Chapter 4

Music cognition: defining constraints on musical communication

Annabel J. Cohen

Introduction

The mind enables musical communication but it is also a limiting factor. This chapter examines musical communication from the point of view of these capabilities and limitations. It argues that a cognitive theory of musical communication must define not only what is communicated but also what can not be communicated. The argument is developed in a historical context, touching first on the early years of experimental psychology, then the period of behaviourism, and, finally, the present cognitive era. Several experimental paradigms are reviewed to demonstrate how the capacities and limitations of music communication can be quantified. A brief comparison between language and music literacy is drawn, and a plasticity framework for understanding the role of early music exposure is also presented. It is concluded that a foundation now exists for the creation of a fairly complete though complex quantitative cognitive representation of music communication.

History of experimental approaches to music communication

Early experimental psychology (1850–1920)

To the nineteenth century founders of experimental psychology, music raised important questions. This is exemplified by three of the most influential scientists, each of whom held a prestigious professorship – Gustav Fechner and Wilhelm Wundt at Leipzig, and Hermann von Helmholtz at both Heidelberg and Berlin.

Gustav Theodor Fechner (1801–87) and psychophysics

With the ambitious aim of providing an 'exact theory of the relation of mind and body', Fechner (1860/1966, p. xxvii) developed the field of *psychophysics*, the systematic study of the relation between the physical world and its mental representation. According to the translator of Fechner's book *Elements of Psychophysics*, 'Fechner's early interest in music appears in his chapter on the psychophysics of tones' (1860/1966, p. xxi). Through psychophysics, he attempted to quantify the functional relation between physical and mental events. Part of Fechner's approach was to establish laws that governed changes in sensation that were just detectable. He began with determining the limits or thresholds of sensation, including, of course, tones. Fechner's interest extended beyond elementary lawful relations among tones to broader aesthetic issues, the topic of a later book (Fechner 1876).

Hermann von Helmholtz (1821–94)

Like Fechner, Helmholtz was a polymath for whom music played an even more significant scientific role. His *Sensations of Tone as the Physiological Basis of the Theory of Music* (1887/1954) drew attention to melody, tonality, scales, and the physics of sound including the role of harmonics. In *Physiological Optics* (1896/1962), he proposed the notion of *unconscious inference*, the idea that based on past experience, the mind guesses the physical cause of the subjective impression created by the energies impinging on the sense organs. These empirically based guesses or expectancies determine perception.

Wilhelm Wundt (1832–1920)

Wundt had worked briefly with Helmholtz on studies of perception before establishing the first experimental psychology laboratory in Leipzig in 1869. His *Principles of Physiological Psychology* (Wundt 1874) discusses musical combinations of tones as well as aesthetic issues. In the area of aesthetics, Wundt postulated maximum preference for a moderate level of intensity as opposed to lower or high levels, as depicted in Fig. 4.1 (Berlyne 1960 pp. 200–1).

Other psychologists, such as Theodor Lipps (1905/1995), Wundt's doctoral student and Carl Stumpf (1883, 1890), Wundt's peer in Berlin, directed attention to perception of piano tones, tonal fusion, melody perception, and musical talent. Ernst Mach (1886/1897), the philosopher, physicist, and psychophysicist, also included chapters on tone perception in his book *The Analysis of Sensations*.

Implications

The nineteenth century scientists encouraged the analysis of the mental representation of music and its components. Their insights remain relevant. Fechner's aim of relating objective and subjective worlds predates a goal of cognitive psychology; in addition, his focus on defining limits sets the stage for the present argument that to understand representation in music communication it is necessary to understand precisely what information can and cannot be represented. Helmholtz' concept of unconscious inference precedes similar contemporary accounts of perceptual and cognitive phenomena including those of music cognition research. For example, the first seven notes of the *doh re me fa so la ti doh* scale, (i.e. up to *ti*), will prime an expectation of an eighth note *doh*. Even fewer notes of the scale will prime the entire scale (Cohen 1991; Krumhansl 1990). Inference, or expectation, also plays an important role in the work of music theorists such as Leonard Meyer (1956) and Eugene Narmour (1990, 1991). The latter proposed a theory of *Implication–Realization* which assumes that listeners unconsciously generate implications or inferences after each tone they hear. Notes that match a preceding implication are *realized*; notes that violate the implication create surprise (e.g. Schellenberg 1996, Schmuckler 1997; Thompson *et al.* 1997). Finally, the aesthetic theory of Wundt, summarized as the Wundt Curve, became a building block in the 'new experimental aesthetics' of Daniel Berlyne (1971, pp. 86–91) a century later.

It is remarkable how much progress in music psychology was made during an era in which recording of sound only became possible towards its end. Experiments might resort to hitting tuning forks, or to inviting the local violinist to play tones to listeners who held Helmholtz resonators to their ears (Fig. 4.2). The period of behaviourism that followed had the advantage of technological innovations like phonographs and tape-recorders, but the climate was no longer receptive to musical problems.

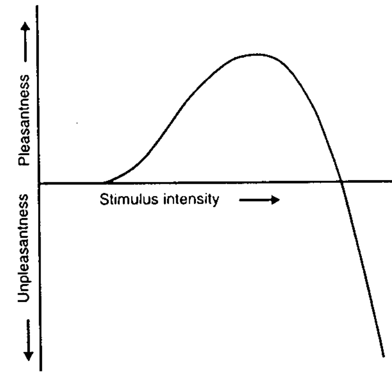

Fig. 4.1 Wundt Curve. The relation between liking for music and its complexity. Based on a diagram in Berlyne (1960, p. 201).

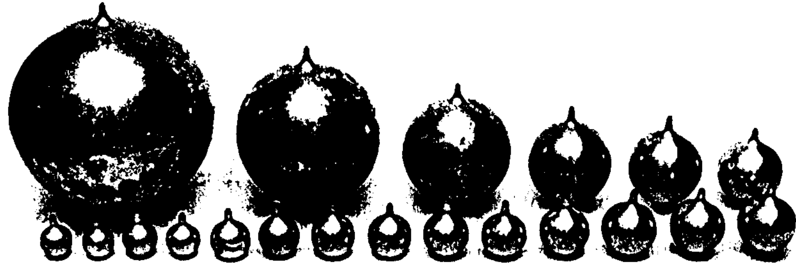

Fig. 4.2 Helmholtz Resonators. A set of Helmholtz resonators (manufactured by Koenig 1870) used to illustrate that listeners could hear out individual components of complex tones. Each resonator vibrated in sympathy with a particular frequency, and this vibration could be heard when the resonator was placed to the ear. (Courtesy of the Clarendon Laboratory Library archive, University of Oxford).

Behaviourism (1920–60)

John Watson and behaviourism

Few, if any, of the insights of the early experimental psychologists reviewed earlier had led to obvious applications. In contrast, by studying animal behaviour, Russian physiologist Ivan Pavlov had discovered the conditioned reflex, a principle of learning. In an influential article, the American psychologist John Watson (1913) recommended the behaviourist approach, urging psychology to focus on 'objectively observable behaviour'. According to the strict behaviourist view, introspection was an empty pursuit as were the topics of mind, thought, creativity, beauty, and imagery. Because music involves all of these topics, its neglect during this period was not surprising.

