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Any college-level instructor who has taught Music Theory or Aural Skills during at least the past decade (perhaps the past century?) has probably lamented: "Our students don't come in nearly as prepared as they used to." Not surprisingly, the topic of inadequate preparation resurfaced (as it does from time to time) in the SMT-talk forum in October of 2010, with a thread begun by Timothy Cutler.[1] This often-remarked-upon state of affairs probably obtains at all but the most elite conservatories and music departments, and my institution is no exception. But taking it one step further, I would suggest that the lack of preparation is both quantitative and qualitative.

By quantitative, I mean that students may have had less formal training on an instrument (often, much less) than was the case in the past; by qualitative, I mean that the training they have may be on non-orchestral instruments, and that their previous exposure to music lies mainly in the popular realm, as opposed to what we broadly refer to as the classical realm.[2] So while this discussion may be (happily) irrelevant for instructors in top-level conservatories and music departments, it may be helpful for high school music teachers, and particularly instructors in two-year and four-year colleges and universities where students are accepted who, through no fault of their own, enter without a rich, or even adequate, musical background.[3] This creates challenges for the Music Theory

[1] See Timothy Cutler's post of October 10, 2010: http://lists.societymusictheory.org/htdig.cgi/smt-talk-societymusictheory.org/2010-October/000877.html

[2] Music departments, including my own, are admitting students whose primary instrument is electric guitar, electric bass, or trap set; these students often have little formal musical training, and their previous musical experience often consists primarily of playing in a garage band. I expect this trend will continue.

[3] Even students who play traditional orchestral instruments, or sing, often have little in the way of formal training, as music programs continue to be cut in many primary and secondary schools. Nevertheless, college music departments may have no choice but to admit weaker students in order to keep their enrollments at an acceptable level.

instructor, but particularly for the Aural Skills instructor. For that reason, this paper will focus on meeting these new challenges in the Aural Skills classroom, though it will limit itself primarily to a consideration of the singing portion of such a class; a detailed treatment of the dictation portion is beyond the scope of this paper.[4]

Notwithstanding the fact that different college and conservatory programs will have different standards of acceptance and achievement for their students and thus must use approaches that best accomplish the intended outcome, all music departments share at least one common goal: to cultivate the musicianship of all their students, enabling each to be a better musician than he or she was upon entering the program. In a general sense, that means increasing the literacy and fluency of all music students. It may, therefore, behoove us to revisit and reevaluate what most of us would probably agree is a standard Aural Skills curriculum (as reflected in many commercially-available college-level Aural Skills texts[5]) to determine whether the model is still as universally valid as it once was, and if not, to consider plausible alternatives. To begin, I present an overview of what I believe to be the general goals and assumptions in such a standard Aural Skills program. I will then present an overview of some of the current brain research that is germane to our topic, and conclude with some recommendations.

Painting with a broad brush, most college-level Aural Skills texts and approaches are based on a set of assumptions about the students who will be using the materials, and the pedagogical underpinning is essentially the same; that is, an Aural Skills class provides a conceptual framework for the musical sounds and patterns that students have presumably already internalized

[4] I plan to deal with this topic in a separate article.

[5] See, for example, Sol Berkowitz, Gabriel Fontrier, Leo Kraft, Perry Goldstein, and Edward Smaldone, *A New Approach to Sight Singing*, 5th ed. (New York: W. W. Norton, 2010); Thomas Benjamin, Michael Horvit, and Robert Nelson, *Music for Sight Singing*, 6th ed. (Boston: Schirmer Cengage Learning, 2012); Gary Karpinski and Richard Kram, *Anthology for Sight Singing* (New York: W. W. Norton, 2007); Joel Phillips, Paul Murphy, Elizabeth West Marvin, and Jane Piper Clendinning, *The Musician's Guide to Aural Skills*, 2nd. ed., Vols. 1 and 2 (New York: W. W. Norton, 2011); Robert Ottman and Nancy Rogers, *Music for Sight Singing*, 8th ed. (Upper Saddle River, NJ: Pearson Prentice Hall, 2010); Maureen Carr and Bruce Benward, *Sight Singing Complete*, 7th ed. (New York: McGraw-Hill, 2007).

from years of singing and/or playing an instrument (and perhaps playing in an ensemble), prior to entering college: the patterns of common-practice music, or functional tonality. The Aural Skills class attaches functional tonal labels to these ostensibly familiar melodic and harmonic patterns, and teaches students to map solfège syllables or scale degrees to these patterns, such that those syllables/scale degrees come to act as audibly-identifiable tonal markers within a referential system.[6] The aim is to increase progressively the skill level of the students, enabling them aurally to comprehend melodic, harmonic, and rhythmic patterns, musical form, and so on, in order to inform their performance[7] and deepen their understanding of musical style and structure. And, in so doing, the Aural Skills class teaches students to notate these patterns from an aural presentation, as well as to sing at sight music they have never heard or seen before. These are fundamental skills for any musician to possess.

