musical imagery has looked at its application to performance, with the exception of Brodsky *et al.* (1999) who explored the inner hearing of orchestral musicians. Kvifte (2001) also explores imagery for performing musicians, describing the importance of imagery for the memory of form in Norwegian Hardingfiddle music. The author's main concern is to determine 'the *relation* between observed formal structure and possible internal images of them: how can we infer from behaviour to structure of internal images?' (Kvifte, 2001: 219/220). The proposed answer assumes a close relationship of imagery with overt behaviour, describing a feedback between one and the other in the process of performance. Kvifte additionally argues that the function and type of musical activity will draw on different degrees of imagery detail. For example, the declarative knowledge required to teach a musical instrument requires a greater degree of conscious awareness than the procedural basis of the imagery experienced in performance:

> It seems reasonable to expect that the images perceived and used will depend on the actual situation, and be geared to suit the tasks at hand. Given that images are in some way functional and are used as tools by the fiddler, this is quite obvious: My need for conscious access to details is greater when I teach than when I play. (Kvifte, 2001: 232/3)

Musicians and psychologists have considered the imaging of different musical dimensions in performance. One important role of musical imagery is in the establishment of a mental representation of tempo. Research has been done on this issue by a number of researchers (see Lapidaki, 2000, and Repp, 2001). Some of the most acclaimed performers and conductors have both reported and demonstrated skills of absolute tempo. Stravinsky said:

> I think that any musical composition must necessarily possess its unique tempo (pulsation): the variety of tempi comes from performers who often are not very familiar with the composition or feel a personal interest in interpreting it. (1979: 118).

Stravinsky's view suggests that integral to musical meaning is an absolute tempo, and that a performer's duty is to image and communicate that tempo. Speaking from a performer's perspective, Brendel conveys the importance of being able to image dynamics, specifically in the piano works of Beethoven. A pianist, he is nevertheless able to image different timbral sonorities to that of the piano for the music he performs:

> Schubert's piano style is no less orchestral than it is vocal. In the *Wanderer* Fantasy, the piano is turned into an orchestra much more radically than had ever been done before; not only the individual colours of orchestral instruments are evoked, but also the full blast of the 'tutti'. (Brendel, 1976: 66).

The context of this quote implies that Brendel is not simply using a metaphorical description, but describing his imagery experience. It is noteworthy in relating an ability to simultaneously hear music and image additional sound qualities. Brendel goes on to comment that in playing Schubert's music, the pianist should imagine himself or herself to be a conductor, advising how the piano might be transformed into an orchestra through various performance techniques.

There is a tradition of performing from memory in expert musical performance. Marek (1982) reports that Toscanini was renowned for his musical memory and the veridicality of his imagery.

> His memory was strengthened by what I may call the "mind's ear", meaning the ability to hear a composition by reading it. That ability is essential to a conductor, but Toscanini possessed it to an amazing degree. He had but to glance at a page of complex music, his glance seemingly casual, and he heard the page both horizontally and vertically in his imagination. (Marek, 1982: 416)

While such feats are unusual, discussion with expert musicians might reveal more about the nature of memorising music in general. Marek believes that 'Retention of minutiae is an attribute of the interpretive artist; it lies at the base of performance, and it can be trained.' (Ibid.: 415). It is important to note the emphasis on the retention of perceived sound as a foundation for creative interpretation, and the supposed potential to develop this skill.

If perception is crucial to the formation of imagery, how can a musician who was born with a hearing loss have a mental representation of music? The ears need not be the primary vehicle for the perception of music, as Stringer (1997) showed in a case study of a congenitally deaf musician, dealing with issues relating to musical imagery. Her evidence was inconclusive as to the extent to which the mental representation of music of this musician was 'aural', but she did find that imagery was fundamental for this musician, and that it arose from knowledge about music and from alternative forms of perception to hearing. Imagination also played a key role. The musician interviewed by Stringer is also one of the three case studies reported in the current chapter.

In 1983 Cleall wrote speculative notes about the deaf percussionist, Evelyn Glennie, and her perception of sound through vibrations in her body. Glennie's deafness was acquired, and she does have an aural memory. What is not known is the nature of any imagery resulting from such a form of perception for somebody with no aural memory. Marcus (2001) writes of the importance of kinaesthetic and visual perceptions of music for deaf people. Discussing Kemp's work in 1990 on the importance of a whole-body experience of music, she says the following:

> The neuromuscular sensations involved in the making of sounds, or responding gesturally to sounds, become fused with the actual memory traces or image of the sounds themselves. Thus recall of sounds and musical thinking processes are multi-dimensional, producing a powerful amalgam of sensory/perceptual knowledge. (Marcus, 2001: 22)

Other researchers have recognised the contribution of non-auditory factors in musical perception (for example Davidson, 1993). It might be anticipated that imagery for a deaf musician would be a multi-dimensional experience, in line with an awareness of the dimensions that have been perceived.

It has been shown that a variety of literature has addressed musical imagery in musical activity, including contributions from psychological, musicological and biographical sources. These do not present a coherent analysis of the relationship of imagery to perception. This chapter will explore the issue by presenting case studies of three different professional musicians.

7.2 Case Studies

A semi-structured interview technique was employed which was designed to capture the individual experiences of the interviewees. While the respondents were selected because of their activities as professional musicians, the intention was not that they be considered to be representative otherwise of a wider musical population. The purpose of the interview was to explore emergent themes concerning the relationship of imagery to perception in musical activity, and to allow the respondents to express their own accounts of their imagery experience.

Possible interview questions were tried out in advance of the interviews with an independent observer. The interview schedule differed slightly for each respondent (see Appendix L), and was used as a prompt rather than a rigid set of questions. The aim was to encourage respondent-led discussion, albeit within loosely defined areas of researcher interest. At this stage, a detailed survey of existing literature had not been undertaken, allowing for an intuitive development of themes with the respondents themselves.

Interviews lasted between one and three hours.

7.2.1 Respondent Profiles

GN – a composer.

He also teaches in the music department of a university in the UK, and is experienced in directing contemporary music and in piano performance. He studied composition with Bernard Rands and David Blake.

PH – a pianist.

He also teaches in the music department of a university in the UK, and is experienced in conducting. He contributed to work by RAMP (1987) with a paper on the mind's ear of a pianist. PH has studied with Cyril Smith, Nadia Boulanger, and worked with Messiaen.

PW – an organist and pianist.

He is also experienced in choir conducting. He has a congenital hearing loss, and has been profoundly deaf since the age of seven. He regularly works as a musical signer for the deaf, signing opera and musical performances. PW runs a charity to assist in the musical education of deaf children. He was the first profoundly deaf person in the UK to study music at university (Wadham College, Oxford) before doing a postgraduate course in organ at the RNCM.

7.2.2 Analysis

Interviews were recorded with the permission of the respondents. Taped interviews were later transcribed and thematic analysis was undertaken for each individual (see Appendix M for transcripts). Each case study was analysed separately, examining the material repeatedly and systematically in order to determine emerging themes. Ultimately, a comparison of the common themes across the respondents was formally made. Interview analyses are presented in the order in which the interviews took place.

7.3 Results

7.3.1 Composer

GN was asked questions concerning his musical background, the composition process, teaching, directing contemporary music and his own experiences of 'tune on the brain'.

Key emergent themes were: the differences between imaging and imagining music, the respective limitations of imaging and perceiving music, conceptual flexibility, musical meaning, musical familiarity, consciousness issues, and control over the occurrence and nature of imagery.

7.3.1.1 Perceiving, Imaging and Imagining music

GN described the process of composition as one of looking beyond the given. Given material might take the form of either perceived music or imagery of existing music. He explained that composition requires experimentation and imagination, that is to say developing and 'putting in' a certain creative extra. Importantly, GN explained that a hands-on manipulation of sound is frequently the most efficient way to expand a sound world, while imaging sound would be inadequate to the task:

> If you're exploring your own world and pushing the boundaries then you may want some help from external sources. And I find it very useful as a composer to be able to pound the piano and the walls, and whatever, to help me.

This difference between purely mental musical exploration and a physical manipulation of sound was also mentioned with reference to the relationship of composition with improvisation. GN explained that improvisation depends on motor imagery and habit, and that breaking free from learned structures requires the sort of exploration and risk-taking required to break out of a known mental representation.

When questioned about the relative merits of writing down compositional ideas or guarding them as mental constructs GN clearly articulated a need to balance fixing ideas and maintaining flexibility. Describing musical imagery as a faulty tape he explained that:

> If it's a playback mechanism you can't actually be certain that every time it's the same, and I think this is the beauty and the drawback to notation

> that it actually fixes a version. If you're unlucky, that version becomes something that you can't develop any further because it becomes so fixed, you can't see any potential in it any more. It's definitive, it's complete. Whereas you know sometimes its more valuable to try to keep the ideas fluid.

This quotation clearly illustrates that GN considers imagery in his composition to be less a static mental copy of sound than a way to free the imagination in its departure from repetition and fixed musical detail.

7.3.1.2 Familiarity

For a composer, musical imagery has a role in retaining the balance of conceptual freshness. When talking about the 'use' of imagery in electroacoustic composition (a medium in which has only occasionally written), GN explained that having perceived the same music repeatedly can lead to over-familiarity with the material:

> An instrumental composer is imagining a performance or imagining a sort of idealised performance whereas the studio composer's hearing the real thing. And you can, in the studio, get bored with the material and feel that you need to produce more layers of activity to liven it up, whereas the listener coming to that afresh might find it very exciting.

It is true that a listener would rarely attend to a piece of music in as much detail as the composer, and so this boredom from overly hearing the material might be avoided by composing some of the work through imagery rather than perception. Imaging music in composition serves to avoid the familiarity that perception entails.

When asked whether practice at composition had affected his own image formation, he replied 'Yes, I think it must. I mean I can't say that I'm tremendously confident that I'm better at it now than I was, but I suppose I must be'. Familiarity also has a role to play in 'tune on the brain' experiences for GN:

> It's . . . likely to come as a result of something I'm working on, or have been working on; repertoire or perhaps something the children are working on you know, which I've heard a lot.

It is hardly surprising that musical familiarity, experience, and perceptual input have had a direct bearing on GN's own musical imagery. However, this is taken a stage further as he relates such influences to the imagery of others. For instance, GN speaks of musicians with extremely eidetic auditory imagery, acknowledging that people with such musical skills exist but being personally unable to comprehend their abilities. He goes on to relate their specific musical imagery skills to their past experiences and to functions of memory:

> There are some celebrated examples of autistic children aren't there who can reproduce at the piano things that they've heard once, but interestingly enough only within a particular idiom. So I'm not quite sure what that means, but you know if you played some Mozart or you played something as far along as Bartok they might be able to get it, but if you played them some Stockhausen they wouldn't.

Thus GN relates even extraordinary cases of musical imagery to familiarity with a particular idiom and the realms of personal experience.

7.3.1.3 The Imagery Experience

GN's use of imagery is understandably practical. As described above, mental imagery is a useful tool both to retain musical information in the mind, and to deliberately encourage the development of an idea. In addition, GN was asked to talk about any harmony and counterpoint training he had received, and the degree to which imaging was required for this. He commented that inner hearing was a useful skill for the exercise, and that the development of his skills had been driven by a need to employ them.