The stimulus and experimental method

From approximately 1920 to 1960, behaviourist research increasingly characterized psychology laboratories, typically entailing the conditioning of rats or other animals. The behaviourists developed strong methodologies: the use of research design, control of variables in experiments, and statistical analysis. Their concept of *stimulus* referred to the independent variable in an experiment that systematically affects responses of the participant. Conditioning studies sometimes used tones as stimuli (e.g. Pavlov 1928; Razran 1949). Watson himself emphasized sound as a conditioning stimulus (1916). The connection between the function of a tone as a conditioning stimulus and its function in music perception was rarely addressed (for an exception, see Humphrey 1927). One behaviourist study by Blackwell and Schlosberg (1943), however, suggested that the octave functioned similarly in both humans and rats. In this study, rats learned to press a bar when a particular tone frequency sounded, and their response *generalized* to the octave of this tone. Later researchers referred to this as evidence for an inborn or innate response to this musically significant octave relation (e.g. Deutsch 1969). Despite the behaviourist chilly climate for research on anything 'mental', some psychologists nevertheless maintained a strong interest in music (e.g. Seashore 1938/1967).

Gestalt psychology

A small group known as the Gestalt psychologists, most notably Wolfgang Köhler, Kurt Koffka, and Max Wertheimer, focused their attention on mental structure (see Ash 1995 for a review) though it was not in keeping with the behaviourist trend. For the Gestaltist, music was a clear example of organizational phenomena. Melody was the prototype of the Gestalt since *gestalt* means structure or pattern in German (though it is difficult to define precisely). Christian von Ehrenfels (1890), a philosopher of the earlier period who was passionate about music, is considered the originator of Gestalt psychological thought. His article in 1890 (also a shorter version published in English in 1937), entitled 'On Gestalt Theory', argued that one of the best examples of the Gestalt is *melodic transposition*. In melodic transposition, two melodies that begin on different pitches can be recognized as having the same tune if the corresponding pitch relations are the same within each melody. Although the elements, the tones, differ from melody to melody, the whole melodic pattern is still preserved. As a simple example, think of a birthday celebration in which different people begin the *Happy Birthday* song on different notes. Gestalt psychologists also introduced the principle of *Prägnanz* which meant 'the simplest and most impressive structure' (Ash 1995, p. 1 and p. 133) and is associated with 'simplest aesthetics' (Ash 1995, p. 185). To account for perceptual structure or grouping, they introduced laws of organization based on principles such as proximity, similarity, and good continuation (Ash 1995, pp. 224–5). The early description of Gestalt phenomenon challenged psychologists in the next

historical period for a more precise explanation. Post-behaviourism developments in communication or information theory provided some tools and answers.

Cognitive zeitgeist and communication theory (1960 – present)

The prominence of behaviourism receded after the Second World War. The need for a measure of communication efficiency and accuracy had become important during wartime and had led to a mathematical theory of communication (Shannon and Weaver 1949) otherwise known as information theory. Unintentionally, its components, as depicted in Fig. 4.3, offered metaphors for mental processes and provided a new way to think about the mind. Consider such terms as *source* of a message, the *message* itself, *receiver* of the message, the *information channel* through which the message passes, and *noise* that prevents perfect transmission. Consider one mind as the source of a musical message. The message is a musical idea that is ultimately expressed as an acoustical energy pattern. This pattern travels along an information channel within a second mind, the receiver. The accuracy of transmission of the message depends on both the degree of noise and the capacity of the information channel. The correlation between the source and receiver (i.e. comparing the message at the beginning and end of the channel) represents the efficiency of transmission, from one mind to the other. A high correlation confirms that transmission is effective. With respect to music communication, consider as one example, the correlation between the mind of the performer and the mind of the listener. See Moles (1958/trans. 1968) for a specific illustration (pp. 10–11) and for an extensive application of a mathematical theory of communication – information theory – to music.

In the 1950s, the developing computer technology (or information processing technology) provided additional metaphors for mental phenomena. Terms such

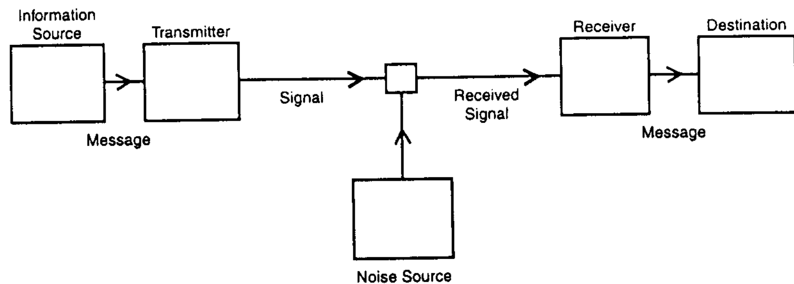

Fig. 4.3 Elements of a Communication System. Image redrawn from Shannon and Weaver (1949, p. 7).

as *data, programs, memory*, and *storage* served as vocabulary for discussing mental phenomena that were taboo during behaviourism. This terminology helped those psychologists who realized that they could no longer avoid the problems of how the brain carried out tasks of recognition, communication, thinking, memory, creativity, and problem solving. Closely aligned with communication theory, the information processing approach assumed that perception was not immediate but occurred in stages, which took a finite amount of time and was associated with capacity limitations which could sometimes be overcome by recoding (Haber and Hershenson 1980, pp. 293–4). These assumptions apply to music in the following way. Although subjectively, it seems that music perception is immediate (turn on the compact disk player and hear the music), many processes occur, each of which takes a finite though short amount of time. From the peripheral hearing mechanisms to the higher cortical mechanisms, musical information is transformed from the real world into mental representations. Each stage limits the to-be-transmitted information. Recoding musical information in particular ways may assist in overcoming these limitations.

There is then a need to identify the different stages of transformation of the real-world music-stimulus information and to examine the accuracy with which the information is preserved from stage to stage. Fortunately, 100 years after the beginning of experimental psychology, a technology had developed for controlling sound precisely. Computer-controlled tone generators and high quality headphones and tape recorders represented the first major advance, and studies to be described took advantage of this new level of control. The later discovery of digital synthesis enabled presentation of almost any musical sound to listeners in experiments. Yet it is important to appreciate that very simple sound stimuli can contribute to understanding how humans acquire and use knowledge, the primary concern of the new spirit of the time, cognitive science (Harnish 2002; Sternberg and Ben-Zeev 2001).

Experiments showing the limitations on music communication

Absolute judgment

Procedure

Consider a set of tones differing only in highness and lowness of pitch. How many tones can an individual identify with absolute accuracy by saying, 'I know, that tone is the lowest I heard, that one is the 4th lowest, that one is the 2nd highest, etc.?' The experimental method for answering this question is absolute judgement. Its simple though rigorous procedures and analytic techniques came out of communication theory. In studies conducted in military

communication research laboratories (e.g. Pollack 1952, 1953), a listener was presented with a set of items (or stimuli) each of which had a name or symbol designated by the experimenter. The set of items might be 12 tones of the chromatic scale, for example. The name assigned is typically a number, such as *1* for the stimulus with the smallest value on the dimension, *2* for the stimulus with the 2nd smallest value on the dimension, etc. If there were 12 items in total, than the number *12* would be the name given to the tone with the largest value on the dimension (the highest or loudest tone).

