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## Bimusicality and bilingualism: Insights into the nature of complex cognitive faculties

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### Resumen

El estudio comparativo entre la música y el lenguaje ha llamado la atención de científicos cognitivos de diferentes campos desde hace muchos años. Recientemente, un estudio interdisciplinario ha realizado avances importantes en diferentes direcciones, incluyendo en la discusión sobre el surgimiento evolutivo de las habilidades musicales y las lingüísticas. Este artículo, basado en dicha investigación, propondrá una nueva perspectiva para el estudio de las facultades musicales y el lenguaje: la aplicación de un marco teórico proveniente de los estudios del bilingüismo a cuestiones interculturales desde el punto de vista de la cognición musical. El estudio concluye con una evaluación de dos propuestas importantes en este campo: la arquitectura modular para el procesamiento musical (Peretz and Coltheart 2003) y la hipótesis de la integración de recursos sintácticos compartidos de Patel (2008).

### Palabras clave

Musicología comparativa, bilingüismo, modularidad, universales culturales, tonalidad, Facultad de Música

### Abstract

The comparison between music and language has attracted the attention of cognitive scientists from a number of fields for many years. More recently, a concerted interdisciplinary collaboration among investigators has made important advances in a number of directions, including an interesting discussion on the evolutionary emergence of musical and linguistic abilities. The following review of the research proposes a new perspective for studying the faculties of music and language: application of the research framework from the study of bilingualism to cross-cultural aspects of music cognition. The article concludes with an evaluation of two leading proposals in the field: the modular functional architecture for music processing (Peretz and Coltheart 2003) and Patel's (2008) shared syntactic integration resource hypothesis.

### Key words

Comparative musicology, bilingualism, modularity, cross-cultural universals, tonality, Faculty of Music

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## Bimusicality and bilingualism: Insights into the nature of complex cognitive faculties

Norbert Francis

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*We opened the cases and unpacked our recording apparatus... You don't want to talk to us about your music," I said finally, "Very well, we'll let you hear ours." And at full strength Pierre started up a Mozart symphony. All the Indians immediately fell silent. It was quite obvious that they were flabbergasted... They stood there in silence and listened without moving a muscle, their eyes glued on the strange apparatus from which the glorious sounds came... Some time passed and then suddenly we heard again the same deep trumpet-like sound we had heard from the distance when we came into the lagoon, but this time it was quite close and extraordinarily loud. Above the deep and throbbing bass notes... there was a clear high-pitched melody, soft and harmonious... It was our turn to remain silent and listen, our turn to hear strange music we had never heard before.*

(A. Gheerbrant, *Journey to the Far Amazon*, 1953: 88-90)

### 1. Introduction: a new perspective on music-language parallels

What appears at first as an unremarkable intercultural exchange, the music sharing between the French explorers and their Piaroa hosts reminds us of problems in musical cognition that involve research of far-reaching implications. How is it that both Europeans and Amazonians seem to have spontaneously recognized each other's presentation as musical and worthy of close attention? As Gheerbrant went on to clarify, the music-making apparatus wasn't completely strange in every way to the villagers, as reports of similar types had filtered back to the village from towns down river. The explorers, apart from their scientific observations, evidently reciprocated with a deep-felt aesthetic response of their own, testifying to such in an account of a subsequent concert to which they were invited (pp. 106-122). During another expedition through the same region, musicologist Alejo Carpentier (1985 [1953]) reported on a related encounter in his novel *The Lost Steps* [*Los pasos perdidos*]. Aside from the obvious outward commonalities shared by the music of all cultures, what kind of common underlying knowledge allows us to apprehend widely diverging musical idioms in a similar way?<sup>1</sup> The question is not as trivial as it seems at first because we can

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<sup>1</sup> Romance language speakers will note take note of the interesting coincidence (for this article) that "idiomas" can refer to both languages and musical idioms. Arbitrarily, and only for the purposes of the present discussion in this paper, *idiom* will be used in the narrow sense of "tonal idiom" recognizing that in both common and academic usage the term covers a broad spectrum, including styles (both tonal and atonal) and all variety of genres.

also recognize the speech of persons from any culture as human language, but the level of engagement is clearly not the same in the case of a language that we don't know; Morrison et al. (2003) discuss some of the interesting brain research comparing native and non-native language and music processing. More recently, investigators have asked whether, or to what extent, listeners actually perceive music from other cultures with recourse to the same cognitive resources. Shaped during our early childhood experience, these perceptions appear to depend on knowledge associated with the particular musical idiom(s) of our primary culture. Intriguing analogies with first and second language development have been suggested (Fiske 2008). Even though listeners may react with an aesthetic response to a foreign musical style, it appears that perception differs, resulting in an experience that is not the same.

In fact, research on the music-language connection goes far beyond simple analogy to include analogy in the biological sense: the parallel evolution of some design features and the evolution of others that today might be shared between music and language (Cross 2007). Both song and speech, relying on systems of vocal expression and auditory perception, conceivably have been subject to the influence on each other of interactions of many kinds. Investigators have uncovered categories of similarities and differences between musical and linguistic abilities that bear directly on this interaction. A strong hypothesis even includes the possibility of a common origin, in a primitive holistic precursor to both (Mithen 2009). To take two strikingly apparent and widely commented components of language as an example, research has focused on the (plausibly music-related) linguistic properties of:

- tone (where it is implemented in language) and intonational contour, and
- metrical patterning.

Then the question is: what underlying cognitive structures in these domains might be actually shared with musical abilities? How might these be deployed in "hybrid" abilities, such as in poetic uses of language, and how do special interactive links between musical and linguistic systems serve them in performance? ("Performance" here includes receptive capability as well).

In this review it will be proposed that one dimension of the music-language comparison in particular could be especially informative for casting some interesting research questions for future work, not only in music but in language as well: the parallels between *cross-musical idiom* and *cross-linguistic* phenomena. Two closely related ways to approach this comparison are in the study

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of:

- (1) hypothetical universals and
- (2) the problems of development/learning, processing, and representation in bimusicality and bilingualism.

This cross-idiom/cross-language approach is suggested by recent work in biomusicology, a 2006 special issue of *Cognition* bringing together leading practitioners and theorists. Two reports, on the nature of the Faculty of Music (FM) (Jackendoff and Lerdahl 2006) and on research summarizing advances in neuropsychology (Peretz 2006) will frame our discussion for now.