In common with findings from the participants of the ESM study (see Chapter Three), GN reported being able to superimpose a mental image of sound onto actual musical perception. The example he provides is one of being unable to produce all the lines of music required on the piano, so that imagining additional lines to those being played is necessary. He also said that:

> Thinking now as a pianist, sometimes you want to open up the sound of the piano more by imagining another instrument playing the same thing. So in a way it's sort of orchestration at the piano.

Timbre is an integral part of musical meaning for GN, and consequently features in his mental representation. However, he explained that perception couldn't be matched by imagery in terms of the veridicality of sound colour. For example, when asked to describe any surprising outcomes of finally hearing his compositions performed he replied:

> I've always felt that the colour comes up more vividly in real life, and it's always better than you imagine it's going to be.... Timbres are also going to be that much brighter; at least that's what I find, than the way I imagine them. They're always a little bit kind of, a little bit hazy you know. They're not quite as resonant as they are in real life.

Imagery does not always serve a compositional or practical musical goal, as in the case of hearing everyday music 'on the brain'. It is interesting to note that without prompting, 'tune on the brain' episodes assumed a negative value for GN. At one point he even likened imagery to a parasite. For GN this sort of 'tune on the brain' often takes the form of a loop of music, comprising a heard musical fragment, rather than the entire work with all its less well known parts. GN described this sort of imagery as passive. Because his tune on the brain experience seems involuntary and passively occurring in the background, he argued against any connection between imagery and mood. He also explained that he was in control of his compositional imagery, putting it aside as a mental activity he would deliberately devote time to rather than working on casually. This description distinguishes between voluntary and involuntary, passive and active imagery experience, as a function of the role of imagery for the chosen musical activity.

By way of comparison between GN and the participants of the ESM study (Chapter Three), the elements most frequently mentioned as part of his musical mental image were harmony, tension, motion, spatial imagery, texture, and rhythm. Speaking of melody as the principal way in which people talk about music, he noted that:

> If they try to reproduce it that's what they'll sing, or whistle or hum, but they probably have at least some sense of the tensions that are in it, that are spelt out by the underlying harmonies

GN also reported having occasional powers of absolute tempo, but he observed that this ability fluctuated according to his physical state.

7.3.1.4 Musical Meaning

The elements reported to feature in GN's mental imagery seem to correspond with those meaningful to his concept of music. In fact, he deliberately pointed out this relationship, saying that musical imagery necessarily relates to an individual composer's musical language. An example of this concerns what he considers to be good examples of timbral writing in the composition of others:

> It's partly to do with working with the instrument and getting the best out of the instrument. . . . finding something which is so characteristic of the

> instrument that you can't imagine another instrument playing it. . . . Some timbres seem absolutely right for particular situations.

GN reported a conversation he had with a colleague about whether harmony is experienced as part of the mental image for music, using the example of the slow movement from Rachmaninov's *Symphony No. 2 in E minor.* His argument was that harmony is necessarily 'heard', and his colleague's disagreement made him 'question his musicality'. When asked if there were any musical styles that he would find harder to internalise and remember, he explained that he could not image the whole of *Gruppen*, but that as gesture is the main meaning of that music, so gesture constituted the aspects of sound he could hear in his mind's ear. This highlights the translation of important musical moments to GN's imagery for that music.

7.3.1.5 Consciousness

As mentioned above, GN found the metaphor of a faulty tape to be a useful means of describing musical imagery. The faulty nature of the playback is precisely what facilitates experimentation. When asked whether this playback could be described as a sort of stream of musical consciousness, he explained that conscious musical imagery was not always present for him, and certainly not always a source of valuable compositional ideas:

> It's intermittent. I know people do talk about it being, Max Davies talks about it being like a tap turned on . . . I do hear stuff going on in my head most of the time, but it tends to sort of be detritus.

He said that he has come to trust his unconscious musical processing, such as the solving of a musical solution overnight:

> In fact I really don't see any great divide between the conscious and the subconscious. I used to feel very puritanical about music that I'd worked on, as opposed to music that I hadn't worked on; you know valuing the one and not the other. But as the pieces recede from you in time, you can't remember which bits you worked on, and which bits didn't present any problems at all.

In general though the act of composition is presented as a conscious one for GN, of extending material and analysing it.

In order to understand the imagery component of his compositional ideas, GN was asked whether he worked primarily from an abstract concept or imaged note-level detail. He outlined a process which takes place on both micro and macro levels. A 'casual listener' to his own musical imagery, GN might attempt to 'capture the drama':

> I've got strategies for trying to get the music down quickly. I mean there are two distinct processes, one which is to try to write down the music that's going on in your head, and the other which is to project more music. So one is constructivist if you like, and the other is trying to capture something on the wing.

Giving an example of 'capturing music on the wing', he described how in order to produce a twenty minute composition assignment as a student he had once attempted to imagine music in real time for that period of time, but that:

> What came out eventually at the end of that summer was richer than what I heard in my head. Because I hope that I built into it layers of meaning; you know layers of activity which the casual listener the first time round wouldn't have heard. And in that position I was of course the casual listener.

The composition process necessitates making something more of this inner sound, so that the product is greater and richer than the image.

In introspecting on their own musical imagery, interviewees might form a view about how introspection and self-report effects the experience. GN was asked to comment on this, and as he did so he described imagining *L'Après-Midi d'un Faune*, saying that:

> I suspect that it's to do with the sense of what in the textures you're listening to are most immediate. . . . And I would suspect that trying to describe it to you would tend to make these layers drop away. So what's immediately retrievable will stay, so the flute will stay and the harp will stay at the beginning, but other things might drop away.

This presents imagery in the light of an ability to focus in on different sounds much as might occur in perception. It is important as an indicator of how changes in introspective attention might alter the entire imagery process.

7.3.1.6 Summary

In summary, as a composer, the distinction between imaging music and imagining music was important, namely, that imagining music involves the development of given material, while imaging music is a means of examining the given material. For GN, balancing perceived and imaged sound as the source of creative nourishment is essential in order to ensure both fluidity and fixity in the process of composing. Familiarity with music was described as a pre-requisite to imagery, but over-familiarity with perceiving his composition might stifle fresh development. Timbre was an important musical component both to GN's musical appreciation, and to his own approach to composition. This was one dimension that he stressed as being the most rewarding when perceived over imaged, due to a level of vitality otherwise absent in the mental image. GN described composing through two methods: the deliberate projection of music through developing an idea and the spontaneous attending to his imagery as a casual listener might listen to the radio.

7.3.2 Pianist

As a starting point to the interview, PH was able to show me a manuscript he was preparing for publication entitled 'From Score to Sound'. This presented many of his strongly held views about an ideal working method for a performing pianist, including the importance of mental preparation. Interview questions were centred on this manuscript, and also addressed his musical training, his role as a teacher, everyday musical imagery, aural skills, and synaesthesia.

Key emergent themes were: the definition and centrality of a guiding 'conception', the importance of formulating detailed thoughts about a piece before hearing it, balance in mental preparation, ideals and realities, conceptual flexibility, and tricks to develop auditory perception.

7.3.2.1 'Conception'

Fundamental to PH's musical understanding and method of approaching performance is the 'conception'. This could take the form of a mental musical image, but bears closer resemblance to a more abstract schema generated for each piece. Indeed, the conception might be seen to be an underlying generative view of an individual piece of music: essential to a musical understanding, and able to accommodate surface level changes. He compared the conception with the largely structural overview held by a novelist. Reference to a mental conception is expressed as being important particularly to pianists who need to change instruments when they perform in different venues without being unduly perturbed by the experience.

> Hopefully I could go out in public in a different acoustic to what I'm used to, and a quite different piano of course, maybe feeling different, . . . having people listening which is something too, and I could do something quite different from day to day without actually changing my sense of the shape. . . . It's a conception but it isn't one that's set in stone in every detail.

PH discussed his acquaintance and work with Messiaen, explaining that this composer's global conception of the music was more important than the minutiae of surface level sound. However, PH also explained that the details of a musical performance are what "bring it to life", thus placing the emphasis once more on the perceptual reality of music.

For PH, being able to image the detail of a piece of music is a secondary stage to the establishment of the conception, but an essential part of the mental preparation which he believes must take place before playing the music on an instrument. He envisaged the relationship of conception and detail to be an ongoing cyclic process, described as follows:

> The business of forming a kind of view on a piece of music is obviously an incredibly subtle one . . . I think you start with a conception, but clearly when you work on the details, I mean they are conceived too, and will feed back into the wider conception which will be modified accordingly, and indeed they may be modified by the instrument which you're playing on, and even in performance itself by the performance, and so on.

The entire interview centred around this strongly held conviction that mental rehearsal should precede and lead any physical practice. 'We want to lead our hands, and our ability, and our technique, wherever it resides. We don't want to be giving in to it'.

The conception once clear in the mind, acts as a form of imagined model against which to compare all perceived renditions. PH explained that 'I like to know what I'm aiming at, and then I will find the means to realise it'. For him, listening to the interpretations of others before formulating and practising his own conception of a piece is both lazy and cheating. Yet he recognised that listening to others is an important learning process, but one that should be reserved until a later stage as 'it may well show up to me some sort of frightful complacencies in my own approach, you know. But it'll be learning because I've already done my own thing'.

7.3.2.2 Balancing Mental Preparation

At the time of interview, PH was in the process of preparing performances of J.S. Bach's *48 Preludes and Fugues*. He spoke of the task as being hard work, and described this work as mostly mental preparation: 'I'm working on it all the time in my head'. He associated a time in his life when he had first begun to work on avant-garde music with a period of intense mental work on the music:

> I mean I would literally spend the best part of a week sitting at a table like this with a pencil and rubber and so on, kind of minutely going through the score and working it out.

It is clear that such detailed analysis away from the instrument necessitates mental representation and not perception. What PH describes is unusually extreme in its total isolation of aural mental work from the physical performance and motor imagery of the piece.

The extremity of isolating the mental preparation of a performance should be contrasted with PH's description of the balance needed to become what he described as "a great pianist":

> Everything has to be in balance. When things are in balance you're playing well, and when you're not playing well, when you've lost your form, whatever it is, it's just like golf or something like that, or tennis you know, it's usually almost always because there's some key area that you're neglecting, whether ear, or indeed the conception...

This balance relates to the practicalities of managing repertoire in terms of mental and physical preparation:

> It seems to me in a way that every day you come to practise a piece, and if it's a very difficult piece you may have to practise it day after day after day, but still every day you have to bring some new imagination to it, because otherwise the work simply becomes kind of technical, and in some way divorced from the imaginative impulse.

Although PH began by describing divorced mental preparation as the most vital component of musical performance, he has subsequently made it clear that at some stage the balance must tip to allow for the physical manifestation of the imaged work.

Balance is also mentioned as important to the work of a conductor in safeguarding a conception and accommodating any change brought about by individual performers.

> I say the task of being a conductor is really you know, treading that particular tightrope, isn't it? . . . There has to be some kind of balance in a conductor's work, and so it is obviously with any kind of instrumentalist, there's a balance between your pre-rehearsal planning, or pre-practice planning, and then what you actually do. But essentially, of course, you're able to diagnose, correct, improve and so on because you do know what it is that you want.