It follows that a critical component of this method would be that the Aural Skills class use music with which the students are already familiar, or music that is drawn from a repertoire syntactically similar to the music the students know; that is to say, music whose vocabulary, grammar, structure, conventions, idioms, turns of phrase, and so on, have already been internalized, or encoded, from years of prior exposure and engagement. The task is to then make explicit the musical norms and syntax contained therein.[8] This is a crucial point: the cognitive significance of musical conventions, or norms, is that once they become internalized, they influence how a listener hears and organizes music into coherent patterns,[9]

[6] My discussion assumes a moveable-do approach, whereby solfège syllables designate functional scale degrees.

[7] For example, recognizing the difference between tonic and dominant arrivals at a phrase ending enables the student to shape the phrases by making one sound more final than the other; similarly, recognizing a deceptive cadence enables the student to underscore the surprise of it; and of course, good aural perception is essential for improvising.

[8] In *Music, Language, and the Brain* (New York: Oxford University Press, 2008), 241-242, Aniruddh Patel defines musical syntax as "the principles governing the combination of discrete structural elements [tones, timbres, time values, etc.] into sequences," and points out that the "vast majority of the world's music is syntactic," though that syntax will vary across cultures and eras, with but only a few universals.

[9] Patel, *Music*, 242. See also A. Patel, "Language, Music, Syntax,

and they enable the listener to develop expectations about future events. Leonard Meyer explains that syntax "makes possible the existence of complex hierarchic structures," and establishes "sets of *possible* functional relationships," making some events "more *probable* than others"(italics Meyer's).[10] And, many would agree, it is the violation of those probabilities, or statistical regularities (or the delayed or unexpected realization of those expected outcomes), that create affect in music.[11]

We call the mental representations of these organizational patterns musical schemata. A schema may be thought of as a model, or framework, comprising a network of interrelations into which our brains try to fit incoming sensory information and evaluate that incoming information for goodness of fit (i.e., does it fit our existing schemata). For example, in tonal music, one simple melodic schema is *re-ti-do*. After sufficient exposure to that pattern, hearing *re-ti*, will elicit the expectation for *do* to follow, because that fits our existing schema. An example of a simple harmonic schema is ii-V-I, or even just V-I. A more complex schema, comprising a network of interrelations, would be the combination of the melodic pattern *re-ti-do* with the harmonic pattern ii-V-I.

We have schemata representing our knowledge about all concepts, and, as our knowledge becomes more sophisticated, so do our corresponding schemata.[12] David Huron explains:

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and the Brain," review, *Nature Neuroscience* 6, no. 7 (2003): 678-81; Robert Gjerdingen, *A Classic Turn of Phrase: Music and the Psychology of Convention* (Philadelphia: University of Pennsylvania Press, 1988); and Ray Jackendoff and Fred Lerdahl, "The Capacity for Music: What is it, and What's Special About it?" *Cognition* 100 (2006): 33–72.

[10] Leonard Meyer, *Style and Music: Theory, History, and Ideology* (Chicago: The University of Chicago Press, 1989), 15-19.

[11] For the classic treatment of this topic, see Leonard Meyer, *Emotion and Meaning in Music* (Chicago: The University of Chicago Press, 1956).

[12] For a more thorough account of schema theory, see David E. Rumelhart, "Schemata: The Building Blocks of Cognition," *Theoretical Issues in Reading Comprehension*, ed. Rand J. Spiro, Bertram C. Bruce, and William F. Brewer (Hillsdale, N. J.: Lawrence Erlbaum Associates, 1980), 33-58. For two excellent accounts of schema theory in music, see Robert Gjerdingen's *A Classic Turn of Phrase: Music and the Psychology of Convention* (Philadelphia: University of Pennsylvania Press, 1988); and David Huron's *Sweet Anticipation: Music and the Psychology of Expectation* (Cambridge, MA: The MIT Press, 2006).

> It is the ability of brains to form multiple schemas that provide the psychological foundation for distinguishing different styles and genres. Without this foundation, baroque and reggae would meld into a single general musical schema. Our experiences with baroque harmony would interfere with our ability to accurately predict harmonic progressions in reggae, and vice versa.[13]

Thus, comprehension of basic syntax and possession of basic musical schemata constitute the essential foundation that make possible further study and continued progress in any given style of music. Not only does this make sense intuitively, but it can now be demonstrated neurologically.[14] The brain develops elaborate, specialized neuronal networks[15] called *feature detectors* that process the individual components of music, such as pitch, timbre, harmony, rhythm, spatial location, and so on.[16] Through constant exposure to the regular patterns and grammar of a given style of music, whether through listening or, even more so, through playing and performing, those networks become more robust, enabling

[13] Huron, *Sweet Anticipation*, 204.