Early studies revealed accurate identification up to only five frequencies or five loudnesses. Confusions arose as the number of items increased beyond that. Given the potentially infinite number of frequencies or loudnesses, memory for only five of them seems like a big limitation. In his celebrated article 'The magic number 7 ± 2: Some limits on our ability to process information', Miller (1956) summarizes the early evidence for the limited capacity on information processing for many sensory dimensions, including auditory dimensions like frequency and intensity. Miller also observes that the memory limitation can be improved by: (1) recoding or structuring groups of items into meaningful chunks, and (2) by increasing the number of dimensions on which the items vary (for example, changing both frequency and intensity of the tones).

In music, the limitation of around seven coincides with seven different notes in the musical scale (*doh re me fah sol la and ti*), and the first seven harmonics of a complex tone. This series of harmonics furnishes a wealth of musical material (major, minor, dominant seventh chords and all 12 musical intervals except the semitone). Because each of the 12 musical intervals (two-note combinations) has an inversion, the set of intervals also reduces to just six basic intervals. Thus, several small sets (diatonic tones, overtones, intervals, relative durations, and metres) furnish building blocks for an infinite variety of music. This small number of items fits well within the 7 ± 2 limit on the ability to remember and transmit information. Still, the question remains, how can the limitation on absolute judgement be overcome? Experiments described as follows review attempts to improve memory for tones through special training, inclusion of musical structure, and altering the probability that any particular tone will occur.

Improving memory for tones

Cuddy (1968) compared two methods of training memory for 10 tones separated by semitones. The first training method, designated *series* training provided feedback about the correctness of response after every trial. The second method, designated *reference* training, provided feedback on only one of the 10 tones in the set. Surprisingly, feedback on the single reference tone improved memory for the entire set of tones and was superior to the series training.

In a further study, performance was superior for a set of 12 tones spaced as the major triad structure as opposed to a set drawn from the chromatic scale or from the frequency continuum covering the same four-octave range (Cuddy 1971). In another study, the role of the probability of presentation of tones was examined for its effect on memory for a set of 9 tones (Cuddy *et al.* 1973). In a *biased-probability* condition, one tone was presented on 1/3 of the trials and each of the other tones was presented on 1/12 of the occasions. In the *equal-probability* condition, all tones were presented with equal probability (1/9). Performance per tone was better in the biased-probability condition even though most tones had been presented less frequently than in the equal-probability case (i.e. less opportunities for learning). The results suggested that listeners were able to exploit the redundancy within a set of tones to facilitate memory through establishment of an anchor or reference. Sensitivity to statistical pitch characteristics of melody was also shown by Oram and Cuddy (1995) and Eerola *et al.* (2001).

In another study exploring the role of the major-triad structure, an absolute judgment study was conducted using a set of nine 5-note melodies – one melody representing a major triad (*doh me sol me doh*) and the others representing a systematic set of distorted approximations to this major triad. Listeners with a great deal of musical experience could take advantage of the major triad structure so as to better identify the various melodies absolutely (Cohen 1994, 2000). This and other studies comparing listeners with various levels of musical training suggest that musicians may more easily bring what they know to new musical situations to facilitate musical communication.

Summary and implications

Studies of absolute judgement of tones define the limitations on memory for tones and the following ways of overcoming the limitations: (1) a learned reference tone facilitates tone memory more than learning every tone in the set, (2) tones from a set of musically (harmonically) related tones are easier to identify than a set of tones chosen randomly from the same range, (3) tones from a set having biased probabilities are easier to remember than from a set having equal probabilities, and (4) musical training facilitates the ability to take advantage of available structure.

Absolute judgement studies are highly controlled in terms of the stimuli, procedure method, and analysis. Sceptics may question the possibility of learning something about musical communication from something so

'unmusical'. In response, consider the implications for understanding one of the most important music-theoretic concepts, tonality. Tonality refers to the establishment of a reference tone, tonic, or sense of key in most Western-European music as well as in music of some other cultures. As I have previously argued (Cohen 2000), if an established reference note in absolute judgement studies can facilitate memory for all the tones sequentially presented, then this benefit should apply whether the tones are in an experiment of absolute judgement or in a musical piece presented for pleasure. The reference tone overcomes memory limitations and permits the listener to keep track of more notes in the piece than would otherwise be possible.

Thus to understand at least some aspects of musical communication, it is useful to consider the information-theoretic concepts of the set of tone-events, the size and structure of the set, and the probability of occurrence of each tone event. From the mathematical theory of communication, the amount of infor-mation increases with (a) the increasing number of events or tones in the set and (b) equi-probability of occurrence of each item (Garner 1962). To illustrate the first point, everyday experience tells us that it is easier to identify one particular shade of red when there is only one other as compared to ten other shades of red to choose from. Regarding the second point, consider the structure of English words. Some letters, such as 'e' and 's', are more common than others. Suppose instead that all letters were equi-probable. In this case, reading would be more difficult without the advantage of our knowledge concerning the structure of the language.

In applying the concept of information measurement to music, notice first that most music compositions typically contain only a few discrete tones (or chroma) in an octave – only seven in the major scale, twelve in the chromatic scale – compared to the infinite continuum of available frequencies. Secondly, for any typical piece of music, tones are not equi-probable. Some tones occur more frequently or for longer than others. Therefore, theoretically, musical sets of sounds have relatively less uncertainty than if there were (a) more notes in the scale and (b) equal-probability of presentation of the notes. In short, music is redundant and listeners can take advantage of this redundancy.

Delayed recognition paradigm

The delayed recognition paradigm is useful for identifying the details that peo-ple can retain after hearing a piece of music. Employing this paradigm to study memory for musical surface features such as pitch and duration, Krumhansl (1991) presented to a group of music students the first part of an unfamiliar modern classical piece by the French composer Olivier Messiaen (1908–92).

Messiaen used a unique and generally unfamiliar 12-tone principle for com-position. Within each of 3 simultaneous lines of music, all 12 notes of the musical alphabet (i.e. C C# D ... B) appeared. Each of the 12 notes always was presented at the exact same highness or lowness (pitch height), duration, and intensity. Thus, a particular duration was linked with a particular loudness and pitch height.

In the experimental procedure, the listeners heard the first half of the piece and then heard six test segments of six types. One type came directly from the presented music. Another was from the part of the music that had not been presented (still based on the same compositional principle). The third type preserved the overall up and down pattern in the melody but altered pitches by just one semitone (e.g. C moved down to B or up to C#). The remaining three types entailed other transformations of the original material.

The listeners were required to rate their confidence that the excerpt came from the piece by Messiaen (regardless of whether it came from the part of the piece they had heard, or the later part). If the segment was judged as part of the piece, then the rating would approach the high end of the scale; otherwise, the rating would approach the low end of the scale. The results revealed high ratings for segments that had actually been presented (the first test type) and also for segments from the unheard second half of the piece (the second test type). High ratings were also ascribed to those segments that had been only slightly changed but preserved the pattern of up and down of the melody of the piece (the third test type). The other three transformations were regarded as not in the piece. The results revealed that listeners can acquire an *abstract representation* of a new style so as to determine whether novel segments fit that style. The abstract representation is limited in its ability to preserve some detail (e.g. exact interval size as opposed to general directional information, i.e. contour). Thus, the experiment helps to define what the listener represents in his or her mind while listening to and remem-bering music, that is, what information about musical surface is and is not transmitted. Such information could explain, for example, what motifs are available to members of a jazz improvisation group as discussed by Sawyer (this volume). The abstract nature of this representation, the range as to what acceptably counts for the piece, can be regarded as a 'field of liberty', a term coined by J. E. Cohen (1962, p. 138) in reference to a musical score.