The balance between mental and physical dimensions might change along the course of preparing to perform a piece, but the guiding conception, a fundamentally mental measure, is present throughout. PH described his own approach to performance as 'controlled imprecision', a phrase that exemplifies the balance required between conscious and unconscious thought in a piece. Control needs to be introduced, and this is a predominantly conscious phenomenon. Unwanted unconscious influence should be avoided: 'The fact that we may be unconsciously influenced in the early stages by what feels comfortable, or safe, or whatever, is bad'.

The conception, once assimilated, might become an unconscious influence on performance manner.

> Understanding your framework that well means, . . . that in a way you don't have to think about it. I meant that's kind of in you. And we have to remember that when you're playing, clearly you rest on a whole bed of things, which is at this point unconscious. But I mean might well have started out as conscious thoughts but are now kind of fully absorbed.

For PH, the concern is less that processes become automatic than that processes should result from mental thought rather than physical tendencies. Holding an idealised performance in mind requires imagery, but acting on it requires a perceptual feedback mechanism. When asked about the balance of imagery to perception in a performance situation, PH replied that:

> You're doing three things at once, you're sort of envisaging what's coming next, you're actually playing it, you're reacting, you're hearing it and, as it were, processing it, and in the light of that processing you're kind of re-envisaging the next bit and so on.

7.3.2.3 Idealism

Ideally, the formulation of a conception, and the subsequent ability to image the desired sound will allow a performer to diagnose their own problems:

> It is unquestionably the *only* path towards radical improvement, and huge standards. I mean, I am convinced, it is the only method. I mean if there's a secret . . . Because it enables you to be your own teacher, your own doctor. You diagnose everything yourself.

However, in his role as a teacher of university music students, PH admitted that in reality it is difficult to persuade pupils to take time away from their instruments and prepare mentally. While zealous about the advantages of his predominantly mental and intellectual approach to performance, he acknowledged the idealism in his ideas: 'So, in an ideal world, we wouldn't have to do any practice. . . . (Laughing) How often do I not live up to these ideals?' When asked at what stage he might transfer from purely mental preparation to playing at the piano he replied:

> Probably sooner than I ought is the answer. But I mean I'm very impatient. . . . I mean, in the real world, maybe we do have to give in to our ability to some point otherwise we'd probably never be able to play anything in a concert, but you don't want to start in surrender mode.

This quote demonstrates that approaching performance with the determination to achieve the ideal is what matters for PH, and not the final 'surrender' to practical concerns.

For PH, it is important to maintain the ideal conception. For example, he described his reluctance to practise at the venue for his next concert because of the piano's inadequacies, and this might tarnish his idealised image of the music. The physical inadequacy of the instrument is largely beyond his control, while the ideal conception of how the performance should go is not. While an ideal performance is difficult to achieve:

> You're never going to get it unless you've imagined it. But you'd be amazed what you can do if you have actually set Everest in front of you, and you really want. . . 'Cause that's the other thing is you're motivated by your imaging. You want it. You're not satisfied with less.

Here it is clear that to set an idealised conception is to challenge himself, and this challenge is one of matching his musical production to his image.

Familiarity with music through its repeated perception is assumed to lead to a strong corresponding mental image. However, an ideal for PH is to avoid excessive familiarity with the music he is working on. The reality of over-familiarity is described as a loss of freshness. A direct comparison can be made between this performer's desire to rejuvenate his musical ideas, and GN's balancing of perception and imagery in order to maintain creative freshness. For the performer, over-familiarity in motor terms means that 'if you're so conditioned in your nervous system and so on, doing it just like this, you can't react anyway'. Once again it is apparent that PH is wary of allowing familiar motor habits to dictate the direction of a performance.

7.3.2.4 Conceptual Flexibility

The principal advantage of forming mental imagery before physically tackling new music is described as freedom from technical constraints. However, it was suggested to PH that mental states are just as prone to becoming fixed as physical ones. When he first adopted the method of mental preparation and imaging sound before playing it, he said that he did get 'locked' into his imagery, and that he has since learned to rely more on the conception than the strict auditory image. He explained that conceptions could be refined and modified in accordance with changing ideas:

> The important thing that you don't want, or I don't want anyway, a performance which is so completely planned and cut and dried in every detail that it has no possibility of further growth really. I mean in a way a certain if you like imprecision has to be built unto the business of being a musician.

PH goes to some lengths to balance flexible and stable dimensions of his performance approach by noting down his initial impressions of a piece for reference at a later date. Referring to the first of the Bach *Preludes* that he was preparing, he said 'I have a conception of that piece which gives me a sort of framework within which I can operate with a certain amount of freedom'.

Balancing fixed and fluid tempi is another concern of the performer's mental imagery. PH felt that performers should be able to image tempo 'and in a way be able to switch ideally effortlessly from one to another, from say a very fast tempo to a very slow tempo, and vice versa'. Freedom is an important theme for PH. In general, he reports that his mental imagery is not restricting but liberating, and that 'the marvellous thing about imaging is that I can fly anywhere I want to'. From that he goes on to say that physical limitations, time and ambition are the only factors that could prevent the communication of a perfect musical interpretation:

> I've no doubt that you could put . . . a lot of repertoire in front of me, and that I can inside myself imagine what Smith would have called a world beating performance.

In spite of his emphasis on imagery, it seems unlikely that PH would choose to image his way through a complete mental performance in real-time. Firstly, extreme concentration would be required. Secondly, the creative freedom that is provided by the flexibility of imagery would surely be lost in a mental performance that takes on the real-time, fixed features of a 'real' performance.

7.3.2.5 Training the mind's ear

PH describes musical imaging as a stage in the preparation and communication of a performance. It is one 'of trying out new solutions to particular problems, really, in my head'. In addition to being a performer, he is a teacher and an academic, thus thinking in declarative as well as procedural terms about performance issues. When asked whether people might lack the aural skills necessary to undertake the kinds of mental preparation he advocates, he replied that this was probably so, but that was all the more reason to do it. From this he went on to describe as unfortunate the separation of aural as a separate activity in grade exams and musical curricula

> The kind of institutionalised sort of boxes is very bad news because it inculcates in one the idea that you work on the ear here and then you forget about it for the rest of the week.

This viewpoint agrees with the findings in the previous chapter in which an integrated approach to aural training, or the recognition of the importance of inner hearing was generally favoured.

PH later went on to describe institutionalised education as flawed in its attempt to quantify and measure student achievement in a short-term fashion, when aural achievement is not easily amenable to such a system. When asked how early in musical development the skills of musical imaging could be called upon, PH replied that young children were probably good at this; they only need encouragement. He proposed games that might help, such as pretending to conduct, dance, or sing a piece of music so that there is limited reliance upon instrument habits. Based on his own experience, and taken from the manuscript in preparation, PH outlined useful tricks for a performing pianist to develop their perception and imagery. For instance, anything that involved playing the music in a physically different way, such as hand swapping, would necessitate aural rather than kinaesthetic cohesion. Singing the left hand of a piano part while playing the right would also guarantee a thorough aural knowledge of the music. The emphasis here, as elsewhere in the interview, was on using indirect methods to practise music, avoiding habit and maintaining a fresh perspective while deepening a musical understanding.

PH does report some direct experimenting at the piano, though this is only allowed once a conceptual foundation is in place:

> I would take it to the piano and you begin experimenting and you're like a kind of painter, mixing colours, you know, and you're trying this and you're trying that and you're getting ideas, and it's wonderful actually. You know wonderful. It's the nicest bit of practice actually. When you're experimenting and you're gradually bringing something to life, something is beginning to emerge.

This description is enthusiastic, and makes it clear that perceiving the sound is a process of invigorating the image: imagery, for all its merits, ultimately lacks the vividness of actual hearing. Playing at the piano does after all have a role in the creative process of preparing a performance.

PH made it clear that for him, score reading is a more productive exercise than sight-reading at the piano, as this bypasses technical problems in favour of a well-founded musical interpretation. For this to be the case necessitates exceptionally good imaging skills. This is in contrast to the neglect that PH observed in most people's inner hearing. He bemoaned what he described as the 'sticking plaster' approach to solving performance errors, whereby individual notes are physically repeated, rather than listening and imaging the desired sound before attempting a performance. PH clearly felt lucky to have been trained by his past teachers, Smith and Boulanger, who had integrated aural activities into their teaching. Their role was clearly seminal to his firm ideas about imaging music in performance:

> I suppose the huge lesson that I learned from my teacher . . . Cyril Smith, whose thinking in this area was incredibly advanced, which is that . . . we want to lead our hands.

As a professional pianist, the memorisation (formation of a memory image) of music was an issue of concern. PH spoke of his approach to memorising music as a developmental trajectory. For him, rote learning was something suitable to a child's mind, but the more experienced a musician becomes, the more an understanding of musical meaning is important to the process of remembering.

As the number of musical episodes that have been experienced increases, the more the semantic rather than the episodic quality becomes significant. Accordingly, PH increasingly found the semantic musical meaning and conception to be important in learning a piece of music. The implications of this are an increasingly analytical relating of the music to linked musical knowledge.

7.3.2.6 Nature of the conception, nature of the musical image

Regarding the nature of the musical image for PH, his mental preparation for performance tries to ensure that it is primarily auditory, and unfettered by physical dimensions. However, his musical conceptions are far from being purely auditory phenomena. PH explained that:

> Anything is grist to my mill. No, I mean I use words, you know. . . . I'll tell a story if need be, or use a kind of metaphor. . . . Paint a picture of whatever.

PH was asked about his everyday experiences of 'tune on the brain'. He reported being a music 'insomniac', but pointed out that waking early with music in his head was often related to his doing deliberate mental preparation for a performance, as was imaging music while out on a walk.

7.3.2.7 Summary

In summary, a foundation for successful musical performance was described as the establishment of a guiding conception of a piece of music. For PH, this conception is like a schematic overview of a piece of music, but might well resemble more 'surface' qualities of the music as a mental image. Above all, PH firmly believed in formulating detailed thoughts about the interpreted music (based primarily on his auralisation of the score) before the distraction of hearing it. In common with GN, imagery was presented in terms of allowing conceptual flexibility, where actual perception might lead to over-familiarity and hinder the development of new creative ideas. In this manner, imagery and perception function similarly for both composer and performer, with creativity the primary concern in balancing image and perception experiences. PH was in a position to proffer distinct pedagogical ideals as regards the importance of inner hearing skills in successful music performance. He believed that inner hearing skills can be developed from an early age, and that the process of learning to image for oneself represents an important transition to autonomous music making where the performance goal exists in the mind. Noteworthy is the superiority accorded by this particular individual to aural imagery, with kinaesthetic concerns taking a subservient role in the music's interpretation.

7.3.3 Deaf Organist

PW was questioned about the way he perceives music, the nature of his musical imagery, his performing, conducting and signing, and to describe 'tune on the brain' experiences.

Many themes emerged from the dialogue, but only those pertaining to musical imagery and perception are discussed here: reliance on musical score, awareness and observation, perceiving through imaging, the 'working out' of music, memorising, imaging as a necessity, and imagination.

7.3.3.1 Musical score and Music Perception

PW began by explaining that he relied entirely on the printed score, as listening to music 'doesn't mean anything, it's just some abstract noise with no recognisable shape, no recognisable form'. He went on to exclaim, 'I just cannot imagine life without a score'! For PW, score is the primary musical experience: 'I love it if somebody is to give me a piece of music and I sit down and work my way through it'. How is PW able to translate score into a musical image given his lack of conscious aural memory and having been profoundly deaf from early childhood?