Three questions will lead us to a detailed consideration of the cross-idiom/cross-linguistic comparison: (1) In what consists the musical grammar, i.e., a competence based on underlying knowledge structures (Raffman 1993) around which listeners construct musical abilities? As in bilingualism,<sup>2</sup> the assumption will be made that the relevant mental representations come to be, to some extent, specific to the musical idiom of one's culture. This underlying musical competence is acquired through children's exposure to the music of their culture. Posed then is the question of the universally accessible resources that listeners require for the task of acquisition, both resources specialized for music and those that are cognitive-general. (2) Although Jackendoff and Lerdahl largely defer the issues of acquisition, an implication from their discussion of the first question is that a Poverty of Stimulus (PoS) problem might present itself in child musical development,<sup>3</sup> parallel, if perhaps not on the same scale, to the PoS problem in language acquisition. (3) The question of which aspects of the musical capacity could be specialized and which depend on general properties of cognition is especially relevant to the music-language comparison. This is the topic of the report by Peretz. As with other so-called cognitive-general competence domains or processing mechanisms, some components of a given musical ability might be shared with another network of components that belong, for example, to language. Peretz presents evidence, for example from studies that suggest double-dissociation, confronting language and musical

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<sup>2</sup> In this article the broad definition of bilingualism will be assumed, including both: (1) balanced/equivalent competence in the two language systems and (2) knowledge of two languages in which one language is complete and of native-speaker level and a second is characterized by ability that reflects incomplete and non-native competence. Often, second language learning falls into the second category of bilingualism. In the present discussion, for the purpose of comparing native and non-native musical competence (the latter typically a second musical idiom learned after childhood), and for considering the parallels with language, the more inclusive definition of bilingualism – including (1) and (2) – turns out to be more useful.

<sup>3</sup> Poverty of Stimulus (PoS) refers to the idea that there is a gap between knowledge and experience, that knowledge in a certain domain is underdetermined by the information that can be acquired from the environment. For example, in language acquisition, the evidence that children receive in the input they receive is not sufficient for them to be able to construct a complete grammar.

disorders, that at least some aspects of the musical capacity are exclusive to FM-specific modules. In other words, not all components of musical knowledge and music processing would be recruited and assembled from components associated with other faculties, according to this view.

With more than half a century after the publication of Mantle Hood's "The challenge of bimusicality" (1960), it is fitting to take stock of his proposals for students of musicology and of the broader implications of the concept suggested in his article. To cite one example, in cross-cultural studies the observed tendency to assimilate unfamiliar intervals into the listener's "native" musical (M1) schema has shown itself to be a useful research tool. Keeping in mind the most obvious difference that we suggested between music and language, what is it that accounts for the "foreign," or "second," musical idiom (M2) experience, analogous as it might be to second language (L2) processing? This should be a more interesting analogy than the one suggested earlier involving a completely unknown language.

There are two related ways of thinking about the comparison between language/bilingualism and music/bimusicality: (1) As two complex cognitive systems each with a grammatical organization involving highly structured knowledge, a better understanding of the parallels and contrasts should help us better understand the nature of each mental faculty separately. (2) As was just mentioned, the relevant parallels might point to actual shared knowledge components and common processing resources. This second approach, reader be warned, can be taken very far, to the point that the very idea of separate faculties, FM and FL (Faculty of Language) comes to be rejected outright. In pursuing these two approaches, our starting point in music will be restricted for now to aspects of tonality; other important aspects, need to be taken up in a separate review of the research, in the first instance intercultural constants in temporal processing (Drake and Bertrand 2001).

## **2. Cross-cultural tonality**

In explanations of the concepts of pitch space and scale system, it is common that writers trace a close association between tonality and Western music; that tonality specifically refers to the patterns of Western melody and harmony. There are two ways to begin to respond to this informal linkage, widely accepted, even among students of music:

- (1) So-called Western and non-Western musical traditions have more in common in how the tonal relationships (understood in the broad sense) within pitch space are perceived than is apparent on first hearing.

(2) Because historical accident has it that most investigators have studied tonal systems as they have come to be instantiated in Western music, we should proceed cautiously and not assume from the beginning exactly the same kind of structure cross-culturally.

(3) Researchers interested in the biological foundations of music go much further. One strong claim would be that tonality, at a more abstract level (not in the specifics of how it is realized in any particular musical tradition) might be a universal and culturally transcendent aspect of musical perception.

What are some of the essential properties of tonal music that might turn out to be cross-cultural? A starting point may be the perception of the octave. Scales, divided in different ways, fall within the boundaries of an octave, and are anchored by a tonic around which the other fixed pitches of the scale gravitate. Studies suggest that the processing of pitches by listeners is carried out within scale frameworks, and perception is guided by context-dependent principles (Kendall and Carterette 1996). Examples of context-dependence would be:

- Memory is better for tones in sequences within a well-defined tonal pattern.
- The tonic is most expected to complete the execution of an incomplete scale, followed by the 5<sup>th</sup>, the 3<sup>rd</sup>, the remaining scale tones, and finally by the non-scale tones.
- Pitches of a “scale core” are perceived as most directly related to each other, followed by the other scale notes; that, for example, the 3<sup>rd</sup> and 5<sup>th</sup> degrees of a scale are perceived as more closely related to the tonic than the 2<sup>nd</sup>, even though they are more distant acoustically.
- Similarly in regard to harmony, chords are judged to be more closely related when they are in the same key, again apart from their physical distance, in vibrations per second.
- Non-scale tones are more often confused with scale tones than vice-versa (Krumhansl 2005).

Thus, certain pitch relationships maintain a psychologically privileged status, all of this implying a tonal hierarchy among the pitches of a scale. The basic pitch space appears to be distributed in five levels: 1 – tonic, 2 – fifth scale degree, 3 – third, 4 – other scale pitches, 5 – all remaining chromatic, non-scale, tones. Hierarchies structure how patterns of musical pitch are processed and stored in memory, even among non-musicians, including young children (Sloboda 2005).

In music we attend to relationships among patterns, specifically patterns of tension and attraction.

Relatedness among pitches is not independent of scale pattern and again depends on tonal context, allowing listeners to establish the key of a piece within the first bars. Asymmetries of various kinds seem to characterize tonality and there appears to be a tendency of “less structured” tones (that are “tense”) to orient toward (be “attracted” to) the tonic. Movement tends to be toward the key context or toward the core of the scale, from unstable tones toward more stable tones. (Dowling 2001, Radocy and Boyle 2003).