The delayed recognition paradigm has addressed other kinds of questions about musical communication as well: memory for familiar versus unfamiliar popular music styles to be discussed later (e.g. Cohen 2000), memory for film music (e.g. Boltz 2004; Cohen 1995) and memory for music versus lyrics in songs with words (e.g. Serafine *et al.* 1984).

Pattern goodness and information theory

Simplicity

The limitations on music communication discussed so far concerned memory. Another important aspect of musical experience is its appreciation or enjoyment. Here again, the brain sets a limit on which characteristics of music can be considered pleasing and which cannot. As already mentioned, the founders of experimental psychology had considered aesthetic issues. Fechner had written a text on experimental aesthetics, and Wundt had defined a function relating pleasingness to an optimum intensity level. The Gestalt psychologists believed that certain structures or characteristics of a pattern led to perceived good form or prägnanz. The task of quantifying these effects challenged the cognitive era.

Taking a communication-theory perspective, Garner (1962) addressed the challenge of quantifying pattern goodness. Consistent with communication theory, he believed that people saw or heard an event not simply as the event itself, but in terms of all the events that might have happened but did not in fact occur. In some cases an event would be one of a few possibilities, but in others, one of many possibilities. Take his example of the symbol Ǝ. It can be perceived as a member of a set of four three-pronged forks, the number 3 in the set of 10 numbers, or as a member of the set of 26 backwards letters (i.e. a backwards E). The set size differs in each case as either 4 (patterns), 9 (numbers), and 26 (letters) respectively. Garner reasoned that the smaller the inferred subset, the better (more beautiful) the perceived form of the item that was presented. Good form was then both in the object and in the eyes (brain) of the beholder.

Garner's (1970) article entitled 'Good patterns have few alternatives' reviews studies of pattern goodness. Using two-element tone sequences, Garner found that high goodness ratings of sequences were associated with small subsets (e.g. xxxxoooo is a better form than xxoxxxoo where x and o represent different tones). The relation between musical structural complexity, goodness ratings, and memory was later shown by Cohen (1976) and further demonstrated by Cuddy *et al.* (1981).

By quantifying the concept of inferred subset, Garner thus quantified the Gestalt concept of good form. He supported his hypothesis that pattern goodness is inversely related to the size of the inferred set. This is consistent with the communication theory notion that messages are quantified probabilistically, and rightly so, as it was this on which Garner's hypothesis was based. But the focus on an imagined subset is also reminiscent of Helmholtz' notion of unconscious inference. Garner had after all showed that the simplest patterns

or messages from small subsets were regarded as more pleasing. The notion of simplicity is relevant to certain aspects of the pleasingness of music (e.g. the consonance of musical intervals, and the appreciation of rhythmic over arrhythmic patterns). But does the concept of simplicity or small subset limit musical appreciation too greatly? Surely it is not only simplicity that is enjoyable.

Optimum complexity

Consider the following experiment by Heyduk (1975). He composed samples of music varying in two dimensions of musical complexity, namely rhythm and harmonic accompaniment. For the simple rhythm, the tones fell on the beat. For the complex rhythm, some tones fell off the beat. Likewise, the simple harmony used fewer different harmonies than did the complex harmony. If simplicity is the only feature affecting pleasure, then pleasingness should decrease with increasing complexity. Instead, listeners assigned their highest rating to passages with intermediate complexity. Moreover, on subsequent hearings, pleasingness increased for the more complex patterns and decreased for the less complex patterns. Some factor other than simplicity must operate to affect the judgements of pleasingness, and this may be optimum complexity, associated with the Wundt curve.

Berlyne's group in Toronto also observed that the judgement of pleasingness followed Wundt's inverted U-shape in a variety of studies. High pleasingness was associated with a moderate degree of stimulus complexity as measured in accordance with information theory. North and Hargreaves (1997) have also discussed this with specific reference to music. The theory and data challenge the Gestalt notion of pattern goodness and simplicity. Platt (1961, p. 230) helps to settle the controversy by stating that individuals need both organization and change, '...what is beautiful is pattern that contains uncertainty and surprise and yet resolves them into the regularity of a larger pattern'.

More recently, Narmour's (1990) implication–realization theory implies the need to specify not only what happens in the music notation but also 'what might have been.' In theory, a quantification of the relative fulfilment of expectations could be compared with measures of aesthetic experience. The need to consider the real-world listening environment in predicting what music will be appreciated has also been emphasized by North and Hargreaves (1997).

Parsing

Another aspect of music communication is the segmentation into groups and phrases as the music unfolds in time. Lerdahl and Jackendoff (1983) applied notions of the Gestalt laws of similarity and proximity to this problem. Their rules represent limitations on the way music information is communicated.

Composers have intuitively exploited grouping principles. Baroque composers, for example, established two different streams of music by interleaving high and low pitched tones in a single sequence (Bregman 1993). What is notated is not what will necessarily be heard: A single melodic line consisting of large interval leaps played by a single instrument may be heard as two lines when played rapidly.

In a study of melodic parsing (Frankland and Cohen 2004), listeners heard a melody and were asked to press a key whenever they felt a breakpoint occurred (end or beginning of a unit). The data of over 100 listeners, for melodies each of which was presented three times for responses by the listener, provided a basis for testing several of the Lerdahl and Jackendoff grouping rules (see also Frankland 1998). Support for the significance of two rules based on proximity in time was obtained (i.e. Attack-Point and Rest). Deliège (1987), Clarke and Krumhansl (1990), and Peretz (1989) have also empirically explored the validity of various aspects of Lerdahl and Jackendoff's theory. Temperley (2001), also working within the Lerdahl and Jackendoff framework, developed computational models for determining perceived breakpoints in melodies. His impressive computational results remain to be tested against data of what listeners actually hear (Cohen 2004).

Liberties, limitations, and music literacy

Music literacy and language literacy

Literacy typically refers to the knowledge required for effective verbal communication – to listening, understanding, speaking, reading, and writing. Literacy is one of the primary factors influencing quality of life, and its aggregate effects contribute globally to the division between first and third world countries. Given the significance of literacy, much scholarship has been directed to factors influencing its acquisition. Sometimes the concept of literacy extends to music because there are parallels to verbal language in terms of listening, understanding, performing, reading notation, and composing. Language literacy arises through everyday exposure to spoken language and to adult models of reading and writing, but reading and writing are routinely attained through formal training. In the music domain, however, adult models of reading and writing music are uncommon (Barrett, this volume), and reading and writing music are not considered as a necessary part of education (cf. Hodges 1992, p. 469).

Notation

Music staff notation appears to precisely designate musical sounds, however, it represents a range of acoustic possibilities or, again, a 'field of liberty'

(*cf.* J. E. Cohen 1962). Music notation, conventional or invented, reveals much of what is communicated by music to the listener but it also conceals what is communicated (Barrett this volume). Bamberger (this volume) describes her experiments with bells differing only in pitch for which children's invented notations have provided insight into the structures that music communicates at an early age to both novices and more musically experienced children.