> I never knowingly sat down and taught myself how to read a score. I always thought that that was something that anybody could do.... It's not something I've knowingly learnt to do. I don't know whether that's been some sort of automatic compensation for my hearing loss, or the fact that I have to relate to what I see.

This explanation is sufficient to PW's needs, but psychologically inadequate: musical literacy is an acquired skill and not innate. This indicates that the learning process for PW was tacit, and as he suggests, effectively achieved as compensation for his hearing loss. Alternatively, score reading for him might not be 'aural' as it is for a musician who has explicitly learned to associate written symbols with aural perception. As long as it is impossible to directly experience another's mental experience, this matter remains unresolved.

PW explained that scores differ in their difficulty of reading, and subsequently in imaging them. Of a particularly dense score he said 'that's not to say I couldn't do it. If you gave me time I could sit there and work out what was going on'. His approach when presented with new score is to 'flick through it' to gain an overview and pick out important features. Given that the musical information represented in score is PW's primary access to music, it is unsurprising to hear that an incomplete score is troubling to him:

> If somebody gives me a lead sheet and some lyrics I don't feel confident at all. I find it so hard to do. *Blood Brothers* is an example. I've been signing *Blood Brothers*, with my best Liverpudlian, for about six years now. They don't have a score. All I have is a vocal selection book so a vast amount of the time I've no idea what the band is doing.

In order to understand the nature of the relationship of perception to imagery for PW, it would be helpful to understand what it is that he 'hears'. He is confident enough in his music perception to suggest that he would make a good music critic, giving an example of a concert that he attended where:

> I gave my friend this whole list of things that I thought were incorrect to do with the actual performance of the piece, the intonation, the attack, the whole lot . . . I was just talking about the overall ambience, the overall feel of the venue...

Without a score PW is able to perceive rhythm, though he describes his frustration with the dull beat of dance music, and incorrect sound balance at concerts. With his hearing aids in, he can hear some distorted sound, and says that 'I might have some lyrics and I've got the harmonics'.

A striking demonstration of PW's perceptual capability was his frequent singing during the interview to explain a point or recall a piece of music. Moreover, at one moment where he sang, he commented 'Excuse the key, slightly low', demonstrating a keen awareness of pitch. He claimed that this pitch awareness was not perceived as a physical feeling in different parts of the body, such as that described by Evelyn Glennie (Cleall, 1983). Nor did PW feel that he perceived distinct instruments in such a way. He stated two reasons for this: firstly, different people have different builds so that vibrations would affect each person differently, and secondly, he himself did not need to experience pitch and timbre in this way. PW often gave the impression that music was just 'absorbed':

> How did I know that this particular voice sounded right for the line I wrote? I don't know. Intuition. Call it musical intuition. You can't explain it can you? It's just sometimes you know this piece of music will go with

> this person or this line that you're writing is perfect for this particular person. Can't explain it.

7.3.3.2 Perceiving through Imaging

For PW, vision has been the primary method of learning the organ. He uses visual cues to trigger an internal musical representation. This is musical perception. Just as musical perception for a listener who does not have a hearing impediment might be an emotional experience, 'listening' for PW might trigger strong emotional response. Describing a performance he attended of *These Premises are Alarmed* by Thomas Ades, he said:

> And then sitting there I just went 'woah!' and leapt to the edge of my seat. Because it was the way the piece finished. It finishes with a spiccato for the entire orchestra. But then they froze. They didn't take the instruments out of their mouths or put their bows down or whatever...

In addition, vision provides information about the quality of a performance, allowing PW to understand what others are hearing:

> It's amazing how much your face betrays you. If you've got a line of singers and the person in the middle sings a wrong note, these two on either side will inevitably have a physical reaction to it.

PW uses visual information in conjunction with his past experience to formulate a perception of music through an image of sound. For example, promoting the process of playing many different instruments he explained that:

> If you're deaf it's a vital thing to do because when you see somebody else playing an instrument, you need to be able to imagine for yourself what they're playing and what is sounds like.

In this way, he is integrating first-hand knowledge of an instrument with the visual display in order to image what is being played. PW described his appreciation of the exaggerated visual spectacle of Bernstein:

> I think he was the first musician who really grabbed my attention. Partly because he was outrageous, I mean as a conductor some of the things he used to do were incredibly over the top. But my god you didn't need a score when you watched Lenny. He acted everything out.

PW believed that his mind's ear allows for a greater insight and internal perception than the more passive process of listening would allow. He recounted that his tutor at university had explained that he was an easy person to teach because of his deafness:

> And he said 'well the thing is that most students if you asked them to analyse a piece of music they will go away and listen to it, and there is a limit to what your ear can pick up'. So from that point of view, because of my deafness, and because I had to rely on what I saw on the printed page he said that I notice far more.

Imaging music is seen as an active process by PW, and one involving intellectual understanding rather than passive hearing. This helps to explain PW's view that aural perception is less informative than the awareness that is brought about through a combination of the mind's ear and musical knowledge.

PW reported difficulties in recreating music he has heard without a score. For instance, as a child he heard Mahler's *Symphony No. 8 in E flat major* and only subsequently bought a recording and a score. He was then unable to re-experience the passage he had liked at first hearing, perhaps due to memory problems, or perhaps because of a faulty original perception. 'What I imagined was happening and what was really happening may not have been the same thing.' PW proposes that a mismatch between percept and image could have occurred. He expresses this idea explicitly:

> If I go to a concert or on the rare occasions I might listen to a piece of music without a score, but I do know what's going on, I can actually conjure up some kind of picture in my head, but when I get the score afterwards I find if bears no relation at all to what I thought I heard.

This is an example of perceiving music through imaging. Comparing a mental image to the score for PW is tantamount to comparing his mental image to a 'listening'.

7.3.3.3 Imagination

PW was asked whether he could imagine the different sound qualities of different instruments when he read score. His response was positive, and he was able to explain it in terms of first-hand experience in playing different instruments when he was younger. He spoke of having had the 'chance of feeling' the bass clarinet. Interestingly, he expressed a particular interest and ability in orchestrating music:

> Now by rights I shouldn't be able to do that, 'cause you need a good ear, and mine are crap! You need to be able to tell what instruments will sound like when you combine them. . . . Well I freely admit I didn't have an extensive knowledge of the workings of these instruments.

His knowledge is seemingly more procedural than declarative, though it is hard to comprehend how this could be so. PW attributes his ability at orchestration to a vivid imagination:

> I've tried playing different instruments, or being in close proximity to them you build up this imaginative vocabulary, for want of a better word. And somehow your brain just absorbs it.

Thus imagination, which is more creative than imaging, plays a crucial role in PW's timbral experience.

7.3.3.4 Performing music

PW reported that performing music is more emotionally charged than merely listening. 'You've got to be playing it. You've got to be with that piece of music, and sort of combine with it, definitely'. When asked whether there had been any overt emphasis on imaging music in his musical training, he replied that hadn't been the case, probably because he had relied on performed examples to learn. Thus actually performing music forms a central part of the experiences of PW. He has learned to play the organ through observation, yet he says that:

> Interestingly enough I don't frequently have the image of somebody physically playing. If I look at a piece of music I don't imagine somebody sat at a keyboard and how they're going to finger it. . . . That could be because every performance that you do has got to be unique in your own interpretation.

This final comment is illuminating, as it demonstrates a flexibility required in the musical image in order to accommodate individual interpretation. When asked whether PW deliberately listened to and attended the performances of others when preparing a piece for performance he explained that he tended to imagine his own interpretation. Though PW watches to learn technical points from others, his imagery is less about copying than creating a unique interpretation.

7.3.3.5 The 'Working out' of Music

PW's approach to music is both extremely emotional and highly analytic. As a signer of musical performances, his specifically musical training has proved an advantage as it allows him to try and convey musical features such as fugue through sign. When describing favourite moments in pieces of music, his description took the form of the analysis of modulations. Speaking of *West Side*

Story he says 'And I never get tired of listening to that. It's such an incredibly analytical piece of music'. He frequently described a process of "working out" some aspect of music, clearly drawing on his academic background as a primary source of musical knowledge in the absence of sound. He said for instance 'I don't find it difficult to work out the harmony and even the structure just from looking at it' and 'I prefer to sit down and work out my own'.

PW has a good memory for music. When asked what preparation he did for signed performances, he explained: 'most of the time I just memorise it. Work it out in my head, get up on stage and do it'. PW's musical memory is more structural than note-level:

> When I say that I memorise a piece of music, I obviously don't memorise every single note. . . . I suppose it's a pared down representation of the whole thing. . . . If I don't have a score in front of me I tend to play them through in my head. I tend to visualise it in big blocks. . . . I suppose I'm really aware of form in a way.

He claimed not to rehearse much for signed performances: 'partly because of time, pressure of time, I don't do that any more. And also because I'm more experienced.'

7.3.3.6 Imaging as a Necessity

On occasion, PW mentioned that he might image those elements necessary for him to perform a specific musical task, but not more than that. Saying that his memory was not note-specific he explained: 'maybe a conductor needs to do that so that he can direct his orchestra. My knowledge is not as detailed as that because it doesn't have to be'. Similarly, speaking of Evelyn Glennie's ability to feel distinct pitches in her body, he said that:

> I would say that to some extent she probably needs to be more aware of it because she is a solo percussion performer who works with an orchestra . . . So I think for her it's more necessary. I've never been in a situation where I've needed to.

7.3.3.7 Aural imagery

It is impossible to know to what extent PW's aural imagery resembles that of a musician without a hearing impediment. However, he explicitly frames his music in terms of an 'aural tape' playing in his mind. When asked whether he envisaged the score mentally when memorising music he replied:

> No, I don't actually. I know I always tell people that I play through in my head, which I do, I mean I run it through, but I don't see all the music. It's like I have a tape in my head, and I'm playing the tape.

There are surprisingly few mentions of kinaesthetic imagery in the interview. Various physical responses to music perception are mentioned, and the physical dimensions of musical signing are discussed with no implication of a transfer to imagery. However, other dimensions do feature in PW's imagery. For instance, he stated that he is more likely to image music with lyrics than without, and that he frequently experiences colour and feelings of warmth during moments of his imagery. Harmony is clearly a salient musical feature for PW, as it not only features in his favourite musical moments, but also seems to elicit the strongest emotional response.

PW experienced 'tune on the brain' more when he was younger. This often took the form of fragments repeatedly playing in a loop in his mind: 'I used to have pieces of music going round and round and round and round and round my head. And sometimes it used to drive me nuts'. Since then he seems to have gained more control over imagery:

> Now because I do so many shows in a short space of time, I suppose I've trained myself to do a show, get it out of my head, and put another one in. It's almost like I've compartmentalised them.

He describes not having found a definitive cure for unwanted musical imagery, though does state that: 'Sometimes sitting down actually bashing the thing out on the piano would work, sometimes just actually playing a recording of them would work'. This is an interesting method, as it involves turning imaging into perceiving to externalise and hopefully get rid of the sound. PW explained how music would keep him awake at nights, and he would be haunted by familiar music. He explained the persistence of certain bits of music as carrying significant associations for him. Thus meaning as well as familiarity might be contributing factors to a fragment of music's 'stickiness'.

