More About the Musical Expertise of Musically Untrained Listeners

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ABSTRACT: Several behavioral experiments that were designed to compare the abilities of musicians and nonmusicians to process subtle changes in musical structures are surveyed. These experiments deal with different aspects of music perception including the processing of melodic and harmonic structures, the processing of large-scale structures, and implicit learning. In all these experiments, the so-called nonmusician listeners behaved in a very similar way as did highly trained students from music conservatories and music departments. This outcome suggests that when the experimental setting requires participants to process *musical structures* (in contrast to musical tones), the large audience of untrained listeners exhibits sophisticated musical abilities that are similar to those of musical experts. It has been suggested that musically untrained listeners are "experienced listeners" who use the same principles as musical experts in organizing their hearing of music.

KEYWORDS: musical expertise; music cognition; musicians; nonmusicians; harmonic processing; large-scale structure; musical brain

INTRODUCTION

The effects of expertise have been studied in many different domains of activity, sometimes leading to surprising results.[1–3] For example, it has been shown that professional cricketers do not differ greatly from novice players in predicting the point at which a ball will drop[4] and that bar waiters have more difficulty in considering the surface of liquid in a tilted container to be horizontal than does a control population.[5] In this paper we consider the effects of musical expertise. Musicians learn to play an instrument and to describe the musical structures they perceive in explicit terms. To what extent can this dual competence be said to modify the process of listening to music and the type of organizations perceived?

The answer to this question is less straightforward than has been generally supposed. First, methodological caution is required concerning the control of variables confounding expertise and the type of sound stimuli used. When experimental tasks require the judgment of an aspect of musical structure in which musicians have been

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explicitly trained (detecting a change in pitch or timbre, singing back melodies, identifying meter, tapping in time with the music, etc.), important differences between the two groups are frequently observed. Effects of expertise are thus confused with familiarity with a particular experimental task. The case is similar when experimental instructions employ technical musical terms, not explicitly understood by nonmusicians, or use notions so ill defined and so ambiguous that only musicians can grasp the purpose of the study.[6–8] In addition, the music used in experiments (classical music) is frequently more familiar to musicians than to nonmusicians,[9] thereby confounding expertise and familiarity with the stimulus.

What then are the preferred methods for comparing the two groups of listeners? The first consists of exploring the elementary perceptual intuitions experienced by all in their daily experience with music, which are not subject to overtraining in musicians. Examples of this include judgment of similarity between musical materials and the degree of completion of a piece of music, or the identification of the musical emotion expressed by musical extracts (see below). The second method consists of measuring the sensitivity of listeners to musical structures to which the investigator does not explicitly draw the participants' attention (an implicit measure). The use of implicit methods, such as the priming technique outlined below, can determine the structures "naturally" treated by the musical ear, that is, without a conscious effort underpinned by explicit response strategies. The use of implicit tasks is further justified given that musical structures are not devised for explicit perception.

Equally, the scientific study of musical expertise requires an appropriate definition of the term "musical perception." The perception of music is an infinitely rich experience that is not reducible to a sequence of simple situations consisting in the perception of rudimentary qualities of musical sound (pitch, timbre, duration). Elementary experimental tasks of this nature tell us more about the auditory abilities of listeners than their strictly *musical* abilities. That there may be differences between the two groups of listeners at early stages of comparison is not surprising, but it has few implications. Musical perception implies far more complex cognitive operations (categorization, memorization, integration, etc.) that are not necessarily more developed for music students than for students specialized in another field. In this paper we summarize empirical work focusing on four aspects of music listening (processing melody, harmony, large-scale musical structures, and musical learning). This work shows that differences between musicians and nonmusicians diminish, and sometimes disappear, when the requisite experimental tasks require higher cognitive processes. In these studies the term "musician" refers to students at national music conservatories who have studied musical and instrumental techniques for many years (10 years on average) and whose abilities have been confirmed by regular formal examination. Nonmusicians are students of the same age who have not had any specific musical training. As we will see, the differences observed between these two groups, when they exist, are negligible given the scale of differences in their musical knowledge.

WHAT ARE THE EFFECTS OF EXPERTISE ON THE STRUCTURING OF MELODY?