Invented notations, freed from conventions, permit representation of patterns impossible to perform on fixed-pitch traditional instruments but that can be created by electronic means or the voice. Sounds such as quarter-tones, for example, 'fall between the cracks' of traditional notation. New notation systems are needed to represent these possibilities, yet other notation systems are needed to represent other structural characteristics, such as repeated themes or phrases that traditional notation ignores but that even children identify (Bamberger, this volume). Challenges of notation may eventually be met by cognitive psychology, in identifying more completely what sounds and patterns are to be heard when listening – be they groupings, segmentation, timbres, pitches, intensities, durations, or repetitions of these or other structures. Such a notation however might be so complex as to be more like a theory than a usable tool for reading music (e.g. Narmour 1990). From the practical as opposed to theoretical standpoint, the challenge is to develop an efficient but informative code that does not exceed the reader's channel capacity. Mrs. Touchett's remark on the cost of clarity is somehow applicable: 'I never know what I mean in my telegrams. ... Clearness is too expensive.' [*Portrait of a Lady* by Henry James (1881/1979, Chapter 5, p. 42)]

Exposure to music during early and adolescent development

Helmholtz' unconscious inference, Garner's application of communication theory, and Meyer's and Narmour's emphasis on the role of expectancy support the view that for any performance of music, what is heard depends on one's past exposure to music. None of these theorists, however, considers that the timing in the lifespan of this exposure may be critical. Using a linguistic comparison, sounds that function similarly in one language (allophones) may be differentiated as phonemes in another language. Failure to provide exposure to these linguistic distinctions during an early critical period (as early as the first year in life), impairs the ability to make these distinctions later (Werker and Tees 1999). Exposure to language during an early critical period facilitates both first and second language learning (Johnson and Newport 1989; Mayberry *et al.* 2002). Similarly, exposure to music during an early critical period may have lasting influence on hearing music. Gordon (1979) proposed that the child's musical

ability was fixed by the age of 8 or 9 years (see also Hargreaves 1986). A program of research on the liberating and limiting role of exposure to music has been carried out for over a decade in my own laboratory at the University of Prince Edward Island.

This research program employs the same basic experimental paradigm with listeners from different age cohorts. The musical material entails short excerpts of popular music from the last 10 decades (e.g. Bing Crosby, Elvis Presley, Beatles, Madonna). Music from different decades of course has cohort-specific significance. In the first part of the experiment, listeners first rate randomly selected excerpts from each decade for familiarity or preference. The ratings reveal cohort-specific response patterns. For example, older adults, in contrast to younger adults, find recently popular excerpts less familiar and less preferred than excerpts popular several decades earlier. A second part of the study entails a surprise recognition test of some of the previously presented excerpts. Although all excerpts have been heard only minutes earlier, older and younger adults produce vastly different recognition patterns depending on the decade of popularity of the excerpt. The differences are generally consistent with the rule that music originally experienced prior to or during early adulthood tends to be recognized best regardless of age (Clyburn and Cohen 1996, see also Rubin *et al.* 1998). In a study that compared young children, pre-adolescents, and young adults, effects of style increased with increasing age (Bailey and Cohen 2002), suggesting an openness to acquire knowledge about any music in the earliest years.

Contemporary technological developments of the music industry and the Internet have increased public accessibility to music of every style and decade. In addition, there are increasingly more new styles, such as hip hop, techno, and rap, to name only a few (Gjerdingen 2003). Thus, the present generation is less easily characterized by its music than were past generations. Western-European music nevertheless contrasts with music of other cultures employing different musical scales, instruments, and rhythms. Therefore, to continue the inquiry into critical periods for music, responses to native music and music from unfamiliar cultures have been compared in our recent work (McFadden and Cohen 2003). This approach partially parallels developmental psycholinguistic studies that compare discrimination and memory for native and non-native language (e.g. Trehub 1976; Werker and Tees 1999).

Recent brain imaging research has surprisingly revealed continuing brain development during adolescence (Giedd *et al.* 1999). Clinical data also suggest that during adolescence, certain kinds of exposure have lifelong influence, and a developmental plasticity has been proposed as an account

(Steinberg *et al.* in press). Consistent with this view is our cross-sectional research which shows that music styles learned during adolescence influenced music preferences and memory well into senior years (Cohen *et al.* 2002). As Russell (1997, p. 146) states: '...musical tastes formed in youth tend to persist into and across the adult years, especially in the case of popular music' referring also to the work of Holbrook and Schindler (1989) and Stipp (1990). Along with brain plasticity during adolescence, sociobiological significance could also explain adolescent strong interests in popular music (Cohen *et al.* 2003), as also documented by Tarrant *et al.* (2002) and Zillman and Gan (1997).

The notion of critical periods for music acquisition can be accommodated by a Plasticity Framework for Music Grammar Acquisition (Cohen 2000, pp. 446–7) as shown in Fig. 4.4. Here, exposure to music during a critical period readies the brain for particular musical structures. This setting of parameters has a lifelong influence. Music that satisfies the parametric description can 'Go' ahead (be encoded); music that violates the description meets a 'Stop' sign. Thus, the interaction of predispositions and musical exposure both liberate and limit the potential for music communication throughout life. A corollary is that greater adult literacy of musical styles will follow from greater exposure early in life.

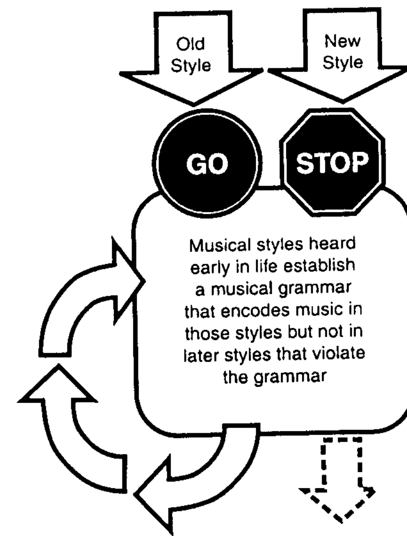

Fig. 4.4 Plasticity Framework of Music Grammar Acquisition as proposed by Cohen (2000).

Constraints on music communication from a cognitive perspective

Music tells us about mind

As the research on absolute pitch showed, by establishing a reference tone, memory for all tones in the set of tones improved. Moving the example from the laboratory to the everyday music listening situation, establishment of a reference tone facilitates memory for all tones in the piece. It enables the listener to remember what has just been presented so that it can be related to the rest of the music as it unfolds. Tonality could then well be a prominent feature of music because it is adaptive to the memory constraints of mind. The redundant structures in music may be there because the composer or performer (e.g. improvisor) can grasp them, and because they implicitly or explicitly know that the audience should also be able to grasp them. Lewis Thomas (1979), former president of the Memorial Sloan-Kettering Cancer Center in New York City and regular contributor to his own column *Notes of a Biology Watcher* in the prestigious *New England Journal of Medicine*, shared his insight that music reflects the mind – music tells us how the mind works. 'Music is the effort we make to explain to ourselves how our brains work. We listen to Bach transfixed because this is listening to a human mind'. (Thomas 1979, p. 154). Thus, the analysis of music itself will help to reveal secrets of human communication in general: what can and cannot be transmitted from composer, performer, or machine to the listener and back again.