A different but related kind of hierarchical structure involves the sequential ordering of pitches that form melodies. The patterns in this case are “event hierarchies,” stable events at the root of “trees,” that very superficially resemble markers of sentence syntax; subordinate events branch off. Known as *reductional structure*, it describes the patterns of melodic tension and attraction in phrases, related to degrees of pitch stability. The contours of rising and falling tension appear to be governed by constraints that are both systematic and are violated predictably. As in language, interfaces with other components of the FM, meter and grouping, are implemented in performance, also in a systematic way (Jackendoff and Lerdahl 2006). In actual perception experiments, listeners’ judgments of these contours tend to correlate with a theoretical hierarchy. In addition, competing mental forces, some deliberate and subject to awareness, and others encapsulated and unconscious, come together in different ways in real-time musical construction (Justus and Bharucha 2001, Krumhansl 2002). Thus, one hypothesis that presents itself is: that essential elements of tonality (not necessarily exactly the ones just outlined) correspond to actual knowledge structures and processing mechanisms in the domain of a musical faculty. The proposed “essential elements of tonality,” it must be made clear, are still not well understood. And again to emphasize, the above-mentioned structures and predispositions would not be the particular ones that came to be established in the “Western” variant of tonality.

Because in any complex ability there are different kinds of knowledge structure, a number of questions come to mind. Do the features summarized above depend on a music-specific predisposition or to a general capability to track statistical regularities in auditory input? Do they imply enduring internalized tonal schemata or short and long-term activation of repeated patterns of pitches? Here, the issue of domain-specificity has to be taken as an open question, avoiding any facile parallel with the organization of language knowledge. And it should be kept in mind that “faculty” is not synonymous with “module” or other type of innately endowed and encapsulated mental representation that is preprogrammed in fine detail. Is music a sociocultural construction only, such that variation in scale systems would be without limit, and only constrained by general

cognitive constraints? Would commonly observed patterns in music cross-culturally such as the unequal division of the octave be essential properties or socially determined conventions that have spread from one community of musicians to another? All of the questions presented so far lead to the problem of development: how an interlocking combination of acquisition mechanisms comes together to construct a complex network of competencies and processors, tonal knowledge and processing being only one.

If the acquisition of a musical grammar relies on “pre-existing resources” for a “capacity for music” (Jackendoff and Lerdahl 2006), then the principles of tonality, whatever these turn out to be, cannot refer to any one musical tradition in particular. All of the above now presents us with two clearly opposing possibilities: (1) Some component(s) of the FM is (or are) music-specific, interfacing with “broader cognitive capacities” –and– (2) All components of the musical capacity and its underlying cognitive components are domain-general, and/or recruit from competence and processing components of other faculties (language, competencies associated with general auditory capabilities, etc.). As we will see, proposal #2 cannot be excluded based on current research findings. Patel (2008: 355-412) offers an evolutionary motivation for leaving this possibility open.

### **3. Types of universal**

Cross-language comparisons give us another model for approaching the concept of bimusicality. Newmeyer (2008) notices encouraging signs, still tentative and unsteady, of a dialogue between surface universal/descriptive and theory-driven researchers (Universal Grammar-oriented, typically). In large part, truth be told, motivation for some openness from the latter might be related to disappointments, after many years, in the realm of Universal Grammar-oriented work on linguistic universals. As it turns out, there might be more merit in inductive data-driven, “e-language” (“e” for “external” as opposed to “internal”) type analyses than was once thought. In linguistics, by some accounts, the distinction between competence and performance had become casehardened. Thus, reintegrating conceptions of knowledge and processing should also reestablish dialogue that has broken down in the cognitive sciences (Jackendoff 2007: 25-75). This new turn might be especially useful in better understanding cross-language variation in bilingualism, assuming that each language subsystem of the bilingual speaker corresponds to a separable mental grammar (Francis 2007, 2008). Likewise, a thorough description of variation from one tonal system to another might help us reduce the core properties in musical competence to



those that can plausibly be considered cross-cultural.

One way to view the possibility of identifying cross-cultural constants would be to start with a surface universal that is of the “statistical” kind: that the widely attested feature in question (a proposed universal of tonality) nevertheless stands in contrast to exceptions that cannot be easily explained away. For example, most vernacular music traditions will share the feature, but the small number that appear not to share it contradict the claim of universality. Then, proceeding to ensure that this widely observed feature of tonality cannot be easily accounted for by simple diffusion from one culture to another, a reasonable hypothesis could be the following: that the common feature, as described, may not be, as it seems to be manifested “on the surface,” the true universal that was originally conceived (the exceptional cases compelling us to concede this point). But at the same time, the strong statistical evidence suggests that the investigation is on the right track; that formulated differently or at a more abstract level, fewer exceptions would then present themselves. Work continues, interactively both top (theory)-down and bottom (data)-up, with an eye toward arriving at descriptive generalizations of wider application. Excluding chance and simple inter-cultural transmission, the perception of octaves and scales, for example, could be proposed as a universal.

If the proposed universal finds expression among widely diverse musical traditions, historically dating back to the earliest separations in human evolution and migration, the case is strengthened for an absolute cross-cultural universal. The evidence in musical performance of a hierarchy among pitches (some more stable or fundamental than others) may be an example of a more abstract constraint that turns out to be constant across musical cultures. Thus, in studying the hypothetically tonal traditional/folk idioms of the world, a plausible framework for advancing toward approximations of greater and greater precision could be:

- Identification of common features distributed widely beyond chance occurrence;
- Near-universals with few musical genres that are outliers;
- Absolute surface and absolute formal universals.

Proposed universal properties can then be evaluated along two dimensions:

- the musical *genres* themselves, and
- music *communities* (counterpart to the category “speech community”).

First considering the musical genres, among the extant families of tonal system around the world, research could proceed by asking the following questions: Are there some modern traditional/folk idioms that do not belong to any recognized “branch” or subfamily? One possibility might be that

these idioms structurally resemble atonal genres of 20th and 21st Century concert music that systematically suppress any hierarchy of scale tones. Crucially (considering the second dimension), would such non-tonal genres be the only type that circulates and is known in a given musical community? Or would there be a diverse landscape of genres (including both tonal and non-tonal genres)? For example, in speech communities around the world, especially where multilingualism is the norm, linguistic diversity encompasses not only contact among “fully-formed” languages but contact among other types of linguistic system (second languages, pidgins, etc.) as well. Similarly, the stable and now long-term interactive coexistence of tonal and atonal systems, in particular evidenced in the very productive intermediate and approximating styles in modern music since the late 19th Century, is well understood today.<sup>4</sup>

Now, for argument’s sake, in reference to *genres* that are “outliers,” the assumption could be made that there are music *communities* in which only non-tonal genres are performed and known. But the question then is whether individual members of the community would process (foreign) tonal exemplars “tonally,” or not. For example in an experiment, individuals might perceive the relevant constraints of scale hierarchy because nothing in their (non-tonal) musical experience and stored schemas actually contravenes tonality. In other words, simply because a community appears not to exhibit examples of tonality in its music, does not necessarily mean that, cognitively, listeners are not predisposed to process tonal music in the same way as listeners of other communities, who do possess tonal music as a part of their repertoire.