7.3.3.8 Summary

To summarise, PW relies on musical score in order to experience music, though he is unable to explain how he acquired his apparently detailed auralisation skills. Score reading combines with a general awareness and observation of musical situations, such that music for this organist is more clearly an amalgamation of sensory modalities than otherwise acknowledged in music perception. As regards the relationship of imaging to perceiving, imaging is presented as distinct from perception when PW describes episodes in which he had been haunted by 'tune on the brain' phenomena. He also describes perception in imagery terms, as perceiving necessitates image formation and the two are part of the same process. As a deaf musician, PW speaks in terms of 'working out' music in a fairly analytical way. This is similar to PH's often analytical approaches to performance, whereby he would mentally prepare his own interpretation of the score. PW demonstrated good memory skills for music, linked to his reliance on memorising score. However, in common with the other two musicians, his imagery was described in practical terms, as being a necessity for various musical activities. This combined with an obviously vivid imagination, to which he attributed his enjoyment of and ability in orchestration. For PW, music is rarely framed in the purely aural terms that dominated the dialogue of PH. Instead, visual, kinaesthetic, haptic and spatial dimensions play a prominent role.

7.3.4 Summary of Shared Themes

A certain number of themes arose for all interviewees, and these concern the balance of musical perception and imagery according to task type and image function. Firstly, there was general agreement as to the use of imagination in music making, with it differing slightly from imagery in its creative function of reaching beyond given stimuli. For instance, the composer framed imagination as a process of expanding given material, and creating beyond that already existing. Perceived or imaged representations of musical material might equally constitute this given material, so that imagination is related but separate. For the composer, hands-on manipulation of sound might be a more fruitful source of imaginative development, though imagery might also help break free from learned material through its inadequacies as an exact mental representation of given music. For PH, the 'imaginative impulse' in musical performance was at risk of being stifled by overly perceiving rather than imaging music. For him, going beyond the given meant looking beyond the surface information in the score, without distraction from the 'given' material presented through perception, in order to create new meaning. PW also spoke of imagination, as having had to establish an 'imaginative vocabulary' of timbre. Implicit in his use of the term, once again, is the notion of extending given material, as for him, aural information for timbre had not been aurally given, but needed to be created through combining and extending proprioceptive, observed, and analytic knowledge.

Secondly, all three respondents expressed in various ways the importance of flexibility in perceiving and imaging music. For instance, in composition it was a delicate balance of fixing a musical idea without letting it become stagnant and too ingrained either mentally or through notation and perception. With performance the flexibility lay in the conception, a schematic framework which allows for both image and perception change. For PW too there was a need to ensure that learning the technique of others did not transfer to mere copying without room for interpretative variation.

GN and PH described situations in which over-familiarisation with perceived music could occur. For GN this might involve hearing a composition repeatedly and becoming indifferent to its potential to grow, while for PH this would be the unwanted influence of other performers' renditions, or being ruled by physical factors before a mental conception has been created.

It is important to note that, in accordance with the theory that intentionality and musical context affect the imagery experience, all of these professional musicians described the unintentional 'tune on the brain' experiences as being quite different from the imaging required of their respective areas of musical expertise. They would devote time to mental work, be that preparation or composition, which is quite different from the passively occurring, occasional imaging of familiar fragments of music. Musical imagery for work was reported in terms of being a tool that could be consciously employed to hold the music before the mind's ear, to retain freshness, to experiment with, and to modify.

7.4 The Relationship of Imagery and Perception in Music

The interviews reported above demonstrate the tight-knit relationship of imagery with perception in music. Moreover, imagination is an extra though intricately related dimension occurring not only for composers, but also for any musician creating a personal style. However, imagination has been expressed as going beyond and developing new material from old: some form of perception is a necessary pre-requisite before the conscious emergence of musical ideas can arise. GN spoke of learning to trust musical ideas seemingly arising from unconscious development. In common with this experience, Stockhausen reports the unconscious resolution of a compositional problem overnight:

> I remember that very often when I'd worked until late at night, I gave up; the brain continued working on the problem during my sleep, and I knew the solution next morning. (Stockhausen; cited by Cott, 1974: 52)

Saxton articulates the intricate negotiation of perception, imagery and imagination involved in composition, saying that: 'For a composer, there exists continual two-way osmosis between the material itself and applied methods of treating the "received" musical ideas' (Saxton, 1998: 6). Perception or imagery may furnish these 'received' ideas, while imagination works to develop this, either consciously or unconsciously, to present in a new form. GN described mental imagery as a faulty tape, its weakness as a means of faithful reproduction lending it value for experimentation and modification.

Dubiel outlines the relationship of imagery with perception for a composer as follows:

> The activity of composing involves occupying various positions in the range between hearing what you've got and imagining what you want, and moving every which way between them. And even the mental activities at the extremes of the range are not necessarily distinct. We cannot draw a boundary between 'hearing what's there' and 'imagining something', because hearing sound as music always involves imagination... (Dubiel, 1999: 264).

However, the musicians of this study drew certain fairly clear boundaries between imagery and perception. Imagery as described by the respondents might be an idealised musical representation, being held up as the perfect goal in performance. However, perception might never live up to the exemplary image. This perspective imbues imagery with a freedom that cannot be matched in musical production. Stringer (1997) quotes from Barford's work in 1971 on Beethoven:

> To be deaf is to reinforce the ideal experience of sound, so that tonal imagination, musical thought and contemplation come into a deeper focus than might otherwise be achieved. (Barford, cited by Stringer, 1997: 31).

This notion suggests the use of imagery as a form of compensation for perceptual loss. Paradoxically, the reliance on imagery in the absence of perception runs counter to the established idea that the greater the amount of perceptual exposure to a stimulus, the greater its consequent imagery.

PW expressed his belief that the mind's ear was capable of discerning greater detail and insight than 'real' listening. This might be due to the fact that imagery can be evoked at will and can therefore transcend problems of temporality, as well as the practicalities of producing sound at will. Yet this perspective contrasts the advantages of aural perception as vivid experience as described by GN and PH. While mental work is essential, the ultimate goal is the actual production and perception of music. It is difficult to know what this striving for heard sound implies for the musical intensity of PW's musical imagery: there could be no doubting his love of music. Perhaps the key lies in his preference for the intensity of performing music over listening. Recall that a method he used to banish unwanted music from his mind was to perform it out of his system, thus making it real and life-like. The remarkable nature of PW's experience demonstrates very strongly that auditory perception is not all-important.

Perception and imagery also play crucial roles with respect to the need for creative musicians to fix their ideas. This applies as much to performers as to composers. For instance, in accordance with the views of PH, Brendel (1976) says that having to re-learn music rather than easily retaining it in memory is an asset to fresh performance. Here the mental image is not a fixed 'master record' but a flexible conception. Different stages of learning or creating a piece of music will inevitably necessitate a different reliance on perceived sound rather than imaged music.

Schemata based on past experience mediate perception, so that each perceptual act is a process of extracting meaningful information from the perceptual event. The musicians in these studies described imagery comprising features that correlated directly with those features they found interesting and meaningful in perception. For instance, timbre was an important dimension in the imagery and imagination of GN. This is not unusual when considered alongside the reported imagery of some famous composers. Stravinsky continually stressed the important use of instrumental colour as an integral part of a musical idea. He presents the way to write effective instrumentation as comprising imagination and declarative knowledge about the instrument, stating that Berlioz had both aptitudes (1979: 29). Elgar also experienced instrumentation as part of the musical meaning of his composition:

> The fact is I mentally hear the instruments, and when scoring put down what I feel that the sentiment of the words, if there be words, demands for the most perfect expression attainable. So far as I am concerned the thing is already complete in my mind: to make others feel it as I do is the trouble. If I could only write as fast as I think! (Elgar, cited by Buckley, 1912: 87/88)

The interview with the expert pianist, PH, highlights some different imagery experiences from those reported elsewhere. For example, contrary to his approach, Baker (2001) stresses the importance of embodied cognition in music with the physical keyboard playing a key role in not only the mental imagery of keyboard music, but also its perception. While PH isolated the music as an abstract auditory entity to 'get right', Baker might argue that the physical role of instrumental practice is an integral part of the memory for music in performance.

As stressed at the start of this chapter, the purpose of the study was to gather detailed information about the perspective of individuals on the relationship of imagery to perception in professional musical life. Despite the importance of considering each interviewee as an individual, evidence in common from all three respondents suggests a flux between perception and imagery in music-making. Often, the two may be so intertwined as to appear inseparable. Certainly, for PW, perceiving music necessitates the immediate formation of a musical mental image, and imaging music through score reading is equivalent to perception for him.

To summarise, musical imagery is closely bound to musical perception, and vice versa. Professional musicians employ imagery in a practical way, to fulfil functions in their musical activities. It is interesting to consider one aspect of Rowell's description of musical imagery in India, for which:

> Images of musical sound – or of anything – are something more than convenient, disposable tools for the imagination and the memory: they are the mind's only contact with the reality they represent' (2001: 291)

In other words, images are not merely subservient to other cognitive processes, but in themselves constitute an individual's experience or reality, representing the mind's interpretation of the environment. This view is comparable to the ideas of Dubiel (1999) in which perception and imagery are so intertwined as to be conceptually inseparable. For PW in particular, perceiving music instantly triggers a corresponding aural image, such that perception and imagery are the same musical experience. Although less evident for the other musicians studied here, it should not be forgotten that composing, performing and listening to music all necessitate the formation of a mental representation of music, and not merely a transitory, isolated perception.

Above all, musical imagery for these expert musicians has been described as a practical tool in music making, an intentional experience in addition to the common, involuntary phenomenon of 'tune on the brain'. Imagery was frequently reported where music could not be heard for practical reasons, or where perception should not be heard for artistic reasons. For example, imagery might be used to mentally try out different solutions to a particular musical question, where perception would be too fixed an alternative. Both PH and GN warned of the dangers of becoming too accustomed to the heard music, as this might stifle the potential for mental growth. This implies an inverse relationship between the amount of music heard and the amount of music imaged and imagined. These views all underline the delicate balance of perception to imagination in the creative process. At highly specialised levels of musical experience, imagery is actively employed alongside perception, in ways that relate directly to the musical context.

CHAPTER EIGHT – A PSYCHOLOGICAL DESCRIPTION OF THE RELATIONSHIP OF MUSICAL IMAGERY TO PERCEPTION

8.1 Summary of research

The aim in conducting the studies reported in the preceding chapters has been to explore the psychological reality of musicological intuitions about the nature of musical imagery in its relationship to perception. A progression from the unintentional 'tune on the brain' through to intentional imagery 'use' in music-specific activity has allowed for a thorough exploration of the phenomenon in its various distinct forms. The results highlight a shifting relationship depending upon the contextual factors of image intentionality and musical task.

This thesis began with a review of previous work in musical imagery, including neuropsychological research able to compare imagery and perception directly. Summarising the current state of empirical knowledge in this field indicated that auditory imagery and perception share many neuronal pathways. In a simplified argument this suggests that the two experiences are manifestations of one cognitive system that differ in magnitude. Yet while neuroscientific understanding is valuable in its own right, it says nothing of the felt experience of imaging and perceiving music. It was proposed that this could be acquired through the amalgamation of theoretical, experimental and introspective research.