Toward a cognitive model of musical communication

In summary, the early science of psychology provided strong roots for current research on musical communication, endorsing music as an obvious area for inquiry. Fechner established the goal of determining the functional relation between objective and subjective reality, quantifying this relation and defining its limits. Whereas his psychophysical methods provided solid data, in contrast, Wundt's introspective analysis of imagery and perception failed to do so, but his methods complement other forms of data collection, and his ideas on preference founded a quantitative approach to experimental aesthetics. The second phase of experimental psychology, behaviourism, supplanted introspection with an emphasis on objectively observable responses, much to the detriment of interest in music. While ignoring music, research methodology and data analysis developed and could be adapted to music issues when the time was once again right to address mind. Gestalt psychology advanced as a separate branch of psychology, establishing principles of good form and similarity that impacted the next period, cognitive psychology, that once again admitted mind into experimental psychology. Half-way through the twentieth century, political and technological developments led to a mathematical theory of communication and to information theory, which indirectly supported a renewed interest in mind and supplied metaphors for mental processes. Thus, began the third and present phase of experimental psychology, the cognitive zeitgeist, during which music has increasingly regained its place. The many research paradigms that followed started to define processes underlying music memory, emotional and aesthetic response, parsing, and the implications of notation. In many cases, these results can be looked on as elucidating the liberties and limitations placed by the mind on music communication. More studies on capacities and limits are needed (see e.g. Parncutt and Cohen 1995, on defining the limits of scale-step size for identification of sequential patterns of tones).

The chapter has touched on the heritage of concepts provided during the first century of experimental psychology: from Fechner, Helmholtz, and Wundt; the technical rigour of behaviourism and its concept of stimulus and response; the perspective of communication theory, the research paradigms of absolute judgement, delayed recognition, pattern classification, and parsing, and developmental studies of musical literacy. Together these furnish a rich foundation for understanding the liberties and limitations of musical communication as a result of the mind as source and receiver of music. History also reveals the constraints imposed on theorizing. There is no better reminder than the 40 years of behaviourism during which most psychology departments regarded the mental phenomena of music as tangential at best. Only slowly has this changed. The twenty-first century seems freer of ideological constraint and offers seemingly unbounded technology. Although history cautions us against complacency, the foundation seems well established for a cognitive theory of music communication that accommodates and defines the liberties and limitations arising from music structure and style, socio-cultural development, performance practices, and individual differences.

Acknowledgement

Research support from the Natural Sciences and Engineering Research Council and the Social Sciences and Humanities Research Council is appreciated as is the assistance of Elizabeth McFadden and Robert Drew. The historical context owes much to my mentors in psychology at Queen's University: Professors Lola Cuddy, Douglas Mewhort, David Murray as well as Albert Bregman at McGill University. Appreciation for feedback on the article is expressed to the editors of this volume.

References

Ash, M.G. (1995) *Gestalt Psychology in German culture 1890–1967*. Cambridge: Cambridge University Press.

Bailey, B.A. and Cohen, A.J. (2002) Acquisition of musical vernacular in children and young adults. *Canadian Acoustics*, **30**, 7–8.

Berlyne, D.E. (1960) *Conflict, arousal, and curiosity*. Toronto: McGraw.

Berlyne, D.E. (1971) *Aesthetics and Psychobiology*. New York: Appleton-Century-Crofts.

Blackwell, H.R. and Schlosberg, H. (1943) Octave generalization, pitch discrimination, and loudness thresholds in the white rat. *Journal of Experimental Psychology*, **33**, 407–19.

Boltz, M. (2004) The cognitive processing of film and musical soundtracks. *Memory and Cognition*, **32**, 1194–205.

Bregman, A. (1993) *Auditory scene analysis*. Cambridge, MA: MIT Press.

Clarke, E.F. and Krumhansl, C.L. (1990) Perceiving musical time, *Music Perception*, **7**, 213–51.

Clyburn, L. and Cohen, A.J. (1996) Memory for popular music in elderly and young adult listeners. *Canadian Acoustics*, **24**, p. 31.

Cohen, J.E. (1962) Information theory and music. *Behavioural Science*, **7**, 137–63.

Cohen, A.J. (1976) Perception of tone sequences from the Western-European Chromatic Scale: Tonality, transposition and the pitch set. (Thesis summary). *Journal of the Acoustical Society of America*, **60**, p. 1421

Cohen, A.J. (1991) Tonality and perception: Musical scales primed by excerpts from the *Well-Tempered Clavier* of J. S. Bach. *Psychological Research*, **53**, 305–14.

Cohen, A.J. (1994) Musical training and pitch schemata: Tonal influences in microtonal contexts. In *Proceedings of the 3rd International Conference for Music Perception and Cognition*, (ed. I. Deliège), pp. 79–82. Liege, Belgium.

Cohen, A.J. (1995) One-trial memory integration of music and film: A direct test.' Paper presented at the Annual Meeting of the Canadian Acoustical Association, Quebec City.

Cohen, A.J. (2000) Development of tonality induction: Plasticity, exposure, and training. *Music Perception*, **17**, 437–59.

Cohen, A.J. (2004) Review of D. Temperley's. *The cognition of basic musical structures.* Cambridge, MA: MIT Press. *Psychology of Music*, 111–26.

Cohen, A.J., Bailey, B.A., and Nilsson, T. (2002) Importance of music in older adults. In *Psychogeromusicology* (ed. A.J. Cohen). Special issue on the psychologies of music and aging. *Psychomusicology*, **18**, 89–102.

Cohen, A.J., Bailey, B.E., MacDonald, L.M., and McFadden, E.D. (2003) Popular music as a probe for adolescent brain development. Adolescent Brain Development [New York Academy of Sciences Conference Poster]. New York.

Cuddy, L.L. (1968) Practice effects in the absolute judgment of pitch. *Journal of the Acoustical Society of America*, **43**, 1069–76.

Cuddy, L.L. (1971) Absolute judgement of musically-related pure tones. *Canadian Journal of Psychology*, **25**, 42–55.

Cuddy, L.L., Cohen, A.J., and Mewhort, D.J.K. (1981) Perception of structure in short melodic sequences. *Journal of Experimental Psychology: Human Perception and Performance*, **7**, 869–83.

Cuddy, L.L., Pinn, J., and Simons, E. (1973) Anchor effects with biased probability of occurrence in absolute judgment of pitch. *Journal of Experimental Psychology*, **100**, 218–20.

Deliège, I. (1987) Grouping conditions in listening to music: An approach to Lerdahl and Jackendoff's grouping preference rules. *Music Perception*, **4**, 325–60.

Deutsch, D. (1969) Music recognition. *Psychological Review*, **76**, 300–07.

Eerola, T.U., Järvinen, T., Louhivuori, J. (2001) Statistical features and perceived similarity of folk melodies. *Music Perception*, **18**, 275–96.

Ehrenfels, C. von (1890) 'Über "Gestaltqualitäten"', Vierteljahrsschrift für wissenschaftliche Philosophie, **14**, 242–92, Eng. trans. In *Foundations of Gestalt Theory*, (ed. Barry Smith), Munich and Vienna: Philosophia, 1988, 82–117.