A melody is a dynamic structure whose perceptual identity is defined by the integration of all its constitutive parameters. This integration leads to the perception of

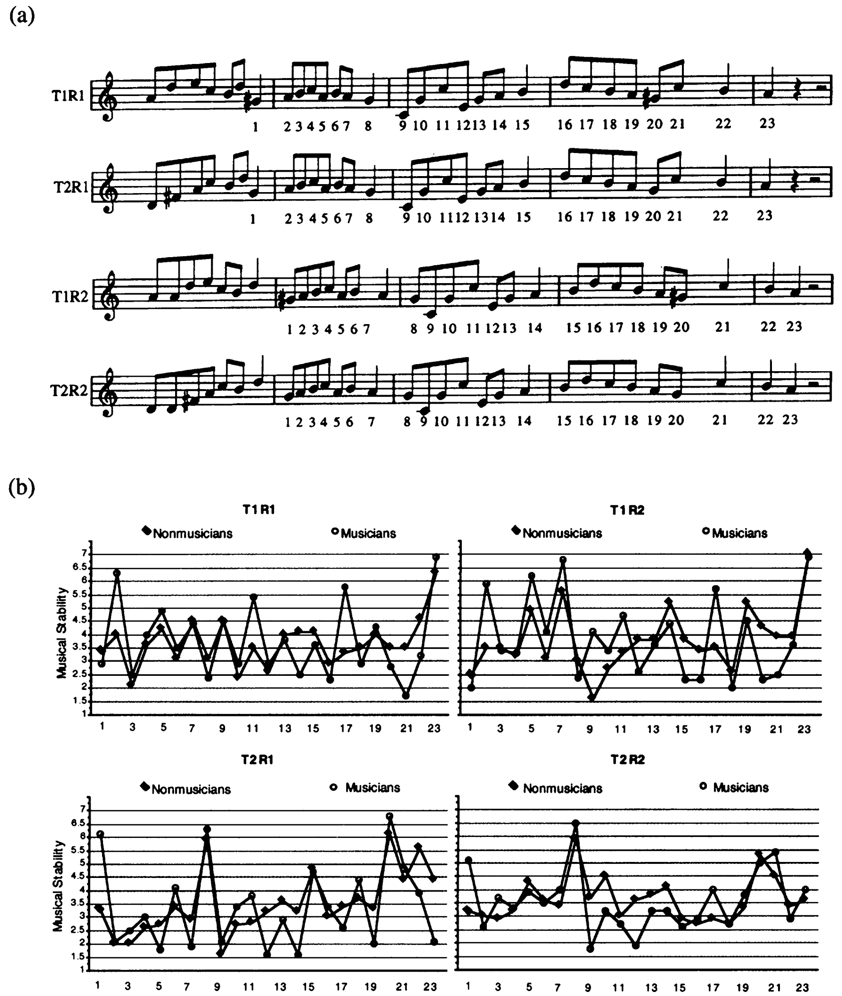

FIGURE 1.

melody as a dynamic form comprising musical tensions and resolutions that span several levels of time.[1,10] Different studies have been undertaken to specify how the different parameters of sound contribute to the definition of these dynamic forms. Consider the melodies in FIGURE 1a. The aim of this study was to determine the extent to which tonality and rhythm contribute to a definition of the dynamic form of the melody for musicians and nonmusicians.[11] The T1 melodies contain almost the same notes as the T2 melodies, the same rhythm, and the same contour. The tonal functions of these melodies are nevertheless greatly different because the T1 melodies are heard in A minor and the T2 melodies in G major. Therefore, the notes numbered 2, 5, and 7 (tonic notes) function as perceptual anchor points in T1, but as subtonic notes that are perceptually less salient in T2. The situation is reversed for notes 1 and 8, which are tonic in T2 but not in T1 (subtonic). Careful examination of the score reveals that the tonal function of the T1 and T2 melodies is inversely correlated. The experimental task used to investigate the sensitivity of listeners to changes in tonal function consisted of judging, on a 7-point scale, the degree of "musical tension" perceived for each melody note. The resulting profile would therefore be considered as an approximation of the perceived dynamic form.

The profiles obtained from the experiment (FIG. 1b) indicate that listeners were indeed sensitive to the contextual changes of tonal function between T1 and T2 and to changes in rhythm between R1 and R2. As can be seen, results from musicians and nonmusicians are strongly correlated in each of these situations, suggesting that common principles of melodic structuring are at work for these groups of listeners. We have also observed that these dynamic profiles are essential in the memorization of melodies.[12] Accordingly, musicians and nonmusicians estimate that more than 50% of the notes changed between T1 and T2 melodies, as well as between R1 and R2 (no note was changed in this case), and up to 64% of notes changed when the two types of change were combined (T1R1 versus T2R2).

Overall, the results we have obtained for the perception of melody support the conclusion that musically expert and novice listeners represent Western tonal melodies mentally as an abstract structure, which typifies the principal attentional trajectories developed during listening. For the two groups of listeners, these trajectories seem to be punctuated by the relationshops of musical tension and resolution that span the different levels of musical time.[1]

WHAT ARE THE EFFECTS OF EXPERTISE ON THE STRUCTURING OF HARMONY?