[14] For discussions of musical syntax (what it is, how it is acquired, how it informs our perception of music) in the neurological literature, see, for example, Daniel Levitin, *This is Your Brain on Music* (New York: Plume, 2006); Sebastian Jentschke, Stefan Koelsch, and Angela D. Friederici, "Investigating the Relationship of Music and Language in Children: Influences of Musical Training and Language Impairment," *Annals of the New York Academy of Sciences* 1060 (New York: The New York Academy of Sciences, 2005), 231–242; S. Koelsch, T. Grossmann, *et al*., "Children Processing Music: Electric Brain Responses Reveal Musical Competence and Gender Differences," *Journal of Cognitive Neuroscience* 15, no. 5 (2003): 683–693; Mireille Besson and Daniele Schön, "Comparison Between Language and Music," and Stefan Koelsch, Burkhard Maess, Thomas C. Gunter, and Angela D. Friederici, "Neapolitan Chords Activate the Area of Broca: A Magnetoencephalographic Study," *Annals of the New York Academy of Sciences* 930 (New York: The New York Academy of Sciences, 2001): 232-258 and 420-421, respectively.

[15] I use the term "neuronal" rather than "neural," following James Zull, *The Art of Changing the Brain: Enriching Teaching by Exploring the Biology of Learning* (Sterling, VA: Stylus Publishing, 2002), 109, fn 1, who explains that the term "neural networks" has taken on a very specific meaning in cognitive science referring to computers.

[16] Levitin, *This is Your Brain*, 103-104; Rumelhart "Schemata," 42.

the brain to quickly process and comprehend pieces with similar grammar and structure. These interrelated neuronal networks are embodied musical schemata, and they develop in response to the kind of music one listens to.[17] Thus, "what you listen to changes how your brain is configured."[18]

And there's the rub.

While the underlying principle of Aural Skills texts and curricula remains valid—to extract principles from a common body of music whose grammar one already knows[19]— the assumption that is no longer valid for many entering college students is their familiarity with that common-practice repertoire. Nevertheless, most Aural Skills texts rely heavily, if not exclusively, on that repertoire for both the singing and dictation examples (or examples composed for the text that replicate that style of music).

If students lack traditional musical training and exposure, these patterns have not been sufficiently encoded (as would have been the result of countless iterations of instrumental or vocal practice over a number of years and/or participating in an ensemble), to allow for the fluency necessary to progress in an Aural Skills class. Thus, learning is inhibited. Such students are not yet able to process music in a way that is consonant with how most Aural Skills texts and curricula are designed. Consequently, we need to further investigate how the brain processes and encodes information and creates new knowledge, how it acquires and develops musical ability, and how it creates musical schemata, which then support further musical development.[20]

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[17] Barbara Tillmann, Jamshed J. Bharucha, and Emmanuel Bigand, "Implicit Learning of Tonality: A Self-Organizing Approach," *Psychological Review* 107, no. 4 (2000): 885-913. See especially p. 892.

[18] Eric Jensen, *Music with the Brain in Mind* (Thousand Oaks, CA: Corwin Press, 2000), 10; Elizabeth A. Reynolds Losin, Mirella Dapretto, and Marco Iacoboni, "Culture and Neuroscience: Additive or Synergistic?" *Scan* 5 (2010): 141-158.

[19] That this principle is indeed valid is demonstrated by an experiment that will be discussed presently. See Psyche Loui, David L. Wessel, and Carla L. Hudson Kam, "Humans Rapidly Learn Grammatical Structure in a New Musical Scale," *Music Perception* 27, no. 5 (2010): 377-388.

[20] The topic of musical ability and its biological foundations is a subject of much ongoing interest and debate among cognitive scientists, neuroscientists, etc. Many (Levitin, for example) believe that musical ability preceded language acquisition, and in fact, provided

Dr. Laurel Trainor (Director of the Auditory Development Lab and the McMaster Institute for Music and the Mind) and psychologist Dr. Erin Hannon write about the acquisition of musical knowledge through two basic processes: enculturation (implicit knowledge, as discussed above), and formal musical experience (explicit knowledge).[21] This enculturation process "follows a clear developmental trajectory in which universal aspects [consonance/dissonance] are grasped during or before infancy and system-specific aspects [key membership, harmonic knowledge] are acquired during childhood."[22] And, most importantly for our discussion, "throughout development, these networks become increasingly specialized for encoding the musical structure of a particular culture."[23]

But what *is* the music of our culture? We might pause here to consider that children's songs, folk songs, patriotic and holiday songs, and so on, would have at one time constituted a large part of such a developmental repertoire, along with some of the more "popular" classics. But today, for a number of reasons, there are many children who are not learning this common body of music, either at home or at school, nor are they taking private lessons on piano or orchestral instruments, or participating in traditional

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the foundation for the development of language. On the other hand, Stephen Pinker, in *How the Mind Works* (New York: Norton, 1997), 534, claims music is a "spandrel," a by-product of language. Spandrel is a term borrowed from architecture, defined by Merriam-Webster as "the sometimes ornamented space between the right or left exterior curve of an arch and an enclosing right angle." (http://www.merriam-webster.com/dictionary/spandrel). Levitin points out in his book, *This is Your Brain on Music*, 247-249, that "many spandrels are put to such good use that it is hard to know after the fact whether they were [evolutionary] adaptations or not." Levitin goes on to discuss a conference presentation given by Pinker, in which Pinker asserted that language was an evolutionary adaptation, and music was its spandrel. Levitin quotes Pinker as saying: "Music is auditory cheesecake . . . . It just happens to tickle several important parts of the brain in a highly pleasurable way, as cheesecake tickles the palate."