Ehrenfels, C. von (1937) On Gestalt-Qualities. (M. Focht, trans). *American Journal of Psychology*, **44**, 521–4.

Fechner, G. T. (1860/1966) *Elements of Psychophysics*. (trans H.E. Adler; eds D.H. Howes and E.G. Boring). New York: Holt, Rinehart and Winston.

Fechner, G.T. (1876) *Vorschule der Aesthetik*. Leipzig: Breitkopf and Härtel.

Frankland, B.W. (1998) *Empirical tests of Lerdahl and Jackendoff's (1983) Low-Level Group Preference Rules for the Parsing of Melody*. (Doctoral dissertation, Dalhousie University, Halifax, N.S.).

Frankland, B.W., and Cohen, A.J., (2004) Parsing of melody: Quantification and testing of the local grouping rules of Lerdahl and Jackendoff's *A Generative Theory of Tonal Music. Music Perception*, **21**, 499–543.

Garner, W. (1962) *Uncertainty and structure as psychological concepts*. New York: Wiley.

Garner, W. (1970) Good patterns have few alternatives. *American Scientist*, **58**, 3–42.

Garner, W. (1974) *The processing of information and structure*. Potomac, Maryland: Erlbaum.

Giedd, J.N., Blumenthal, J., Jeffries, N.O., Castellanos, F.X., Liu, H., Zijdenbos, A. *et al.* (1999) Brain development during childhood and adolescence: A longitudinal MRI study. *Nature Neuroscience*, **2**, 861–3.

Gjerdingen, R. (2003) What to listen for in rock: A stylistic analysis by Ken Stephenson. (Book review). *Music Perception*, 2003, **20**, 491–7.

Gordon, E.E. (1979) *Primary measures of music audiation*. Chicago, IL: G.I.A.

Haber, R.N. and Herschenson, M. (1980, 2nd edn). *The psychology of visual perception*. New York: Holt.

Hargreaves, D.J. (1986) *The developmental psychology of music*. Cambridge: Cambridge University Press.

Harnish, R.M. (2002) *Minds, brains, computers: An historical introduction to the foundations of cognitive science*. Malden, MA: Blackwell.

Helmholtz, H. von (1896/1962) *Treatise on physiological optics*. J. P. C. Southall (ed. and trans). New York: Dover.

Helmholtz, H. von (1887/1954) *On the sensations of tone as a physiological basis for the theory of music*. N.Y.: Dover. (Originally published, 1863; English translation of the 4th edition 1877 with additional notes by A. J. Ellis, 1885).

Heyduk, R.G. (1975) Rated preference for musical composition as it relates to complexity and exposure frequency. *Perception and Psychophysics*, **17**, 84–91.

Hodges, D. (1992) The acquisition of music reading skills. In *Handbook of research on music teaching and learning*, (ed. R. Colwell), pp. 466–71. N.Y.: Schirmer.

Holbrook, M.B. and Schindler, R.M. (1989) Some exploratory findings on the development of musical tastes. *Journal of Consumer Research*, **16**, 119–24.

Humphrey, G. (1927) The effect of sequences of indifferent stimuli on a reaction of the conditioned response. *Journal of Abnormal and Social Psychology*, **22**, 194–212.

James, H. (1881/1979/1996) *The portrait of a lady*. Toronto: Penguin Signet.

Johnson, J.S. and Newport, E.L. (1989) Critical period effects in second language learning: the influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, **21**, 60–99.

Krumhansl, C.L. (1990) *Cognitive foundations of musical pitch*. New York: Oxford University Press.

Krumhansl, C.L. (1991) Memory for musical surface. *Memory and Cognition*, **19**, 401–11.

Lerdahl, F. and Jackendoff, R. (1983) *A generative theory of tonal music*. Cambridge, MA: MIT Press.

Lipps, T. (1905/1995) *Psychologische Studien*. Trans. W.E. Thomson as Consonance and Dissonance in Music. San Marino, CA: Everett Books.

Mach, E. (1886/1897) *Contributions to the analysis of the sensations*. Trans. C.M. Williams. Chicago, IL: Open Court Publishing.

Mayberry, R.I., Lock, E., and Kazmi, H. (2002) Linguistic ability and early language exposure. *Nature*, **17**, 38.

McFadden, E.D. and Cohen, A.J. (2003) Recognizing familiar and foreign words and music by children and adults: An examination of the critical period hypothesis. *Canadian Acoustics*, **31**, 7–8.

Meyer, L. (1956) *Emotion and meaning in music*. Chicago, IL: University of Chicago Press.

Miller, G.A. (1956) The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, **63**, 81–97.

Moles, A. (1958/1968) *Information theory and esthetic perception*. Joel. E. Cohen (trans). Urbana, IL: University of Illinois Press.

Narmour, E. (1990) *The analysis and cognition of basic melodic structures: the implication-realization model*. Chicago, IL: University of Chicago Press.

Narmour, E. (1991) The top-down and bottom-up systems of musical implication: Building on Meyer's theory of emotional syntax. *Music Perception*, **9**, 1–26,

North, A.C. and Hargreaves, D.J. (1997) Experimental aesthetics and everyday music listening. In *The Social Psychology of Music*, (eds D.J. Hargreaves and A.C. North), pp. 84–103. Oxford: Oxford University Press.

Oram, N. and Cuddy, L.L. (1995) Responsiveness of Western adults to pitch-distributional information in melodic sequences. *Psychological Research/Psychologische Forschung*, **57**, 103–18.

Parncutt, R. and Cohen, A.J. (1995) Recognition of serial patterns in microtonal melodies. *Perception and Psychophysics*, **57**, 835–46.

Pavlov, I. (1928) *Lectures on conditioned reflexes: I*. Oxford: International. Republished, 1963.

Peretz, I. (1989) Determinants of clustering in music: An appraisal of task factors. *International Journal of Psychology*, **24**, 157–78.

Platt, J.R. (1961) Beauty: Pattern and change. In *Functions of varied experience*, (eds D. Fiske and S. Maddi), pp. 402–29. Homewood: Dorsey Press.

Pollack, I. (1952) The information of elementary auditory displays. I. *Journal of the Acoustical Society of America*, **24**, 745–49.

Pollack, I. (1953) The information of elementary auditory displays. II. *Journal of the Acoustical Society of America*, **25**, 765–9.

Razran, G. (1949) Attitudinal determinants of conditioning and of generalization of conditioning. *Journal of Experimental* Psychology, **39**, 820–9.

Rubin, D.C., Rahhal, T.A., and Poon, L.W. Things learned in early adulthood are remembered best. *Memory and Cognition*, **26**, 1998, 3–19.

Russell, P. (1997) Musical tastes and society. In *The Social Psychology of Music*, (eds D.J. Hargreaves and A.C. North), pp. 141–58. Oxford: Oxford University Press.

Schellenberg, E.G. (1996) Expectancy in melody: Tests of the implication-realization model. *Cognition*, **58**, 75–125.

Schmuckler, M. (1997) Expectancy effects in memory for melodies. *Canadian Journal of Experimental Psychology*, **51**, 292–306.

Seashore, C.E. (1938/1967) *Psychology of Music*. New York: McGraw-Hill, reprinted by Dover.