Western tonal harmony achieves a skillful balance between psychoacoustic constraints and the cultural conventions formed across several centuries of scientific, esthetic, and spiritual reflection. How does the contemporary Western musical ear apprehend these structures? What is the influence of musical education? We have undertaken two types of study in order to address these questions. In the first, we asked listeners to evaluate the musical tensions created by certain harmonic relations. We showed that the perception of musical tension in short musical sequences[13] and long musical sequences[14] is strongly correlated for musicians and nonmusicians. Thus, it seems that the perception of harmonic tension does not differ as a function of musical expertise.

Many other studies have been performed using the paradigm of harmonic priming. Using this technique, attention is drawn to an elementary perceptual task which the subject performs on a *target* chord, while the musical context in which the target chord is presented is manipulated without the subject's knowledge. The task may consist of deciding as quickly as possible whether a target chord is in tune or out of tune, whether or not it contains a clearly dissonant note, whether its constituent notes are played exactly together (15 for a review), or of identifying the phoneme on which the chord is sung.[16] The critical point is to determine how the performance of this perceptual task is influenced by the harmonic context in which the target chord appears.

The initial studies showed that judgment of a target chord's consonance is faster and more accurate when the chord is preceded by a harmonically related chord (C–G, for example) than a nonrelated chord (C–F#). The harmonic context leads the listener to implicitly anticipate compatible chords in this context according to the rules of Western harmony. The anticipated chords are thus cognitively present *before* being heard, which facilitates their perceptual processing when they actually occur. In the last five years, we have used this paradigm to show that Western adult listeners have an implicit sensitivity to very fine differences in harmonic function. Consider, for example, the musical sequences in FIGURE 2. The final two chords in these sequences are identical in all three contexts. However, their harmonic function changes from one context to the other. In the "highly expected" context, the final chord is a tonic chord (I). In the "unexpected" context, it acts as a subdominant chord (IV) following a perfect cadence in the key of D. In the "moderately expected" context, the harmonic function of this chord is more ambiguous. Perceived in relation to the second part of the sequence (which is identical to that of the unexpected condition), the target chord is a subdominant (IV) one. On the other hand, if it is heard in relation to the first part of the sequence (which is identical to the highly expected condition), this target chord may function as a tonic chord, marking a return (albeit rapid) to the principal key primed by the opening chords. In other words, the target chord is "primed" in the (moderately expected) condition by the first part of the sequence, which is not the case in the unexpected condition. In spite of the small scale of the perceptual difference between these three conditions, response for the target chord

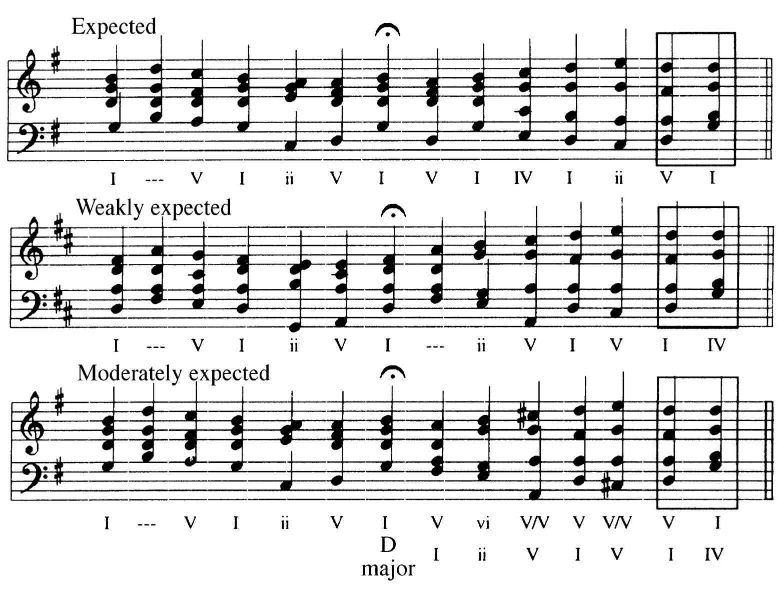

FIGURE 2.

is faster and more accurate in the highly expected and moderately expected conditions than in the unexpected condition. Given the subtlety of the harmonic manipulation used, it is remarkable that the nonmusicians accomplish this task similarly to musicians with a differentiated response to the unexpected and moderately expected conditions.[17]

Harmonic priming is at the root of perceptual expectations that develop automatically during listening and that play an important role in musical expression and emotion. For the present subject, the existence of these perceptual expectations for nonmusicians is important in view of the knowledge that an essential characteristic of expertise (in any domain) is the ability to anticipate events. The fact that the perceptual expectations of listeners—be they musicians or nonmusicians—do not differ or barely differ, either on a behavioral level[15] or on a neurophysiological level,[18–20] suggests that listeners without musical training are musical experts in spite of their inability to describe explicitly what they hear.