#### 4. Perceiving tonality: intercultural comparisons

In the studies on cross-cultural music perception, contrasting listeners’ responses to native and non-native genres, three separate research questions are posed:

- (1) Transfer and interference effects in M2 processing – For example, can the differences between M1 perception (by native listeners) and M2 perception (by non-native listeners) be attributed to the non-natives’ M1 tonal schema; and if so in what manner?

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<sup>4</sup> To be clear, almost to go without saying, for many years (over a century now) some of the most inspired and aesthetically significant music composed is atonal, by many accounts this assertion being a tall understatement. In addition, notions regarding the “naturalness” of tonality are still not clearly specified. But, there may be a sense in which types of M1 tonal music are “primary” and lend themselves to processing by the FM in a way that is analogous to the non-deliberate and effortless (“natural” so to speak) processing of one’s primary native language. A hypothesis for research then would be that a different, and surely overlapping (with tonal processing) suite of modules and processing mechanisms might be deployed in the apprehension of atonal or non-tonal music. Some of the most popular genres among young people today appear to have no pitch space of any kind, and in this instance perception might depend on a precisely defined subset of the components of the music faculty.

(2) Aside from the effects of listeners' M1 on M2 perception, are there any cross-cultural tendencies that are independent of previous musical background knowledge?

(3) Are the same categories of analysis applicable across idioms at all? The hypothesis to consider here would be that the indices that have been suggested to be characteristic of tonality mark the same tendencies among native-listeners of different musical cultures.

If the answer to the third question is negative, then any differences in processing between M1 and M2 would turn out to be less interesting. On the other hand, the results of comparisons would be more interesting if M1 and M2 listeners responded in a similar way. That is, "non-native" listeners respond to the foreign idiom in a commensurate way, similar to how they respond to the tonal organization of their "native" idiom. We should expect to see some transfer or interference effects from a listener's native music, but there might also be, at some level, evidence of a common musical perception if the foreign example under consideration is not completely atonal. And finally, common response patterns under all circumstances invite explanation that then has to try to reconcile all results within a single model. It happens that the experimental methods that reveal tonal competence were first developed in studies of Western music; but as was pointed out earlier, they could just as well have been discovered in the study of another music that is self-evidently tonal, as in the case of the traditional music of North India (Castellano et al. 1984).

To begin with question (3), evidence suggests that actual categorical perception of pitch tends to be more or less uniform even when the number of intervals within an octave at the disposal of the musical culture varies significantly (e.g., the "tonal material" in Indian music is comprised of more than 20 notes). In addition, despite this variation a strong tendency reduces actual scales (the "tuning system" that selects intervals within the octave range for the composition of melodies) to 7(+/-2) pitches, including Arabic *maqamat*, North Indian *thāts*, Indonesian *sléndro* and *pélog*, Western major and minor scales, and the heptatonic and pentatonic scales of China and Southern Asia (Carterette and Kendall 1999, Justus and Hutsler 2004). Studies of the above musical systems point to the acquisition of tonal schemata among non-musicians that differ in the specifics of tuning and scale formation from one to another, but that share certain basic properties: hierarchical ordering of pitches, within an octave, and tonal center. Application of the probe tone method, developed in the study of Western tonality, yields results regarding these basic properties that are consistent with prior and independent music-theoretic models of the musical systems under investigation (Bharucha 1987, Castellano et al. 1984).

The probe tone technique has been one of the important methods of comparing responses

of native and non-native listeners, measuring perception of the stability of pitches forming part of a scale. Subjects are presented with a passage that establishes a tonal context that is familiar to some and foreign to the others. After a short pause, the context is followed by one of a number of probe tones (including scale and non-scale pitches within the octave) that listeners rate according to how closely it conforms musically to the preceding passage.

The Castellano et al. (1984) study on native and non-native perception of North Indian tonality is an early foundation in the field of cross-cultural music perception, widely cited to this day. Two groups of eight, mainly musicians, rated twelve probe tones (1 – 7 for closest fit) in an octave range after listening to commonly employed North Indian *rāgs* (melodic patterns built from a wide array of scales, *thāts*). On the first set of measures agreement between Western and Indian listeners turned out to be remarkably close. Ratings matched the predicted tonal hierarchy at the same level for both groups, comparing *thāt* and non-*thāt* tones, centrality of the tonic over all other *thāt* tones, following by the fifth, and then by the *vādi*, a tone that plays an important role in the tonal hierarchy. In contrast, on more subtle measures, native listeners showed more sensitivity to relationships between *rāgs* and their corresponding scales, for example detecting more successfully deviations from the “parent *thāt*” in *rāg* tuning.

In discussing the findings the authors consider problems of explanation that subsequent research would return to over the years. In the case of the non-native listeners, they were interested in what accounts for the subjects’ partially successful (but clearly quite impressive) spontaneous on-line analysis of the foreign tonal hierarchy. Knowledge structures of different kinds are potentially brought to bear:

- (1) acquired schemata and expectations drawn from M1 tonal competence now applied “flexibly” to new music (despite the differences, listeners are able to attend to shared structural features) and
- (2) a “general” capacity to extract key patterns from the input itself. In this case, the musical segments were, according to the authors, “rich in information,” potentially accessible to all subjects in the experimental passages. On the other hand, some aspects of processing depend on extensive experience that is idiom-specific, accounting for aspects of performance demonstrated only by native listeners.