[21] Erin E. Hannon and Laurel J. Trainor, "Music Acquisition: Effects of Enculturation and Formal Training on Development," *Trends in Cognitive Sciences* 11, no. 11 (2007): 466.

[22] Hannon and Trainor, "Music Acquisition," 468.

[23] Hannon and Trainor, "Music Acquisition," 470.

school bands, orchestras, or choirs. This is indeed problematical with regard to the process of enculturation to pitch structures of Western tonal music.[24] Without sufficient exposure to these pitch structures, the concomitant schemata will not develop adequately.[25]

For more evidence of this enculturation process, we can turn to the work of neuroscience researcher and musician Psyche Loui. In an effort to tease out the variables involved in how humans acquire knowledge of and preferences for music, with regard to grammar, syntax, and even scale system, Loui conducted a study at the Music and Neuroimaging Lab of Beth Israel Deaconess Hospital and Harvard Medical School. Her discussion begins by echoing Hannon and Trainor, pointing out that people of different cultures become sensitive to the statistical regularities of their own music, and that "experience and exposure are crucial to musical knowledge."[26]

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[24] The same can be said about harmonic and rhythmic structures, and timbral identification and associations.

[25] We should all advocate for the continued inclusion (or reintroduction) of common children's songs, folk songs, and so on, in elementary school, not only to preserve a multigenerational common body of music, but also because this music serves to establish basic tonal music literacy in children. We might also ponder whether there may be reason to believe that listening to a lot of music in which there is much pitch distortion and lack of differentiation between discrete pitches (somewhat to the exclusion of listening to music with clearly-defined tonal centers and pitches), may actually hinder the encoding of basic tonal structures.

[26] Loui et al., "Humans," 377. For a detailed discussion of statistical learning, see Jenny R. Saffran, Richard N. Aslin, and Elissa L. Newport, "Statistical Learning by 8-Month-Old Infants," *Science* 274, no. 5294 (1996): 1926-1928. Saffran et al. explain that "a fundamental task of language acquisition, segmentation of words from fluent speech, can be accomplished by 8-month-old infants based solely on the statistical relationships between neighboring speech sounds. Moreover, this word segmentation was based on statistical learning from only 2 minutes of exposure, suggesting that infants have access to a powerful mechanism for the computation of statistical properties of the language input" (p. 1926). Saffran, Elizabeth K. Johnson, Richard N. Aslin, and Elissa L. Newport, in "Statistical learning of tone sequences by human infants and adults," *Cognition* 70 (1999): 27–52, then examined whether statistical learning would apply to tone sequences as well as language: "We asked whether this statistical learning ability is uniquely tied to linguistic materials. Subjects were exposed to continuous non-linguistic auditory

Loui then discusses three experiments run by her research team.[27] They used the non-traditional, unfamiliar Bohlen-Pierce musical scale, and "created finite-state musical grammars from which [they] composed sets of melodies."[28] In the first experiment,

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sequences whose elements were organized into 'tone words'. As in our previous studies, statistical information was the only word boundary cue available to learners. Both adults and 8-month-old infants succeeded at segmenting the tone stream, with performance indistinguishable from that obtained with syllable streams. These results suggest that a learning mechanism previously shown to be involved in word segmentation can also be used to segment sequences of non-linguistic stimuli" (p. 27).

[27] I summarize the study below, but it is far more detailed and sophisticated than can be fully taken up in this paper.

[28] Loui et al., "Humans," 377. Loui explains that the Bohlen-Pierce scale "was first proposed by Heinz Bohlen in the early 1970s and [is] designed to be different from Western music, while still giving rise to a sense of tonality. . . . [It] is based on 13 logarithmically even divisions of a tritave, which is a 3:1 ratio in frequency." The melodies were generated as follows: Two four-chord progressions containing identical chords were created, the first progression comprising chords 1, 2, 3, 1, the second comprising chords 1, 3, 2, 1. Each melody begins on a note contained in the first chord. Any note may progress up or down to another note in the chord, stay the same, or move to a note in the following chord, thereby allowing for six possible successions for each note. Consequently, each note occurs the same number of times in each of the two progressions, but the reordering of chords 2 and 3 in the second progression changes the probability of one note following another compared to the first progression. For example, in common-practice music, a melody line, *do-la-ti-do* ($\hat{1}$-$\hat{6}$-$\hat{7}$-$\hat{1}$) occurs frequently as part of a I-IV-V-I progression, but those same pitches would appear infrequently as *do-ti-la-do* in a I-V-IV-I progression. The pitches occur the same number of times in each melodic line, but the probability of *la* going to *ti* is much greater than that of *ti* going to *la*.