Given the centrality of imagery to musical activity, there is a history of musicological dialogue on the subject. However, there is little agreement as to the extent to which imagery may be defined as separate from musical perception. Psychological inquiry has sought to elucidate the reality of intuitions that imagery is central to musical understanding, that it often coincides with perception, and that imagery is experienced at many levels of resolution. In Chapter Two, a survey of the literature on musical imagery highlighted the disparate nature of research to date. In particular, it was noted that psychological theories pertaining to imagery have largely ignored mental representations of music, thus calling for a focused drawing together of existing knowledge in the field. Consolidation of previous research has been hindered by problems of defining imagery, both in its own right and in its relationship to perception.

For the purposes of this thesis, musical images have been defined as distinct from abstract mental representations, or schemata of musical events. That is not to say that a conscious mental image of music cannot resemble a schematic image, but imagery functions differently and is essentially a more sensory, 'concrete' cognitive phenomenon. Thus defined, it has been determined that music listening involves imagery when this is a conscious representation of events beyond the perceptual moment. In general, however, musical expectancies are not consciously 'heard', and do not take the form of imagery according to the present definition. In music listening, musical images seem to occupy a phenomenal position between the schematic, sub-conscious anticipation of events to come, and the conscious experience of eidetic imagery.

An aim of this research has been to explore imagery in its various occurrences. Having focused on imagery in the perceptual context of listening, the sampling study of Chapter Three aimed to determine just how common incidences of 'pure' musical imagery might be. It was found that on average the music students who volunteered imagined music for a high proportion of their waking time. However, there were considerable individual differences exhibited within the sample. That participants were able to name most of the music they imaged indicates a high familiarity with the music 'in their minds', and respondents themselves made clear associations between the music they heard and the music imaged. Another interesting finding is the reporting of episodes in which different music was heard and imaged simultaneously. This is counter-intuitive, given the known limitations on conscious attention: some participants suggested that rather than simultaneity, a fast alternation between heard and imaged music took place. A similarly surprising result was the frequency of episodes reported in which participants imaged music while interacting with others or working. Data also showed that participants imaged music more in the company of others than alone, with a pattern more like that of hearing than music-free episodes.

More research is required to determine the extent to which imaging music might interfere with whatever task is in hand, or provide a congruous accompaniment to it.

Chapter Three also presented data about the *nature* of having a tune on the brain. This was sometimes described as a multi-modal experience, with vision and occasionally kinaesthetic dimensions being reported. On average, melody and lyrics were rated as the most vivid components of the imagery, with dynamics and harmony less distinct. Episodes of hearing music seemed to increase throughout the day, with imagery remaining constant until dropping to half the number of episodes during the final two-hour testing period of the day. Overall, the sampling study testified to the reality of imagery experience, justifying further empirical investigation of the possible characteristics of mental representations of music.

Chapters Four and Five compared experiment task data under perception, imagery, and inference conditions. Here the veridicality of deliberate memory imagery for timing and pitch was inferred, and in accordance with data from the sampling study, timbre was explored as a more elusive imagery component. The veridicality of imagery for different musical dimensions was suggested by the data, and the measurement of response time enabled the sensitive detection of behaviour that was different in kind (and not simply magnitude), when imaging and perceiving music. In addition to the predicted pattern of faster and more accurate perception than imagery experiment results, unaltered targets (original timing or pitch) for imagery produced fast response times in relation to altered targets, while the reverse was true for perception. Task demands probably elicited different processes: in the perception task confirmation of a note's suitability was demanded, while imagery tasks asked for a more active comparison of the target to an image, a finding that was not, however, replicated for the timbre experiments of Chapter Five. Perhaps the difficulty of both timbre experiments (but particularly the first where the pattern is reversed) is responsible for this difference.

Consciousness is a key issue in considering apparent differences between imagery for timbre and imagery for other musical dimensions. Participants reported difficulty in consciously 'hearing' timbre, although their superior imagery data to inference data confirms that, on some level, the timbre had been internalised. Clearly, veridical, conscious imagery for timbre required greater familiarity with the musical material than did imagery for other musical dimensions (pitch and timing). Liking for the music, attention paid to timbre, and the meaning attributed to timbre, are possible additional factors affecting the formation of timbral imagery.

Chapter Six explored the development of inner hearing skills in a population of university and conservatoire music students. The overall feeling among course tutors and students was that inner hearing could be developed. Focused listening and music performance were named as the most helpful ways to accomplish this. This finding adds weight to the association between perceiving music and imaging music. In advocating physical performance to develop aural skills, musical dimensions apart from the purely auditory are stressed. Consequently, in relating perception to imagery the term 'perception' should incorporate kinaesthetic and visual properties of music. The current pedagogical situation was one in which 'inner hearing' was rarely, if ever, conceptualised as a separate aural skill, even though discussion with participants revealed an agreement that this should be central to teaching.

The research in this thesis began with a consideration of general music listening before looking at increasingly specialised musical activities. In Chapter Seven, an account has been presented of the imagery of expert musicians. The interviewees described musical imagery as inextricably linked to perception, and vice versa. Musical dimensions important to their imagery were also presented as being important to their comprehension and perception of music. Imagery was referred to in practical terms - as a guiding conception of ideal performance or a method of maintaining compositional flexibility. The profoundly deaf organist was particularly interesting in his musical experience, as perception was not predominantly aural, but visual and kinaesthetic. However, his extraordinary score reading skills were evident, and his frequent singing of music testified to his experiencing an aural image of music. It is interesting to compare PW's experience with the ideas of Dubiel (1999) in which perception and imagery are so intertwined as to be conceptually inseparable. For PW in particular, perceiving music instantly triggers a corresponding aural image, so that perception and imagery are the same musical experience.

As a word of caution, all of these findings must be considered in the light of some of the methodological and theoretical issues outlined in Chapter One. First of all, verbal expression has been the chief means of gathering information about the qualia of musical imagery (though any resulting difficulties of expression are similar for both imagery and perception). Secondly, while the experimental designs of Chapters Four and Five by-pass self-report, they make use of a rather unusual priming task, in which the prime is not a single event (as in Bharucha's classic studies from 1987), but a temporally extended sequence, and further more involves the manipulation (presence or absence) of an imaged continuation of the prime. Finally, psychological testing inevitably searches for generalised patterns of behaviour, over-looking individual perspectives. There are grounds to consider that musical imagery, belonging as it does to the realm of subjective musical thought, might be particularly prone to individual difference. Post-experiment interviews, case study interviews and discussion with aural course tutors and students combine to highlight quite individual experiences of musical imagery. In the controlled experiments from this research, people attained similar ends, but their strategies may have been different.

Musicians have been the focus of this research. This is because they alone fulfil the criterion of experiencing musical imagery in all its various forms; not only as a tune on the brain and through music listening, but also in its occurrence in performance, conducting, improvisation and composition. Consequently, there may be ways in which the findings from this research do not generalise beyond the small musician population. A particular caveat is that musical training may have furnished the participants in this study not only with a specific descriptive vocabulary, but also a different perspective on, and experience of, imagery.

8.2 Musical Imagery: Hearing and Imagining Music

What conclusions can be made about the relationship of perception to imagery? Are perception and imagery fundamentally related along a continuum of musical experience, or is the picture complicated by other factors? One way to approach the problem is to view perception as an externally generated experience, and imagery as ultimately endogenous. Although most forms of musical imagery and perception are a mixture of both inner and outer hearing, both phenomena can exist conceptually and in reality as 'pure' phenomena. Active listening to unfamiliar music, particularly in an unfamiliar idiom, can be classified as the closest thing to pure perception, when there can be no concurrent involvement of a conscious musical image. Likewise, imagery retains an identity apart from perception as in the 'silent' experience of tune on the brain, the deliberate evocation of an auditory image of a score, or the internal manipulation of sound through composition.

It may be that perception and imagery as 'pure' forms of experience are comparatively rare occurrences, both for musicians and non-musicians. Most musical encounters inevitably resemble more closely the idea expressed by Dubiel (1999) and Rowell (2001), whereby perception and imagery are intertwined. Firstly, general theories of perception posit that incoming sensory information is related to internal representations of the relationships between events. Thus imagery is involved when perception generates internal representations that are conscious. Secondly, musical imagery can be triggered by a perceptual event, or overlap with perception in an important way. An instance of this would be listening to a familiar music album and mentally anticipating the next track. In other musical activities, imagery and perception can be conceived of as separate phenomena, yet they are mutually dependent. For instance in conducting and performance the projection of an ideal sound image is in constant flux with perceptual feedback. In composition, maintaining the optimum balance between fixed and fluid thought requires the careful measurement of perceived, imaged, and imagined sound. All of these examples implicate elements of both perception and imagery.

One way of viewing the inter-relationships of internal and external source, perception and imagery types is to describe their balance in terms of different stages of musical familiarity. Familiarity might be viewed alternatively as memory: clearly, highly familiar music has been memorised, unfamiliar music does not exist in memory. However, the term 'familiarity' has been preferred in order to avoid the complex implications of the many different memory systems that have been posited in psychology. Moreover, throughout the empirical research of the preceding chapters the notion of familiarity has been key to conversations and self-report with participants, suggesting that, for them, it is a meaningful term. Both musical perception and imagery are representations and not copies of real sound, varying in veridicality or proximity to the original. Variation in this dimension is dependent on familiarity with the music.

The absence of any musical imagery is assumed when listening to entirely new music. At this stage, perception is the important experience, with the support of a semantic network supplying a background of musical expectancies. After a number of exposures to the music, we can say that a listener has generated a partial image. Experience of this more familiar music is a mix of immediate perceptual input and imaginal hearing. What is the balance of semantic with episodic knowledge when a listener is moderately familiar with a piece of music? One way to understand the situation is that the inter-relatedness of perception and imagery outlined above describes the process of perceiving music in a well-developed semantic context. This might arise when a listener experiences an increasing number of particular, veridical expectancies rather than general, schematic expectancies. When an individual is extremely familiar with a piece of music, perception and imagery of that music converge. However, I would argue that experiencing the two as identical is only achieved in hallucination, as even the most familiar music has a quality when perceived that is different from its mental image.

Many of the same considerations also apply in relation to performance. The moderate to highly familiar stages of knowing a piece of music might entail an increasing intertwining of imagery with perception. This is possible because the image takes on increasingly detailed properties of the perceptual representation.

This state of flux between the two corresponds to heightened 'aural awareness'. When a performer knows a piece of music, this knowledge is both an external recognition, internal image, and a motor programme to execute the piece (see Godøy, 2001). The performer's aural awareness is enhanced by the inter-relatedness of imagery and perception, providing a strong foundation from which to focus attention on the performance. This is similar to the mechanisms of perceptual feedback in performance, but enhanced by a clear image of how the music should sound. Within the Western concert tradition it is generally agreed that in order to perform, musicians must be very familiar with the music, and capable of hearing the sound internally. By contrast, a mental schema is at no stage a consciously audible phenomenon. In performance as in listening, the mental image increases in veridicality, so that it comes to represent a more episodic form of knowledge about the music.

8.3 Discussion and Conclusions

It is worth discussing in detail the theoretical issues raised in the previous section alongside findings from the research reported in this thesis. Conclusions will be made under four main overarching themes. These are 1) the mutual dependence and similarities between imagery and perception, 2) transcending perceptual boundaries, 3) the veridical dimensions musical imagery, and 4) imagery as a perceptual substitute. The function and nature of imagery will be explored, as these play a fundamental role in determining the type of imagery/perception relationship.