Comparing Arabic and “Western”<sup>5</sup> musicians’ processing of *taqsim* (an improvised style) on a

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<sup>5</sup> In relation to Arabic music the contrast to “Western” is somewhat unfortunate. Listeners of internet Arabic music radio can hear examples that are indigenous to parts of Europe, including modern popular song performed currently

number of different measures, both groups were able to segment passages on the basis of salient surface features such as pauses and register change, but only the former were able to do so based on more subtle structural shifts, and (predictably) produce reductions of core melodies (Ayari and McAdams 2003). Similarly, all musician subjects were sensitive to lower-order statistical properties of North Sami *yoiks*, but native musicians showed greater ability to process the higher-order three-tone transitions. Apparently, M2 listeners acquire short-term statistical knowledge of tone distributions, allowing them to approximate M1-type processing on certain experimental tasks, but their native tonal framework cannot be overridden on others (Krumhansl 2004). In an experiment involving Western subjects presented with series of tones from an Indian *thāt* subjects were asked to recall test tones, with the rate of false alarms tracked for different conditions. It was shown that in performing the task listeners' native music schema significantly affected their judgments. Even though short-term learning of the regularities of the foreign idiom help M2 listeners process unfamiliar scales, their M1 musical competence shapes perception, accounting in this way for the musical experience that is different from that of the native-listener (Curtis and Bharucha 2009). Between African and Western music students there was basic agreement on overall melodic complexity of African folk songs; and a subsequent componential analysis revealed differences: the African students' ratings could be better accounted for by rhythmic variables (Himberg et al. 2006). What might appear at first here to be mixed results in the non-native perception studies is exactly what we should expect, parallel to the research on second language processing. Just as in evaluations of L2 performance, counterposing the relative importance of "M1-transfer" and "universal" factors in M2 perception leads us in the wrong direction. Two related research problems present themselves:

- Native music schemata (M1 competence) influences M2 processing in complex ways; and secondly,
- It is not always clear to what degree the misanalysis of the unfamiliar idiom, or a correct analysis, can be attributed to transfer ("negative" or "positive," respectively). In other words the analysis or misanalysis of a piece of foreign music might be unrelated to M1-transfer.

Regarding the first research problem, previous knowledge of M1 grammar provides both a framework for successful approximations to the foreign idiom and a "filter" that assimilates

(distorts) it. Common and similar features of tonal structure, among other musical hierarchies and patterns, and the ability of the processor to accommodate to unfamiliar patterns all favor successful listening of foreign music. The strength of interference effects, on the other hand, is associated with misanalysis. The first issue then is about cross-idiom influence, what we could call “positive” and “negative” transfer (although these categories are not defined well enough). The second problem asks the question about other factors, in addition to transfer, that contribute to M2 analysis or misanalysis by novice listeners and other beginner learners (e.g., performers) of the M2. In other words, cross-idiom influence is probably an important factor, but it does not account for all aspects of learning a second music. Whatever acquisition and processing mechanisms the music capacity can deploy in listening to the new and unfamiliar idiom will contribute to successful perception. In addition, cognitive-general information processing (i.e., nonmusical auditory resources) will also contribute to perception and processing of the unfamiliar idiom.

## **5. Development**

Returning to the acquisition problem mentioned in the Introduction, one way to frame the evaluation of research findings at this point is to lay out the logical/theoretical possibilities:

- (1) All acquisition is guided by domain-specific processing modules, specialized for musical competence;
- (2) Knowledge of music develops exclusively in response to domain-general learning, induction from a rich input;
- (3) The network of acquisition resources includes some that are music-specific and some that are cognitive-general.

Fortunately for our discussion, the field has been narrowed with the practical elimination of (1) as no known line of investigation seriously considers this possibility. The study of bimusicality in child development should contribute to sorting out the critical issues as it considers a dimension of differentiation within the Faculty of Music that doesn't come up in the acquisition of only one musical idiom. The few infant studies carried out so far have tended to be inconclusive and have been restricted to Western populations. Therefore, the assessment of children exposed exclusively to non-Western music with test samples based on Western musical patterns would complement the seriously incomplete current research base (Patel 2008).

Among researchers who might tend to favor one or the other of the second and third proposals (and it is important here not to prematurely divide up sides) there appears to be broad

agreement on the precocious and incidental/non-deliberate acquisition of musical abilities in children. Experiments have shown that prelinguistic infants are sensitive to universal constraints on scale structure; that processing predispositions bias their response to music. Recalling our discussion of different kinds of universal in Section 3, there is a tendency for core features of tonal structure to correlate with order of acquisition: sensitivity to consonance emerging earliest, followed by perception of scale relationships, with harmony (not universal cross-culturally) acquired relatively late (Hannon and Trainor 2007).

Approaching adult abilities, infants begin to detect small differences in pitch that are musically significant, perceive transpositions of melodies (shifts in pitch level) as functionally equivalent, recognize melodies better that do not violate tonal patterns, and attend accurately to mistunings. For example, given an invented scale with unequal intervals, young children are able to detect pitch changes of less than a semitone, in contrast to the same task in the context of invented scales with equal steps. The culture-specific details of tonality develop later between 5 and 7 years of age (Trehub 2003, Saffran 2004).

Hannon and Trainor and Saffran go on to emphasize the prominent role that cognitive-general learning should be able to play in the early development of these abilities. While there is strong evidence for the separation of music and language faculties in adults, early development may be based on structures that are less differentiated, with specialization and modular organization emerging from experience, according to this view. Thus, a single learning mechanism might direct both language and music development, at least during early childhood, building representations from exposure to the statistical regularities in auditory input from both domains. Basic level constraints could be innate but not be domain-specific. If they were encapsulated and non-interactive it would be hard to explain correlations among abilities in language and music (“cross-talk” among knowledge components) and the highly plausible possibility that competencies and processors are shared, as in the parallels observed regarding intonation contour. No early specialization and emergent modularity would also imply that there is no PoS problem for music. Strong hypotheses would link the idea of an undifferentiated early “musi-language” stage to a proposal of no domain-specific acquisition mechanisms or PoS problem for language either. Weaker versions might strike a distinction on this point between evolutionarily “primary” language and “secondary” music (Justus and Hutsler 2005). For example, musical development in early childhood appears (impressionistically) to proceed less robustly, not as rapidly as language, and perhaps less uniformly.

In contrast, proposals that favor a distinction between FM(broad) and FM(narrow), parallel to the similar concept in language, FL(broad) and FL(narrow) (Hauser et al. 2002), take a different approach. They acknowledge the role of cognitive-general learning, and then ask whether some components of musical competence might be structured completely unlike any components shared with or recruited from other domains. Jackendoff and Lerdahl (2006: 59) offer the following candidates for consideration as part of a narrow Faculty of Music:

- scale system knowledge implying fixed pitches and intervals,
- tonal hierarchy,
- a schema for resolving dissonance and instability, and
- how these features of tonality are applied to the organization of melodies (the principles of “pitch reduction”).<sup>6</sup>