Loui continues, "the artificial musical system adheres to various rules for a generative theory of tonal music (Lerdahl & Jackendoff, 1983). This makes the system viable as a new compositional tool from which large numbers of melodies can be generated, while being completely unfamiliar to all participants of our studies." (pp. 379-380) See Appendix 2 for diagrams of the frequencies of the Bohlen-Pierce scale, compared to Western equal temperament; and the transitional possibilities (the probability of one note following another) for each grammar. Audio files of one example melody generated in each grammar are available at http://sites.google.com/site/psycheloui/publications/downloads.

subjects with five to fourteen years of vocal or instrumental training (with a mean of 9 years) listened through headphones in a sound-attenuated chamber to a limited number of melodies composed in one of the grammars (five melodies total, each eight notes long, each melody presented a total of 100 times, for a period of 25 minutes).[29] The researchers determined that repeated exposure to a limited number of melodies resulted in subjects being able to recognize those melodies, and show a preference for them, but not to recognize new melodies composed in that grammar. Thus, the melodies had been learned, but not the musical syntax; subjects were not learning the underlying structure of the melodic exemplars.[30]

The second experiment involved new subjects who similarly had five to fourteen years of vocal or instrumental training (with an average of 9.6 years). This experiment was identical to the first except that these subjects were exposed to 400 melodies in the new grammar, without repetitions of any melodies. (The exposure phase lasted 30 minutes.) Loui found that "exposure to a large set of exemplars leads to generalized knowledge of a harmonically based artificial musical grammar, as compared to the more item-based knowledge observed in Experiment 1."[31]

The third experiment replicated the second, except that the new group of subjects had no formal music training. The results for groups two and three were essentially the same, with no significant difference between the musically trained and untrained subjects. Thus, with limited exposure to only a few melodies (experiment 1), musically-trained subjects could not generalize beyond those melodies to extract more abstract rules of scale, grammar, and syntax. But after listening to an abundance of melodies (experiments 2 and 3), both the musically trained and untrained "participants could extract knowledge of a more abstract nature . . . such that they could distinguish melodies composed in their exposure grammar from melodies composed in an alternate but very similar grammar."[32]

The results of the above-cited studies are consistent with what

[29] Subjects were given the option of drawing on a piece of paper while listening.

[30] Loui et al., "Humans," 383.

[31] Loui et al., "Humans," 383-384.

[32] Loui et al., "Humans," 386. The complete set of melodies generated for the experiment may be downloaded from Loui's "Bohlen-Pierce Scale Artificial Grammar Learning Experiment," *Figshare* (2013), http://figshare.com/articles/Bohlen_Pierce_scale_artificial_grammar_learning_experiment/757721.

many of us certainly have intuited and experienced: the greater the exposure and training, the better. But in this paper, we are talking about students who have limited exposure and training, analogous to the limited-exposure subjects in Loui's first experiment. So we must further consider the learning process in order to determine how best to help students progress from their modest entering level of knowledge, skill, and ability, to a much higher level of fluency.

James Zull, biologist and Director of the University Center for Innovation in Teaching and Education at Case Western Reserve University, states that if one is to teach, one has to create conditions that "lead to change in a learner's brain," by which he means setting up conditions for rewiring the brain in ways that support the learning of the new task, new facts, new skills, and so on:[33] "Knowledge . . . is produced by the brain through formation and change in neuronal networks."[34] "There is a neuronal network in our brain for everything we know."[35]

As an example, Zull points out that when someone named Jane sees her name written out, a group of neurons in her visual cortex fires, and that neuronal network will always fire together when she sees her name.[36] Similarly, hearing the note middle C would enlist one neuronal network, while the pitch A 440 would engage another.[37] Small pieces of knowledge are located in small groups

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[33] Zull, *Art of Changing the Brain*, 5, 8.

[34] Ibid., 92.

[35] Ibid., 98.

[36] Moreover, "the physical arrangement of the neurons that fire when we see an object is a map of the physical structure of the object itself." To demonstrate, Zull provides an illustration depicting part of the visual cortex of an actual monkey's brain, imaged while the monkey viewed a projection of a half wheel. The most active neurons replicate exactly the geometric pattern of the wheel. See *Art of Changing the Brain*, 144.