Serafine, M.L., Crowder, R.G., and Repp, B.H. (1984) Integration of melody and text in memory for songs. *Cognition*, **16**, 285–303.

Shannon, C.E. and Weaver, W. (1949) *The mathematical theory of communication*. Urbana, IL: University of Illinois Press.

Sloboda, J.A. (1985) *The musical mind: The cognitive psychology of music*. New York: Oxford University Press.

Steinberg, L., Dahl, R., Keating, D., Kupfer, D.J., Masten, A.S., and Pine, D. (in press). The study of developmental psychopathology in adolescence: integrating affective neuroscience with the study of context. In *Handbook of Developmental Psychopathology*, (ed. D. Cicchetti). New York: Wiley.

Sternberg, R.J. and Ben-Zeev, T. (2001) *Complex cognition: The psychology of human thought*. New York: Oxford University Press.

Stipp, H. (1990) Musical demographics. The strong impact of age on music preferences affects all kinds of businesses. *American Demographics*, August, 48–49 (cited by Russell, 1997).

Stumpf, C. (1883/1890) *Tonpsychologie* (Psychology of tone). *Vol* 1, 1883 /Vol **2**, 1890 Leipzig: Hirzel.

Tarrant, M., North, A., and Hargreaves, D.J. (2002) Youth identity and music. In *Musical Identities*, (eds R.A.R. Macdonald, D.J. Hargreaves, and D. Miell), pp 151–62. Oxford: Oxford University Press.

Temperley, D. (2001) *The cognition of basic musical structures*. Cambridge, MA: MIT Press.

Thomas, L. (1979) On thinking about thinking. *The Medusa and the snail: More notes of a biology watcher* (pp. 151–4). New York: Viking.

Thompson, W.F., Cuddy, L.L., and Plaus, C. (1997) Expectancies generated by melodic intervals: Evaluation of principles of melodic implication in a melodyproduction task. *Perception and Psychophysics*, **59**, 1069–76.

Trehub, S.E. (1976). The discrimination of foreign speech contrasts by infants and adults. *Child Development*, **47**, 466–72.

Watson, J. (1913) Psychology as the behaviourist views it. *PsychologicalReview*, **20**, 158–77.

Watson, J.B. (1916) The place of conditional reflex in psychology. *Psychological Review*, **23**, 89–116.

Werker, J. and Tees, R. (1999) Developmental changes across childhood inperception of non-native speech sounds. *Canadian Journal of Psychology*, **37**, 278–86.

Wundt, W.M. (1874) *Grundzüge der Physiologischen Psychologie.* [Principles of Physiological Psychology] Leipzig: Engelmann.

Zillman, D. and Gan, S-I. (1997) Musical taste in adolescence. In *The Social Psychology of Music*, (eds D.J. Hargreaves and A.C. North), pp. 161–87. Oxford: Oxford University Press.

Musical Communication

Edited by

Dorothy Miell
The Open University

Raymond MacDonald
Glasgow Caledonian University

David J. Hargreaves
Roehampton University

OXFORD
UNIVERSITY PRESS

OXFORD
UNIVERSITY PRESS

Great Clarendon Street, Oxford OX2 6DP

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide in

Oxford New York

Auckland Cape Town Dar es Salaam Hong Kong Karachi
Kuala Lumpur Madrid Melbourne Mexico City Nairobi
New Delhi Shanghai Taipei Toronto

With offices in

Argentina Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan South Korea Poland Portugal
Singapore Switzerland Thailand Turkey Ukraine Vietnam

Oxford is a registered trade mark of Oxford University Press
in the UK and in certain other countries

Published in the United States
by Oxford University Press Inc., New York

© Oxford University Press, 2005

The moral rights of the author have been asserted

Database right Oxford University Press (maker)

First published 2005

All rights reserved. No part of this publication may be reproduced,
stored in a retrieval system, or transmitted, in any form or by any means,
without the prior permission in writing of Oxford University Press,
or as expressly permitted by law, or under terms agreed with the appropriate
reprographics rights organization. Enquiries concerning reproduction
outside the scope of the above should be sent to the Rights Department,
Oxford University Press, at the address above

You must not circulate this book in any other binding or cover
and you must impose this same condition on any acquirer

A catalogue record for this title is available from the British Library

Library of Congress Cataloging in Publication Data (Data available)

Musical communication/edited by Dorothy Miell, Raymond
MacDonald, David Hargreaves.
Includes bibliographical references and index.
1. Communication in music. 2. Music – Psychological aspects.
3. Music – Social aspects. I. Miell, Dorothy. II. MacDonald, Raymond A.R.
III. Hargreaves, David J. (David John), 1948–
ML3830.M9822 2005781'.11–dc222005007552

Typeset by Cepha Imaging Pvt Ltd., Bangalore, India
Printed in Great Britain
on acid-free paper by Biddles Ltd., King's Lynn

ISBN 0-19-852935-X (Hbk.:alk. paper) 978-0-19-852935-4
ISBN 0-19-852936-8 (Pbk.:alk. paper) 978-0-19-852936-1

10 9 8 7 6 5 4 3 2 1

Charles Byrne is a Senior Lecturer in the Department of Creative and Aesthetic Studies, Faculty of Education, University of Strathclyde. Charles taught music in secondary schools in and around the Glasgow area from 1979 to 1993 and was also Musical Director of Glasgow Schools Youth Theatre. In 1990 he combined his interests in theatre and composition by writing the musical, *Dreams* for GSYT. His research interests include the teaching and learning of composing and improvising in Scottish secondary schools, thinking in music and aspects of flow theory in music education. Publications include articles for the *British Journal of Music Education*, the *International Journal of Music Education*, *Music Education Research* and *Psychology of Music*. Charles is a member of the editorial boards of two international music education journals.

Martin Clayton studied at the School of Oriental and African Studies in London, being awarded degrees in Music and Hindi (BA, 1988) and Ethnomusicology (PhD, 1993). He is the author of *Time in Indian Music: Rhythm, Metre, and Form in North Indian Rag Performance* (Oxford University Press, 2000) and has also published on topics including the history of comparative musicology, British-Asian music and Western music in India. A former editor of the *British Journal of Ethnomusicology*, he also co-edited the acclaimed collection *The Cultural Study of Music* (Routledge, 2003). He is currently Senior Lecturer in Ethnomusicology at the Open University, where he directs the AHRC-funded project 'Experience and Meaning in Music Performance'.

Annabel Cohen (B.A. McGill; M.A., Ph.D. Queen's) is a Professor of Psychology at the University of Prince Edward Island, Adjunct Professor in the Dalhousie University Faculty of Graduate Studies and Fellow of the Canadian Psychological Association. Having published on tonality and transposition, she directs two primary research programs in music cognition: one on the learnability of music across the lifespan and the other on how music influences the experience of film and multimedia. Her research is supported by NSERC, SSHRC, and the Canada Foundation for Innovation. She is a consulting editor for several journals in the field of music psychology.

Initially a classical guitarist, since 1986 **Ian Cross** has taught and conducted research in music and science at the University of Cambridge where he is now Reader in Music & Science and a Fellow of Wolfson College. He has published widely in the field of music cognition. At present, his principal research focus is on the exploration of music as a biocultural phenomenon, involving collaboration with archaeologists, psychologists and engineers.