As Peretz (2006: 17) observes from a review of the literature: “infants are perceptually equipped for assimilating the pitch structure of any musical culture,” and these predispositions channel the development of perceptual skills that do not seem to have any obvious function in language. But at the same time, based on findings from current research, we cannot exclude the possibility that this development is guided entirely by learning resources none of which are specific to music, even in the face of strong evidence of a modular FM architecture in adults. The extensive neural plasticity of the newborn in contact with rich early musical input may shape the different autonomous and dissociable circuits. Research shows that responsiveness to “infant-directed singing” is very early and robust (in studies of two-day old infants). Thus, one model proposes that modularization and specialization develop as the result of the fine-tuning of general-purpose learning mechanisms that intake primary musical data. The alternative scenario suggests that plasticity is not without limit

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<sup>6</sup> An anonymous reviewer called attention to the long-standing tension between ethnomusicological and cognitive science approaches to the problem of defining the notion of tonality. While limitations of space and professional preparation prompted a focus primarily on the latter approach, my intention coincides closely with Becker’s (2009) “crossing boundaries” framework for interdisciplinary exchange. For example, it recognizes the defects/constraints of both qualitative and quantitative methods (such that the respective limitations might come to complement each other), and addresses the serious problem of generalization from narrowly selected populations (e.g., subjects whose M1 is based on the “Western” instantiation of tonality). From this point of view a definition of tonality at this stage of the work should be taken strictly as a proposal for continued cross-cultural research; and thus, from the cognitive science perspective, no context-dependent data from ethnography can be dismissed out of hand. Also, the seemingly limitless diversity in musical idiom, genre and style should be of equal interest to both approaches, as in the important comparison involving between-culture and within-culture variation (Rzeszutek et al. 2011). Interestingly, among researchers interested in cross-cultural and universal musical properties, tied to theories of music origins in human evolution, there appears to be a general consensus on essential foundations that are socio-cultural and interpersonal (Brown 2006, Grauer 2006). While traditionally most ethnomusicologists have tended not to attend to essential and universal properties, a common ground for discussion exists in the shared interest in these socio-cultural and interpersonal factors.



and that general-purpose learning cannot account for all the observed biases, some of which correspond to domains that are plausibly musical, alone (p. 18). In any case, the critical experiments that will shed light on this problem should sharpen the focus farther down than at the faculty or ability level, to the component and subcomponent levels where the notion of “domain-specificity” can become more concrete.

A parallel with recent work on early childhood bilingualism is a study by Lynch et al. (1990) regarding the possibility of a shift in the perception of scales from “non-native (or neutral) to “native.” From a stage of equipotentiality, children quickly set the parameters, so to speak, to the phonological “settings” of their soon-to-be primary language. A consolidated L1 competence “blocks” non-native categories, and “filters” processing of subsequent L2 sound systems and even perhaps of other second language linguistic sub-components, although this kind of “sieve” effect (Navarra et al. 2005) is still not well understood, as it is subject to wide variation from one L2 learner to another. On the other hand, the two L1 grammars of simultaneous, completely balanced, bilingualism would not normally “filter” each other. In the music perception experiment by Lynch and associates, 20 infants and 30 adults with no prior experience with non-Western music listened to computer generated melodies based on native major and minor scales and non-native Javanese *pélog* scales. Using a head-turning procedure, subjects discriminated between a well-tuned version of the melody and an altered version in which the fifth note was mistuned. Performance on trials for both groups was significantly better than chance. While adults showed a superior ability to notice mistuned pitches in the context of the Western melodies, infants’ performance did not differ. In their discussion the authors point to an additional potential finding: that Western scales, with their relatively less complex smaller-integer frequency ratios and an intervallic pattern referenced to the semitone, may not be inherently easier to process by the human auditory system (p. 275).

Interestingly, a follow-up study by Lynch and Eilers (1992) did not confirm these findings, suggesting perhaps an important divergence in the details of how language and musical competence unfold in early childhood. Six-month olds in this experiment, contrary to the earlier results, were able to detect mistunings more successfully on the Western over *pélog* interval patterns. One factor in the second study that may have tipped the results the other way is that the task was made more challenging (random placement of the mistuned note as opposed to always the fifth one). Under these conditions, perhaps, greater demands in processing the more complex interval patterns of the *pélog* scale were revealed in the infants’ performance. Clearly, more work

is needed in this line of cross-cultural research, comparing, for example, scale systems that are contrasting to a lesser degree, with children of different ages. Future perception studies could also compare response patterns from probe tone and mistuning detection data, for example, among children exposed to only one idiom, equally to two from birth, and successively to a “first” followed years later by a “second” tonal idiom (analogous to monolingual, early simultaneous bilingual, and late second language development).

## 6. Cross-idiom interfaces

In the study of language, bimodality refers to a kind of cross-linguistic interaction between the two grammatical systems of bilingual individuals who know two languages each making use of a different modality, for example, speech and sign language. In music, bimodality involves the use of two scales in the same piece, not necessarily drawn from the same idiom (e.g., one could be non-tonal); bi- or polytonality typically implies more than one key from the same idiom. An example of the former is “Boating” from Bela Bartok’s piano series *Mikrokosmos* (1939), of the latter, the alternation between F# minor and A major in Robert Schumann’s *Dichterliebe* (1840); Stein (2005) provides analysis and discussion of the concept of musical ambiguity, related as it is to bimodality and bitonality.

In comparing the two faculties, each with its own mental grammar and syntactic structure, *modulation* turns out to be the object of important and interesting study. Again, the parallels are provocative. In music, modulation refers to a key shift, usually thought of as within the same idiom, but nothing in principle requires such a restriction. In bilingualism, it is better known as code-switching, or code-mixing, the broader category to which linguistic bimodality belongs. The syntax of melodies and the syntax of sentences in bimodal music and bilingual speech has captured the attention of researchers because the problem at hand requires an explanation of how in each case two subsystems of the same type (different scales and different languages) come together and how they are processed simultaneously and alternately in a systematic way. Holding up the two kinds of cognitive interaction for comparison – different scales within the same piece, different languages within the same discourse – might suggest new clues for future investigation.

As in all the previous sections, use of the terms “grammar” and “syntax” does not imply that the same kind of cognitive structure underlies abilities in music and language. With nothing even approximating the kind of interface with semantics that the linguistic subsystems maintain (Culicover 2005, Sacks 2007), *musical grammar* has no need for the kind of syntax that evolved for

language. The language-specific hierarchical structures of word order in phrases and sentences directly serve the expression and comprehension of propositional meaning, unlike how the hierarchical structures of relative stability serve expectancy and coherence in melody (Besson and Schön 2003, Jackendoff 2009). Musical passages evoke memories and affective states, call forth associations and incite aesthetic response to art form. In contrast, it was the emergence of complex human-like conceptual structure, and the need to use it in communication and thinking (comprehension), that led to the selection for *linguistic syntax*. In other words, language evolved to serve the functions of communication and comprehension (thought), functions that music cannot serve. But, comparing mental capacities helps us understand how each one is organized, how they interact in specific performances (of poetry for example) and what kind of cognitive structures they share.