8.3.1 The mutual dependence and similarity of perception and imagery in music

Having defined imagery and perception as separable concepts, I have nonetheless argued that they are mutually dependent in their everyday application or occurrence. This mutual dependence and indeed flux of imagery and perception elements is liable to change in relation to the musical activity in hand. For instance, listening to familiar music involves a primarily perceptual experience, but one that is both interlaced with and determined by a more or less conscious image of that music. Another activity in which imagery and perception depend upon each other is in music performance, in which a mental image of the music drives the execution of the music, while perception of the activity feeds back to the mind. Composers may differ in their preference for the manipulation of heard or imaged sound in the creative process, but inevitably the two inter-relate and depend on each other. Even the pure imagery of 'tune on the brain' might be triggered by a perceptual event.

In arguing for the mutually dependent relationship of perception with imagery, it is important to remember current neurological knowledge of perception and imagery mechanisms. In Chapter Two it was seen that the two share many neuronal pathways, but that they also differ both in terms of the strength of the neural trace and the specialised location of some brain areas in the function of one or the other. This neurological evidence supports the thesis that perception and imagery are mutually dependent yet might function differently according to the task in hand. Musical hallucinations have not been considered in the current research, as they represent a separate though related field of study. What has been termed 'eidetic imagery' holds perception as its analogue, and in theory this might approach hallucination in its content. That musical hallucinations have been reported (see Kosslyn *et al.*, 2001; Hodges, 1996) suggests that the mind has the capacity to represent music for 'hearing' in as vivid a fashion as perception.

Music listening entails first perceiving and then forming a mental image of that music. As a performer, a mental representation must be in place before communicating the music to a listener. This is a cycle of perception and imagery alternation on a macro level. On a micro level, certain perceptual constants such as *gestalt* principles would constitute an interesting point of comparison between perceived and imaged representations. The retention of such principles in a musical image might constitute not only further parallels between imagery and perception, but also evidence of the perceptual influence on mental image formation. The tonal hierarchy explored in Chapter Four is another psychological mechanism that has been promoted as an important cognitive principle (Lerdahl and Jackendoff, 1983) in Western tonal music, though this time as a high level representation. While both perception and imagery tasks were seemingly affected by tonal hierarchy, some experimental anomalies provided evidence of the influence of melodic contour and rules of proximity on performance. These are *gestalt* rules that seemingly shape both perception and imagery.

A final consideration of the influence of cognitive principles on perception and ultimately imagery is that some of the criticisms that have been levelled against hierarchical representations of music (see Dibben, 1996) might apply equally to the experience of musical imagery. For instance, the veridical experience of music is highly dependent on the surface level of music, and cannot be reduced in meaning to a skeletal scheme. On an intuitive level, and according to present data in which participants reported imaging melody over other parameters, a musical image is highly dependent on motivic musical material. This suggests that the large-scale structure of the piece being imaged is less important to its conceptualisation than more local surface detail. This situation is similar to that for the temporal perception of music.

Listening to music that is well known may be accompanied by its mental image, taking the form of veridical musical expectancy. This is as a result of repeated perceptual experience with the music in question. However, these expectancies are rarely experienced as conscious imagery during perception, as the process of listening actively detracts from 'hearing' the image. There is evidence that musical imagery can be suppressed by the simultaneous focus on real auditory input, and particularly vocal articulation (see Brodksy *et al.*, 1999). However, data from Chapter Three provides anecdotal evidence that the simultaneous experience of musical imagery and perception is possible. Perhaps this demonstrates that the mind is capable of processing on multiple levels of consciousness at once, though self-reports in this study indicate that this probably only occurs when both the perception and the image are experienced passively. Alternatively, it could be argued that while the experiences appear simultaneous, the process is actually one of rapid alternation between perceiving one stimulus and imaging another. This is an area that warrants further study.

The close relationship of imagery to perception is exemplified in the finding that perceptual awareness and physical production of music are considered the best means of developing inner hearing (Chapter Six). While physical production is not the same as perceiving, both might involve not only aural awareness but also the concomitant parts of proprioceptive, spatial and visual awareness. Yet aural sense is the sole focus of the more traditional listening-based training courses observed, in keeping with the narrow title of 'aural training'. Traditional views of aural training have isolated skills normally experienced in an applied setting, with the occasional consequence that these skills lose their practical nature. Findings from Chapter Six indicate that students are naturally more confident at sight-reading over score reading. Perhaps this is because sight-reading is translated to physical production on an instrument, involving a helpful proprioceptive dimension to the image/feedback/perception cycle of the task. In addition, score reading is liable to involve imaging more than the music of a single instrument for which timbral imagery is less of an issue. It can be concluded that perception and physical production seem to feed directly into imagery.

A further parallel between musical perception and imagery is that neither is experienced in the same way twice. Both are governed by the general psychological rules of environmental experience, accumulated knowledge parses internal and the external cognitive experience. There are also grounds to believe that both perception and imagery of music are experienced quite personally. It is possible to regard the self-report of interviewees in the current studies as evidence for the particularly subjective occurrence of musical imagery in terms of meaning attributed to the experience and the attentional focus within the image. The similarities between imagery and perception serve to complicate the analysis of the relationship of the two. However, it is apparent that they are mutually dependent processes, with a relationship that varies according to the activity. Generally speaking, perception of some form precedes imaging, though the mutual influence of each is apparent at most stages of the perception/imagery cycle.

8.3.2 Transcending perceptual boundaries

In Chapter Seven interviews with professional musicians revealed that musical imagination is a link between perception and imagery. Imagination is creatively moving beyond given material, be that perception or imagery based. Imagination might also involve unconscious development, in which case both imagery and perception might feed the creative unconscious. In composition, imagery has been described as a faulty tape mechanism. The faulty nature of the image is one of its primary strengths in composition, as it allows for spontaneous change over time, and the development of new ideas (Chapter Six and Seven). In this context, imagery is quite different from perception, as to perceive new sounds first requires specifying them for production and then perceiving them. This process of specifying, producing and perceiving sound reinforces what might otherwise be an ephemeral idea, with the consequence that ideas become anchored.

In any musical creative work, a balance has to be made between perception and imagery. This balance is liable to change through the different stages of musical activity. The pianist of Chapter Six reported very little reliance on actual perception until the final stages of preparing a piece for performance. The composer described more of a fluctuating relationship between hearing and imaging in his work, with a shift towards actual perception towards the completion of his work. At the highest levels of music making, perception is in some ways less controlled than intentional imaging, which is theoretically free to be manipulated at will, while actual music occurs within physical constraints.

The expert pianist and composer (Chapter Seven) explain that perception can stifle mental growth, as it presents musical information to the mind in a fixed form. As imagery is not directly subject to the physical constraints of actual music production and perception, it can in some way surpass the limitations of the physical environment. Those with exceptional imaging abilities can theoretically transcend the restrictions of temporality, and also modify the details of their internal hearing at will. This is the view expressed by the professional pianist, and also one that is reiterated in the psychology of mental rehearsal, be that in sport or music (Freymuth, 1999). Yet evidence for the ability to image detailed musical textures is lacking, particularly for those without musical training. Imaging music in a veridical way seems to be a skill that arises from extensive perceptual experience and deliberate practice. Another way in which skilled musicians evoke imagery is as a means of keeping music before the mind's ear. In such a situation, imagery again functions differently from perception, forming as it does a useful intermediate tool. In short, musicians may essentially 'use' imagery where actual perception is absent or is too restricting in its fixed character.

8.3.3 The veridical dimensions of imagery and perception

This research has gathered information about the *nature* of the imagery experience. In Chapters Four and Five, the veridicality of imagery for timing, pitch and timbre was explored. Comparing imagery tasks with inference tasks which indicated that imaging a musical context aided the discrimination of target moments. This result in conjunction with self-report suggests that a degree of pitch and timing information did form part of the mental image. However, in Chapter Five, participants did not readily report being able to consciously hear timbre in their mind's ear. Even though the experiments explicitly deal with voluntary memory imagery, the capacity to image pitch and timing over timbre for musicians agrees with other data in this study such as the involuntary 'tune on the brain' (see Chapter Three). Note however that this finding may also correspond to findings about the *perception* of musical dimensions (Beal, 1985; Wolpert, 1990). It is suggested that the veridicality of various musical dimensions in imagery is in direct relation to their perceived veridicality.

Intons-Peterson (1992) spoke of the inadequacy of functional and structural theories of perceptual equivalence to account for the ancillary features of auditory imagery such as loudness, timbre, and kinaesthetic dimensions (see Chapter Two). Certainly, timbre in the current research has been shown to operate differently to the dimensions of pitch and timing in musical imagery, requiring greater familiarity with the experiment material for its inclusion in a conscious image (Chapter Five). Intons-Peterson suggests that the more an experiment requires participants to draw on 'real-world knowledge', the more the results from perception and imagery tasks will be dissimilar. Real world tasks and material tend to be less controlled, with the greater potential for the influence of extraneous factors. The experiments presented in Chapters Four and Five, and indeed the research throughout this thesis, involve the use of complex material – music. Thus it might be expected that high-level cognitive knowledge structures have affected the consequent image, in addition to the perception of low-level features. It is not clear from the theories of Intons-Peterson, nor the data presented in this thesis, whether it is the nature of experimental tasks in imagery research or familiarity with the material which determines the ancillary or core nature of different musical dimensions.

In the ESM study (Chapter Three), different musical dimensions were reportedly imaged to different extents, with melody and song lyrics the most vivid, and timbre, harmony and expression the least vivid. This is the only research the author is aware of which has systematically examined the content of everyday 'tune on the brain' mental representations. It is notable that the most prominent features of the imagery were pitch or word based, demonstrating that the term '*tune* on the brain' as opposed to 'music on the brain' is apt. Pitch dimensions are traditionally the most salient aspects of Western music. It is interesting to see that harmony was only weakly 'heard', as was 'expression'. While a mental image inevitably loses some of its perceptual attributes, it is perhaps surprising that expression is not consciously 'heard' to in the image. Two possible explanations are as follows. Firstly, when *perceiving* a piece of music the listener might not have his or her conscious attention drawn to its expressive qualities if the expression fits the music in an unobtrusive fashion. Alternatively, the disconnected nature of 'tune on the brain' experience might somehow reduce expression. After all, expression communicates an idea, and communication is not part of the experience of imaging to oneself.

Auditory experience is not all-important to either musical perception or imagery. The deaf professional musician provides the most extreme case of this. Other examples come from the investigation of imagery development (Chapter Six) in which musical imagery was often experienced in a multi-modal way (with visual, spatial, and kinaesthetic dimensions), with individuals differing in their modal experience. Very different strengths and weaknesses were expressed by the respondents, such as ease of sight-reading or ease or difficulty of 'hearing' harmony. Different propensities to image scenes or feel sounds on an instrument were also expressed.

What can be concluded about the veridicality of imagery for timbre? The current research has demonstrated that timbre can be internalised, but that timbre recollection is not necessarily conscious. One of the ways in which timbre differs from melody and lyrics is that while melody can be sung, the physical limitations of the human voice make it impossible to reproduce most timbre. For instance, the physical apparatus for producing the sound quality of an oboe is absent in the human body. In the absence of physical readiness, it might be more difficult to image a very well known but physically impossible timbre than to image the timbre of the voice. Recent findings from Halpern *et* *al.* (2002) support this theory. While previous neuroimaging has implicated the supplementary motor area (SMA) in aural imaging (an area of the brain traditionally activated by motor activity) her recent work on imaging timbre is noticeable for its lack of SMA activation.