THE EFFECTS OF EXPERTISE IN MORE COMPLEX MUSICAL SITUATIONS

The preceding studies use musical sequences that illustrate in miniature the musical structures that can be observed in Western music. To what extent can the weak differences observed between the two groups of listeners be explained by the reductional nature of the musical stimuli used? Several experimental studies have been conducted with the help of pieces stemming from the existing musical repertoire in order to address this question. They led to results that reflect the weak effects of expertise. In this way, we have shown by using short minuets by Bach, Haydn and Mozart that musicians demonstrate the same sorts of difficulty as nonmusicians in resolving musical puzzles, with both groups experiencing great difficulty in integrating local harmonic structures with global structure.[21,22]

In a recent study, we aimed to better understand this result. It is known that the coherent presentation of the material improves considerably the process of memorization for experts, but not for novices.[23] By the same reasoning, we asked musicians and nonmusicians to memorize 20 extracts taken from the exposition sections of four sonatas by Haydn. These extracts were presented in either a coherent or an incoherent fashion. In the first instance, the 5 extracts corresponding to the exposition of a sonata were presented in sequential order, before turning to 5 extracts from another sonata, and so forth. In the incoherent condition, the 20 extracts from these sonatas were presented in a totally random way. Following this learning phase, subjects heard 44 musical extracts (20 from the learning phase, plus 24 new extracts taken from other sonatas by the same composer) and indicated on a 6-point scale their belief that the extract they heard was new or old. Contrary to the classical expertise effects reported in cognitive psychology, musicians do not perform better in the coherent condition. In other words, they do not benefit more than nonmusicians from the coherent presentation of the material. Based on these results, it can be argued that musicians do not have a better "comprehension" of large musical structures than do nonmusicians. This result, which agrees with that of many others, will come as no surprise to teachers of music analysis who observe the extent to which expert musi-

FIGURE 3.

cians, though good instrumentalists, experience great difficulties in hearing musical structures and forms.[24]

Finally, I present an example noteworthy for its lack of difference between musicians and nonmusicians. The study can be classed as research into the implicit learning of new musical systems.[25] We asked a composer to write 40 canons in the style of Webern, all based on a dodecaphonic series (FIG. 3a). In a learning phase, we presented 20 canons two times. In a test phase, we presented 20 pairs of canons. Each pair contains a canon composed from the same series but not yet heard by the subjects, and its foil (FIG. 3b). The subjects' task was to indicate which canon of the pair had been composed in the same fashion as that from the initial phase of the study. Though perceived as being extremely difficult, this task was accomplished at a rate above chance by musicians (63%) and nonmusicians (60%), with no significant difference between the two groups. This result is in accordance with work on implicit learning that shows that the listener is able to internalize complex statistical regularities (in this case, the same series of 12 sounds) through simple, passive exposure to environmental stimuli.

CONCLUSION

The study of expertise in the domain of music presents a certain number of scientific, pedagogical, and sociological interests. For scientists, the concern is an understanding of how expertise leads to changes in the processing of a specific type of information, by what learning process (implicit or explicit) does this expertise develop, and what mental changes might this learning entail as much from an anatomical as a functional perspective. At the present time, conclusions differ from one study to another. The choice of an experimental method plays a role in explaining this divergence. Equally, it seems that the theoretical orientation of researchers bears on the results that are reported in the literature. In this way, the work on brain plasticity tends to place an exaggerated importance on anatomical and/or functional differences associated with intensive musical training.[26–28] Of course, this work is essential on a neurophysiological level because it demonstrates that intensive perceptual learning can afford a functional reorganization in the brain of musician subjects. However, it would be wrong to conclude that these differences have any repercussions for the general cognitive and neurophysiological structure that allows musical processing in all its complexity.

The results reported above show strong similarities between the two groups of listeners that suggest that this structure is not strongly affected by explicit musical training. On the contrary, the mere repeated exposure to music seems to be sufficient for the development of a sophisticated auditory expertise in the absence of any form of explicit learning. This result is fairly commonplace when viewed alongside the many studies in implicit learning that have been conducted over the last few years, which attest to the extraordinary ability of the human mind to internalize highly complex structures. Mental reorganization resulting from these learning processes is undoubtedly more complex to observe than that resulting from elementary perceptual learning. No doubt these learning processes confer a real plasticity on the human mind. In the domain of music, we believe that this plasticity is translated more by the weak differences observed between musically trained and untrained listeners, than by neuroanatomical and/or functional differences associated with very elementary perceptual learning.

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