One research problem that code-switching and modulation face is that of boundaries, the sites where a shift can be effected, and what “adjustment” might be required to line up the two grammars where they come into contact. The respective linguistic subsystems impose constraints (not inviolable rules), reflected in strong tendencies, accounting for how patterns of differing degrees of “fitness” and “misalignment” are coupled. In bilingual speech (specifically in the more interesting intra-sentential and intra-clausal switching), research has tried to describe how the alternating grammars tend to remain well-formed within each of their fragments, favoring shifts where constituents are ordered in the same way, or how a Matrix Language Frame organizes the insertion of embedded patterns (Poplack 2004, Myers-Scotton 2006). Now turning to music, in the case of modulation, different devices are applied at boundary points. Where music makes use of harmonic patterns, a pivot chord, shared between two keys (but with different functions in the respective pitch hierarchies) can mark the shift. Similarly, common-tone modulation involves repeating or sustaining a single note, signaling transition to the new key to which it also belongs. In contrast, depending on the desired effect, degrees of discontinuity (e.g., no common pitch or pivot) serve to insert marked and even sharply abrupt transitions with an ensuing rise in tension. As in code-switching (between typologically close languages), keys that are closely related afford more opportunities for “unmarked” modulation, and vice versa. Marked key shifts, between psychologically distant scales result in greater difficulty on the part of the listener to retain a tonal orientation (Sloboda 2005: 126).

This kind of sensitivity to modulation and to other aspects of movement in pitch space(s) suggests a distinction between musical knowledge *at the level of the faculty* (the FM) and *idiom-*

*specific* knowledge that accounts, for example, for the ability to judge mistuned notes. This musical competence is similar to the implicit linguistic knowledge that allows detection of ungrammatical language patterns, reliably only in one's primary language, provoked by the omission, insertion or substitution of a single morpheme. An interesting research problem is whether M1 and M2 knowledge structures in bi-musicians are stored separately (but in communication with each other), or in some other kind of network that is more integrated. Again, another parallel might appear with the research on L1 and L2 knowledge structures and how they are stored, separately or in an integrated network.

The unique capability that bimodal bilinguals possess, of expression in two languages simultaneously (speaking and signing at the same time), presents an interesting parallel with musical bimodality where the two scales appear simultaneously in separate voices. Unimodal bilinguals can *process* two languages, but through different channels (as in simultaneous translation). Again, our interest is in how complex ability systems are designed, and how their interacting components ("domain-specific" and "shared") are deployed. See the rich discussion of mode-mixing (spoken and sign language) and contact signing in Berent (2004). Of broader interest to this review of ongoing research are issues such as the capability of maintaining separate representations of each system, mutual interference and transfer (recall the research problems posed in Section 4), age of acquisition (AoA) effects for first and second language/idiom, and the acquisition of competencies guided by innate predispositions that are independent of sensory modality (for language there are apparently three: auditory, visual and tactile). All of this of course suggests the need for more research on hearing impaired musicality, independent from the closely associated aesthetic genre of sign language poetics.

Related issues of music contact in learning and development remind us of the parallels in new music and new language creation – mixed idioms and convergence (also known as "fusion") and creolization. Musical change, product of multicultural contact, advances by means of incremental influences and adaptation as well as more reconstructive type syncretic processes given impulse by young bi-musical performers (Cottrell 2007). Nowhere have these been more productive than in the cyclical and massive reconversions between the traditional popular European genres and West African musics via the Americas (Nettl 2005). In language acquisition/creation, AoA effects have figured prominently in diverse circumstances, most interestingly, by coincidence, in sign language creation, i.e., the emergence of creoles. Here a proposed contrast with musical competence is in order. While a M1 "filter" may prompt transfer

effects in M2 processing, the asymmetry (on average) between M1 and M2 is probably not as sharp as it is between L1 and L2. In addition, there is no convincing evidence of a hard critical period for first music acquisition, as opposed to the consistent finding of strong AoA effects in L1 development. The significance of findings of AoA effects for L2, not as consistent as in the case of AoA for L1, is a separate and more complex question.

### **7. Conclusion: conceptions of broad and narrow musical capacity for future research**

In making use of the specific examples of parallel between cross-idiom and cross-language research on universals, intercultural comparisons in perception, child development, and “code-switching,” we have already touched on what may be the most important emerging controversy in the field of music cognition. Unlike its familiar counterpart in linguistics, the controversy is still relatively young (emerging), and there is reason to believe that the respective claims and counter claims may not break down at every turn along the same lines. The study of modularity in music processing by Justus and Bharucha (2001) is an example, one that is representative of an evolving exchange marked by fewer strong hypotheses having been staked out firmly at the extremes (compared to linguistics, for example). At present, opposing proposals turn on the question of music-specific versus cognitive-general underpinnings of the music capacity. We visited this question in Section 5 on Development. The opposition, such as it is, appears most clearly between the modular functional architecture for music processing (Peretz and Coltheart, 2003) and Patel’s (2008) shared syntactic integration resource hypothesis (SSIRH). The modular view starts with the assumption that important subsystems of the music capacity are “cognitively unique,” evidence pointing to a dedicated module for tonal encoding of pitch, for example. The SSIRH favors a model that suggests a “deep connection” between musical and linguistic syntax, with an emphasis on overlapping domains rather than dissociations.

In line with our theme, the study of bilingual abilities in particular provides a useful framework for understanding research problems in language as a whole and in the present discussion for analogous problems in music cognition, especially now in regard to the modularity-integration debate. Two aspects of the work on bilingualism might help us understand this debate better:

- (1) Because research has naturally tended to focus on abilities and language use (e.g., the entire sub-field of code-switching is all about performance), components of different types and interfaces at different levels come to the fore in theoretical models. One prominent

example attempts to explain the cognitive differentiation between L1 and L2 grammatical subsystems, on the one hand, while accounting for shared components of bilingual proficiency, which do not dissociate (Paradis 2004). The category of shared components, which do not differentiate, reminds us of findings showing how skills learned by musicians through experience with their first, native, idiom can subsequently be applied to a second (Stevens 2004a).

(2) The inherent imbalances and asymmetries in bilingual proficiency and in the use of two languages in communication (Myers-Scotton 2006) highlight the same componential mental organization. In situations of complete equilibrium, components are less visible. Imbalances and asymmetries between native and non-native musical ability might call our attention to similar kinds of cognitive organization.