[37] Ibid., 100. Tillman, Bharucha, and Bigand in "Implicit Learning," 891, explain that "the auditory cortex displays a tonotopic organization in which cells responding best to different frequencies are arranged in an orderly fashion. In the auditory system, tonotopic organization can be found at almost all major stages of processing (i.e., inner ear, auditory nerve, cochlear nucleus, auditory cortex)." Thomas M. Talavage, Martin I. Sereno, Jennifer R. Melcher, Patrick J. Ledden, Bruce R. Rosen, and Anders M. Dale, in "Tonotopic Organization in Human Auditory Cortex Revealed by Progressions of Frequency Sensitivity," *Journal of Neurophysiology* 91 (2004): 1282–1296, further explain, "Tonotopy is a fundamental organizing principle of the auditory system. Tonotopy

of neurons, and complicated information comprises extensive networks.[38] Thus, teachers need to build on existing neuronal networks, or schemata, in order to create more extensive networks that represent more sophisticated knowledge.

It is sensory experience that changes neuronal networks, and lots of it produces "complex and extensive new branching of neurons."[39] Practicing what we already know strengthens *synapses* (the junction between neurons that permits the passing of a chemical or electrical signal, from one neuron to another[40]). As neurologist David Perlmutter points out:

> Synapses that are regularly used are nurtured and thrive, while the synapses that are underutilized wither away. . . . If a specific pathway is used a great deal, . . . more synaptic connections [will develop]. . . . Repeated exposure . . . is required to create a permanent connection. If early experiences are not reinforced, the pathways will weaken and the synapses will disappear.[41]

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arises from mechanical properties of the cochlea and is apparent as a linear arrangement of neurons according to best frequency (BF, the acoustic frequency to which a neuron is most sensitive). In the cerebral cortex, tonotopy is seen as a progressive change in neuronal best frequency with position along the cortical surface—a tonotopic map." Tonotopy, however, has nothing to do with absolute pitch ability. While tonotopic mapping allows us to perceive differences in pitch or intonation, it does not contribute to the ability to memorize and label pitches according to their frequency (as explained by Elizabeth West Marvin in a private correspondence).

[38] Zull, *Art of Changing the Brain*, 98-100.

[39] Ibid., 115-116, and footnotes 5 and 8, p. 130.

[40] Ibid., 117. To vividly and elegantly illustrate the firing of a synapse, conductor Peter Perret calls to mind a beautiful image: that of Michelangelo's *Creation*. He says, "You can almost see an electrical spark in the tiny space between God's finger and that of Adam." Peter Perret and Janet Fox, *A Well-Tempered Mind: Using Music to Help Children Listen and Learn* (New York: Dana Press, 2004), 130.

[41] David Perlmutter and Carol Colman, *Raise a Smarter Child by Kindergarten: Build a Better Brain and Increase IQ Up to 30 Points* (New York: Morgan Road Books, 2006), 15-16. (Perlmutter is a recipient of the Functional Medicine Linus Pauling Award for his work in innovative approaches to neurological disorders.) Perlmutter also points out that this is why, for example, young children love to hear the same stories read to them again and again—repetition is what strengthens their synaptic pathways (p. 16).

To quote an often-used expression in neurological literature, "Neurons that fire together, wire together."[42] All of which is a more elegant way of saying, "use it or lose it."

The importance of synaptic connections and repeated firings cannot be overstated. Education Professors Larry Holt and Marcella Kysilka refer to the research of neuroscientist Susan Fitzpatrick on *long-term potentiation*, explaining that neurons that "fire information across a synapse are encoded exponentially" so that "information is learned multiple times each time it is practiced."[43]

Unquestionably, learning is an iterative process. It is also about constantly refining and deepening our understanding of a topic. To quote Zull again:

> Learning is about forming the right images when we hear or read language. . . . As we become expert in some subject, our images become more and more exact and complex. . . . When we show that we have a precise and complex image for a word, we demonstrate deep learning. We demonstrate comprehension of the language of our field.[44]

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[42] This theory was first articulated by Donald Hebb in his 1949 book, *The Organization of Behavior; a Neuropsychological Theory* (New York: Wiley, 1949). Hebb states: "The general idea is an old one, that any two cells or systems of cells that are repeatedly active at the same time will tend to become 'associated', so that activity in one facilitates activity in the other" (p. 70). See also Perret, *Well-Tempered Mind*, 130, and Zull, *Art of Changing the Brain*, 118-19.

[43] Larry C. Holt and Marcella L. Kysilka, *Instructional Patterns: Strategies for Maximizing Student Learning* (Thousand Oaks, CA: SAGE Publications, 2006), 18. They cite this information as coming from an audio recording of neuroscientist Susan M. Fitzpatrick's presentation, "The Brain, the Mind, and the Classroom," at the 1996 Association for Supervision and Curriculum Development, Alexandria, VA. Fitzpatrick is an adjunct associate professor of Neurobiology and Anatomy at Washington University School of Medicine and vice president of the James S. McDonnell Foundation, one of a limited number of international grantmakers supporting university-based research in the biological and behavioral sciences.