Post-experiment data suggest that timbre is most likely to feature in an individual's imagery when it is seen as being important to the music (either integral to the music's nature or particularly striking). Results from both timbre experiments were poor for imagery and perception where the music was not familiar enough. Increased familiarity led to a more explicit knowledge, indicating that perception and familiarity pass from tacit knowledge to a conscious image. The difficulty of performing the timbre experiments is demonstrated by those participants who claimed that rather than facilitating their performance, the perceived presence of the complex timbre sequence actually distracted them. The first of the timbre experiments showed that it is hard to image atonal, long, and complex sequences of structurally unrelated events. To explain this we can look to knowledge of memory systems. The processes of perceiving, cognising and memorising have certain functional limitations. Meaningless structures in the music and detailed material place a strain on cognitive capacity. Imaging timbre, perceiving and discriminating it require considerable mental resources and concentration. It is therefore unsurprising if timbre is only optionally included in a mental image.

Qualitative data from the ESM show that participants only rarely made a conscious link between their 'tune on the brain' experiences and rhythm, though rhythm may still have an unconscious impact on both the timing and the nature of music that is spontaneously imaged. Another musical dimension, and one that is frequently overlooked, is motion. On an intuitive level, experiencing a tune on the brain may have the effect of creating a forward motion through time, as perceived music most commonly has this effect. Could it be that experiencing a tune on the brain is the mind's way of maintaining drive? This is an area of imagery research that merits closer attention, and one that is discussed later.

8.3.4 Imagery as a perceptual substitute

Certain occasions arise where imagery is a substitute for perception, or as discussed above, is preferable to actually hearing music. On the other hand, the degree to which the mind is capable of generating a detailed musical image should be questioned. Those occasions when imagery has been described as useful for creative purposes, freedom, and veridicality, have all been those in which expert musicians discussed specifically musical activity. Such activity is only a minute part of most human experience of imagery. For most, music is heard in the background, listened to or danced to. In all of these circumstances, it is hard to see how imagery could provide an adequate substitute for the 'real' perceptual experience. The desire to listen to a favourite piece of music causes an individual to put that music on, and not to image their way through. It is clear that while imagery may be at the heart of musical experience, it cannot replace the richness of perception. In this respect, musical imagery and perception are function differently. This functional difference lies in the sparse sounding nature of imagery compared to the vitality of heard music.

In spite of this, imagery can be used as compensation for the loss of perception. For the deaf performer of Chapter Seven, the auditory imagery which he describes, and which he creates from reading score, is in fact his primary method of appreciating music, and consequently an example of imagery replacing aural perception. Looking at data from the ESM, it is possible that on those occasions when music is not actually being perceived, people introduce their own imagery soundtrack to accompany their daily activity. As only 21% of all episodes involved 'no music', this possibility, viewed in conjunction with the type of activities in which music was imaged (such as at work, where there might not be music playing) points to just such a scenario.

Another way in which imagery and perception are not equivalent in function has been demonstrated by the experiments that form the focus of this research (Chapters Four and Five). While every effort was made to establish equivalence between imagery and perception conditions, the tasks inevitably elicited different mental processes. In other words, the perception condition resembled a matching task between the prime and the target moment, while the imagery condition resembled a more active comparison condition. The technique has certainly been helpful in understanding more about the usefulness of an imagery context for task performance, and the variables affecting the formation of that imagery context. However, the task was demanding in its requirements: firstly, it required an immediate switch from the perceptual cue to an imagined continuation. Although it is believed that hearing familiar music is accompanied by a mental image, it is not known how instantaneously this can become the conscious focus of a continuation from perception. Secondly, the task required the deliberate pacing of the image, where this might not happen during normal 'tune on the brain' experiences. Thirdly, the onset of the perceived target might have necessitated too fast a switch from image to perception modes of cognition, in addition to the demands of the discrimination task. Consequently, though imagery and perception contexts were in themselves analogous, the transition from state to state in the imagery task placed additional demands on the participant. Perhaps this is why musicians, who are assumed to be able to hear music inwardly, did not perform in an equivalent manner under the two task conditions of each experiment. It can be concluded that a difference in application or function of the two cognitive processes is the main distinguishing factor.

It has already been mentioned that one domain in which imagery is deliberately used as a perceptual substitute is mental rehearsal. This is in common with techniques used by professional sports players (see Moorcroft, 2002), and was the approach favoured by the professional pianist interviewed in Chapter Seven. As an example of mental rehearsal techniques, he described imagery not as matching perception in efficacy and attention to expressive detail, but as surpassing it in the following ways: 1) it encouraged own invention rather than copying another's interpretation, 2) it could be manipulated at will, thus leading the body, rather than the body leading the mind, 3) attention could be focused on musical difficulties, avoiding subsequent repetition and learning of wrong techniques. This particular performer was perhaps atypical in his belief in mental rehearsal before any perception of the music, and was only able to do this through considerable skill and aural imagination when score reading. It is far from clear whether other musicians would be able to image music sufficiently to by-pass actual listening. Substituting imagery for perception is simply a part of the preparation for an actually perceived and physically produced music performance. Here, as elsewhere, imagery and perception are employed in quite different ways throughout different stages of music making. Their different but similar qualities allow this to be the case.

In summary, musical imagery and perception, respectively defined as the conscious 'hearing' of music that is not present and the actual hearing of music that is present, are mutually dependent mental processes, though they can, and occasionally do, operate as separate phenomena. Musical context affects the balance of perception and imagery being experienced, and some musical activities optimise on the shifting nature of imagery to nurture creativity. The musical image can be experienced as veridical in terms of the analogous aspects of its perceptual counterpart that have been detected and encoded by the listener. Commonly, these are a vivid melody (and lyrics, where relevant), with timbre, harmony and expression less intense in their imaging. Sometimes imagery may serve as a substitute for perception, implying a human capacity to recreate vivid sound in the mind.

8.4 Future research

Given the size of the project, it is not within the scope of this thesis to cover all areas of imagery research. Everyday experiences of tune on the brain are by far the most accessible forms of musical imagery to the majority of people, who do not have a musical training. One question that remains is 'why do people imagine the specific music that they do'? The ESM technique allows for further exploration of both tacit and explicit perceptual associations. By far the most popular trigger attributed to imagery episodes was having heard the music previously, or thinking about the music in advance of hearing it. However, one respondent named his reason for imaging *Brazil* to be seeing a picture of a Brazilian carnival. A couple of participants reported thinking about a particular person and consequently imaging music related to that person. It is not always possible to understand what has triggered a particular image, and factors such as picking up on a particular rhythm, or reading certain literature might subliminally influence the conscious image experience. Knowing more about the triggers to imagery would further understanding of its function and contribute to an important aspect of cognitive processing. Perhaps emotion is linked to musical imagery. Generally speaking, imagery is not as rich an auditory experience as perception. What remains to be seen is whether the physiological responses associated with listening to music (Sloboda, 1991) might be evoked by imaging the same music.

Closely related to the myths of divine inspiration in music is the question of musical imagery and paranormal activity. Willin (1999) undertook research into paramusicology, examining telepathic musical communication and music mediums. Of particular interest to the study of musical imagery are the claims of some mediums to be 'hearing' music communicated from dead composers. While Willin found no paranormal evidence for this, the musical imagery experienced by a "medium" seems to be of a particularly vivid nature. Participants from his study would make fascinating participants in further research into the potential triggers for imagery, and the vivid quality of the image.

An area that has been touched upon in this research but which deserves further study is the transition between perception and imagery experience. For example, both in experiential and physiological terms, little is known about the change from imaging music to humming it, and vice versa. Intuitively, humming the melody line of an orchestral piece focuses attention on the melody, while a pure image of the same music would be more likely to contain timbral and textural detail. This is a hazy area of knowledge. The experimental work presented in this thesis is an example where such a transition takes place: when participants had to switch from perceiving music to imaging, the continuation was a demanding moment in terms of cognitive processing, particularly where the musical texture was rich (as was certainly the case for the Bjŏrk material in Chapter Five). Whether focusing on the transition moment in these tasks or not, the experiment used in this research might be used to uncover the veridicality of imagery and perception for a multitude of different musical dimensions. For instance, imagery for texture, motion, loudness, and the spatial location of sound might be tested.

This thesis has demonstrated that neither musical imagery nor perception is exclusively restricted to an auditory experience. Most imagery research in psychology has focused on vision, and this is informative for music psychologists not only for its theoretical frameworks, but also because musicians frequently experience visual images. Applying imagery research to the practical needs of musicians can only be accomplished through an integration of knowledge across modalities. Moorcroft (2002) discusses the traditional importance placed on visual imaging for singers. Similarly, knowledge about musical imagery could be used to inform dance. Musical imagery would be particularly helpful to choreographers and dancers alike, particularly when it includes visual, kinaesthetic and spatial dimensions.

There is a suspicion, and one that has been partially corroborated by the current research, that musical imagery is a very individual and subjective experience. Ashley (2002) has focused on this aspect of musical imagery, but more work needs to be done in order to understand the different styles of mental representation of music that are encountered. Undertaking research of this kind is challenging within the constraints of psychological inquiry, in which general patterns tend to predominate over individual differences. Individual preferences for a particular imagery modality (for example auditory, visual, proprioceptive) over another might depend on musical background. While Chapter Six explicitly focused on the subject of the development of musical imaging ability, this is an area that would benefit from further psychological inquiry. For instance, although inner hearing was unanimously found to be important to music, and particularly by the pianist in Chapter Seven, it is not known whether imaging sound is essential to achieving high levels of musical proficiency.

Similarly difficult to explore is the role of motion in musical imagery. It may be that tune on the brain episodes primarily occur in response to and in accordance with the context of physical or mental motion. A number of authors have argued for the close correspondence between music and motion (for example Zuckerkandl, 1956; Clarke, 2001), and it would be interesting to know whether the same is true of musical imagery. Finally, Pratt (1990) is unusual in his consideration of the difference in spatial feel between musical imagery and perception. He observed that the spatial experience of sound provenance in a concert setting appears to be largely absent in a mental representation of that concert. Research into this area of imagery is necessary, and potentially revealing of a more fundamental qualitative difference between perception and imagery than the functional differences uncovered by the present research.

This thesis confirms the musicological intuition that musical imagery is central to our way of thinking about musical experience. Though research has been hampered previously by a lack of direct methods to explore the phenomenon, a combination of approaches has allowed a more tangible exploration of some of the properties of musical imagery. First of all, a basic indication of the prevalence of imagery episodes in everyday life has been presented. Building on this knowledge, it has been possible to question the nature of imagery through its comparison with music perception. The derivation of musical imagery from perception suggests that the two experiences might function in similar ways, and this has been found to be the case. Musical imagery is related to perception along an experiential continuum, and not as a binary opposition. Instead, imagery can be situated most frequently as situated between 'pure' perception (with its subconscious, semantic expectancies), and 'pure' eidetic imagery (as experienced in musical hallucination). This thesis has demonstrated the importance of addressing musical imagery in a variety of contexts, because its nature and its relationship with perception depend not only on musical familiarity, but also the function it plays. Whether this function is an involuntary 'tune on the brain', the corollary of musical activity, or the deliberate generation of an image, musical imagery is a crucial component of the musical experience.

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