The distinction proposed by Jackendoff and Lerdahl (2006) between a FM(broad) and a FM(narrow), mentioned in the section on Development, can also serve to identify points of agreement in a common ground from which it should be easier to see where the critical differences really lie. To start with, all theories would coincide, more or less, on the role of most of the proposed domain-general components of FM(broad) – to clarify terms: “component” does not necessarily imply “module.” In addition, starting with categories like *broad faculty* and *ability* allows for a more consistent evaluation of research evidence because findings are usually based on *performance* data of one kind or another. Neither a faculty nor an ability can be “a module”; only singularly defined competence structures or processing mechanisms could be. Recent and continuing investigations involving unimpaired and disabled populations promise to unravel the details of these proposed distinctions.

One last cross-cultural and cross-language comparison deserves our attention as it potentially weighs heavily on the different ways of thinking about modularity, considering the interactions, in this instance, within the broad musical capacity: musical perception and competence among speakers of tonal and non-tonal languages. In addition, tone languages provide an opportunity to ask the question of how pitch systems are similar in language and music, and how they are different. Languages with more than one level tone are more informative for this question according to Patel (2008: 39-46) – Mandarin Chinese, for example, has only one level tone, with three contour tones: rising, falling and falling-rising. Tone languages that contrast more than three levels and do not trend down with sentence intonation would be the most interesting. However, even in these cases, what remains constant is the level of tone in proportion to the range

of the speaker, affected also by contextual factors (affect, for example, that might narrow or expand the range). Thus, discrete level tone languages are not likely to make use of fixed pitch intervals, as in music. Continued research will reveal other aspects of the interaction between pitch in music and language in cross-language studies as in the apparent marked differences between speakers of tonal and non-tonal languages in musical perception (e.g., absolute pitch) and sensitivity to both intonational contour in speech and musical intervals (Deutsch et al. 2006, Stevens 2004b). These studies suggest shared domains that go beyond just intonational contour to include linguistic (phonological) tone. Systems can be separate but also share components and develop connections, in this case between FM and FL. In the literature, sharing and connecting are often referred to as “overlap.”

The second line of investigation, on musical disability, directly engages work on speech disability in charting the neural substrates that might underlie the narrow and broad networks, respectively, of music and language. The broad networks of each should show more extensive connections. Reports from early work perhaps inclined more toward descriptions of amusia with speech unimpaired. While very important for the purpose of analyzing the componential organization of musical abilities, if in the end neuropsychological dissociation turns out to be one-sided, evidence for separable music-specific modules (autonomous from language in particular) would be less than conclusive. Recent studies in fact do suggest a double-dissociation: congenital language impairment or acquired aphasia in the presence of relatively spared music recognition, singing, and prosody in speech (Peretz 2009). An example is the compelling case described by El Mogharbel et al. (2003) of an autistic child with severely retarded intellectual development and virtually no linguistic ability. Nevertheless, at age nine evaluations of her spontaneous singing (melodies sung with speech-like open syllables) show evidence of acquired tonal competence: sung tunes are variations and not simple reproductions of model tunes, and singing performance implements octave identity, jumping to a higher or lower octave when a melody goes out of her range. However, see Patel (2008: 268–276) for counter arguments.

Returning to the research on amusia, descriptions of the various sub-types reveal components and subcomponents, among which some are strong candidates for belonging to domains that are not music-specific. Depending on the ability under assessment, different profiles of impairment and sparing present themselves, for example in the dissociation between disorders of rhythm and disorders of pitch, the former possibly being nonmusic-specific. Based on all the various confrontations and correlations among different kinds of (music and language-related)

disability, Peretz (2006, 2009) characterizes the Faculty of Music as a “confederation.” Just like the language faculty, it recruits “widely distributed networks” and a diversity of processing systems. See Marcus and Rabagliati (2006) who favor a similar approach to the study of developmental disorder in language.

In concluding this evaluation of the different approaches to the modularity-integration problem, there should be from all the above an undercurrent of hesitation regarding how clearly the lines of debate can be drawn. On one point of potential convergence between the SSIRH and the modular functional architecture hypothesis we at least want to set aside differences about what things are called: what is understood as “processing component,” in Peretz and Coltheart (2003) in particular. In presenting a certainly plausible comparison between syntactic processing in long distance dependency in sentences and tonally distant pitches in musical phrases, Patel (2008: 282-285) proposes a model that distinguishes between “resource networks” and “representation networks.” The distinction, in different terms, could be cast as one between two different kinds of cognitive component, respectively: “processing mechanisms” and “knowledge structures.” If representation networks, as Patel’s Figure 5.16 indicates, are “stored in distinct brain networks,” then the SSIRH would not in principle exclude the possibility of music-specific component structures of a FM(narrow). The idea of “overlap” is proposed for resource networks, associated with processing, activation, interface, and the like; these could be considered, perhaps, as part of a FM(broad). The pending question, suggested as well by the overlapping resource networks for language and music in the figure, is now whether *all* processing mechanisms would be domain-general.

On the other side of the discussion, a careful rereading of Peretz and Coltheart (2003) prompts a query: all components of the model of music capacity (“boxes” in the diagram) are “processing subsystems,” “processing components,” and “processor modules.” Interfaces and connections are “pathways of information flow or communication.” In Figure 1, a defective musical ability can result either from a defective processing component or damage to a pathway. Now it seems that the distinction proposed by all the authors is of the same kind that investigators have analyzed in the study of other complex abilities (e.g., research on dyslexia). While Peretz and Coltheart do not make explicit reference to knowledge or competence modules, their “processing modules” appear to refer in some cases to such a category (after all, within knowledge structures, computations and operations are carried out on input). Thus, if part of the idea in “pathways” corresponds to processing mechanisms/resource networks, some common ground has been



established, allowing us then to go forward to what could be the decisive research question: Is the capacity for music a “confederation” that both recruits from other faculties and includes some music-specific components (competence and/or processing) – or – do all music abilities depend exclusively on cognitive-general and shared domains? The SSIRH appears to leave the door open to music-specific competencies that, for example, could be damaged as part of an explanation for tone deafness (Patel 2008: 284).

The idea of one kind or another of diverse and heterogeneous organization of musical capacity recalls the problem introduced at the beginning of this paper regarding the productivity of cross-cultural music apprehension. Universal aesthetic responses, even as these are not “native-like,” are explained because among the wide range of types of music and music-related component at different levels, only some can be peculiar to the cultures under consideration (e.g., tonality is not “Western”); only some of them are even specific to the Faculty of Music.

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