[44] Zull, *Art of Changing the Brain*, 169-70.

With just a few word substitutions, many of us would probably agree that we have a good definition of the process of aural comprehension:

> *Aural comprehension is about forming the right images when we hear or read music. When we show that we have a precise and complex image for a sound pattern, or a precise and complex aural image for a notational pattern, we demonstrate deep learning. We demonstrate comprehension of the language of our field.*

Edwin Gordon would refer to this as "audiation."[45]

To more fully appreciate how one aurally comprehends music, let us consider as an analogy the sonic building blocks of language, beginning with the phoneme. A phoneme may be defined as "any of the perceptually distinct units of sound in a specified language that distinguish one word from another, for example *p*, *b*, *d*, and *t* in the English words *pad*, *pat*, *bad*, and *bat*."[46] A phoneme is an irreducible phonological unit and a fundamental component of a language. (We could consider a single pitch as a musical phoneme.) One phonological level up from phonemes are morphemes. A morpheme is defined as "a meaningful morphological unit of a language that cannot be further divided (e.g., *in*, *come*, *-ing*, forming *incoming*)," and "a morphological element considered with respect

[45] See, for example, Edwin Gordon, *Learning Sequences in Music* (Chicago: GIA Publications, 2007). Similarly, Bruce Benward, in *Sightsinging Complete*, 2nd ed, (Dubuque: W. C. Brown, 1973), vii, says "Experienced musicians often speak of the "hearing eye" and the "seeing ear." What they are describing is a definition-defying sense of musical awareness, a sixth sense of auditory-visual kindred ship." Michael R. Rogers, in *Teaching Approaches in Music Theory: An Overview of Pedagogical Philosophies*, 2nd ed. (Southern Illinois University Press, 2004), 100, cites Benward's expression and says, "the sound-into-notes and notes-into-sound transference . . . might even more aptly be described as developing the *understanding* ear and the hearing *mind*."

[46] Online version of the Oxford dictionary, Oxford University Press, 2011: http://oxforddictionaries.com/definition/phoneme. "There are 44 phonemes in standard modern English, evenly divided between vowels and consonants. The phonemes in a word do not correspond to the letters with which we write it. For example, the word *catch* contains five letters: *c* – *a* – *t* – *c* – *h*, but only three sounds: *c* – *a* – *tch*."

to its functional relations in a linguistic system."[47] Thus, while in-com-ing comprises three morphemes, it comprises more than three phonemes.

And, while the analogy is not exact, perhaps we can nonetheless profitably refer to musical sound patterns, or meaningful musical units, as musical morphemes, or melodic cells.[48] By this definition, an interval would be the smallest musical morpheme, since a single pitch has no meaning outside of its relationship to another pitch or set of pitches. To continue this analogy, we might consider a scale as an über- or super-musical morpheme, since most of the possible melodic and harmonic patterns in the tonal system are members of the diatonic collection. And it is the asymmetrical nature of any diatonic scale or mode that allows for both the multiplicity and uniqueness of melodic/harmonic intervals within a key. Seen through this lens, then, the major and minor scales constitute the aural basis of our tonal system.[49]

After years of playing and/or singing major and minor scales and scalar patterns, the ideal music student will have internalized the sound and logic of a scale, such that (to use a common example) if you played all but the last note of an ascending scale, the student would immediately desire that tonic note, and very likely even sing it (correctly). But if one has never fully encoded the sound of the scale and each discrete pitch therein, one has not learned the most basic tonal patterns—the critical difference between whole steps and half steps within a key. The awareness of this asymmetrical arrangement (which gives rise to half steps, tritones, augmented seconds, etc.) further enables us aurally to infer a key and hear our way around a tonal soundscape. Consider, for example, the estimate that 70% of all tonal melodies move by unison, half step, or whole

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[47] Oxford online dictionary: http://oxforddictionaries.com/definition/morpheme?region=us.

[48] Perhaps we can adopt a new term, *muneme*, as the musical analogy to a linguistic morpheme.

[49] From a purely theoretical standpoint, one may view the scale as a cycle of perfect 5ths, brought within the space of an octave; as some combination of pure and/or tempered 5ths and 3rds brought within an octave; as the orderly arrangement of the notes that constitute the three primary triads; etc., but my conceit here is with the scale as the *aural* basis of our tonal system.

step.[50] If a person is congenitally unable to discern the difference between adjacent half and whole steps, he or she is identified as tone deaf, or *amusic*. [51]

As a point of comparison, most people not so afflicted can distinguish differences as small as a quarter tone, and some can reliably distinguish differences much smaller than that.[52] At the same time, psychologist Lola Cuddy has shown that some people who seem to lack this discriminatory ability are not actually tone-deaf, or amusic, but have simply never thoroughly encoded the basic aural schemata of Western tonal music (presumably due to a lack of adequate exposure and training).[53] However, with sufficient

[50] Krista L. Hyde and Isabelle Peretz, "Brains that are Out of Tune but in Time," *Psychological Science* 15, no. 5 (2004), 357. The authors cite Piet G. Vos and Jim M. Troost, "Ascending and Descending Melodic Intervals: Statistical Findings and Their Perceptual Relevance," *Music Perception* 6 (1989): 383–396.

[51] Different neuroscience researchers apply slightly different thresholds to the categorization of this perceptual defect: Psyche Loui, David Alsop, and Gottfried Schlaug define it as the inability to differentiate between tones smaller than a half step in "Tone Deafness: A New Disconnection Syndrome?" *The Journal of Neuroscience* 29, no. 33 (2009): 10217; while Isabelle Peretz, Julie Ayotte, Robert J. Zatorre, Jacques Mehler, Pierre Ahad, Virginia B. Penhune, and Benoît Jutras define it as the inability to differentiate between tones smaller than a whole step, in "Congenital Amusia: A Disorder of Fine-Grained Pitch Discrimination," *Neuron* 33, no. 2 (2002): 189. Peretz points out that one who cannot distinguish between tones and semitones, the building blocks of the musical scales of most cultures, will be severely impaired musically: "We construe that a faulty perception of pitch might bring the development of the entire musical system to a halt. In this perspective, fine-grained pitch perception might be an essential component around which the musical system develops in a normal brain."

[52] Peretz et al., "Congenital Amusia," 188. The researchers are not referring to the employment of quarter tones or microtones in some musical system, but rather the ability of people to discern that two successive notes, at a distance of a quarter tone or less, are different pitches. To see what such a test is like, visit http://www.musicianbrain.com/pitchtest/, from the Music and Neuroimaging Laboratory at Beth Israel Deaconess and Harvard Medical School.

[53] Lola L. Cuddy, Laura-Lee Balkwill, Isabelle Peretz, and Ronald R. Holden, "Musical Difficulties are Rare: A Study of "Tone Deafness" among University Students," *Annals of the New York Academy of Sciences*

exposure and training (as demonstrated by the above-cited experiments), they may still learn to do so. These are the students we are addressing in this paper.

In an Aural Skills class, we typically evaluate a student's ability to audiate notated music by having the student sing it. In order to do so correctly, the student must first have an accurate mental representation of the tune, corresponding to previously learned musical schemata. If the student cannot sing it accurately, that is an indication that the student has not correctly mapped the music's visual representation to its aural presentation. Similarly, if a student cannot notate a passage correctly after hearing it several times, that student has not correctly mapped this aural presentation to its visual and cognitive representation. Many non-vocalist music majors begin college with underdeveloped vocal instruments (especially if they did not sing much while growing up), and believe for that reason they cannot be successful in an Aural Skills class. Unquestionably, singing is an acquired skill, even at a modest level, but unless students have a compromised vocal mechanism, their lack of a *bel canto* voice will not hinder their Aural Skills progress.[54] What *will* hinder them significantly is a lack of appropriate musical schemata and an underdeveloped ability to discriminate between and monitor the notes they sing. Accurate singing requires auditory feedback processing, so that any mismatch between intended and actual sound output can be detected and corrected.[55] That requires that the students possess musical schemata concordant with the music they are being asked to sing or notate in class.

Take, for example, a few common problems arising from this lack of appropriate schemata and / or monitoring systems that most

1060 (2005): 320. See also John A. Sloboda, Karen J. Wise and Isabelle Peretz, "Quantifying Tone Deafness in the General Population," *Annals of the New York Academy of Sciences* 1060 (2005): 255-261.

[54] Obviously, self-consciousness, embarrassment, tension, and so on, can all play a role, and sitting up straight, breathing correctly, warming up, and so on, can be helpful. But I am considering here a different issue, which unfortunately cannot be corrected by those things, and which can hinder the progress of students with naturally beautiful voices as well.

[55] Ofer Amir et al. state: "auditory information is used in a closed-loop system which provides moment-to-moment feedback for the control of vocal production." Ofer Amir, Noam Amir and Liat Kishon-Rabin, "The Effect of Superior Auditory Skills on Vocal Accuracy," *Journal of the Acoustical Society of America* 113, no. 2 (2003): 1102.

Aural Skills instructors likely have encountered. When singing in a minor key, students often have difficulty singing *le-ti*, *ti-me*, or *le-fi*. Taken purely in half steps, none is difficult. *Le-ti* is enharmonically a minor third, *ti-me* is enharmonically a major third, and *le-fi* is enharmonically a major second. But it is the diatonic tonal context that makes such patterns difficult. In context, those intervals are not a minor third, a major third and a major second, respectively, and none of those pairs belong to a simple diatonic triad, nor a half-step, whole-step scale pattern. What makes these patterns difficult to sing correctly is the lack of an appropriate musical schema; the students have not yet encoded those patterns within a diatonic context. If students have not listened to and/or played a lot of common-practice music before entering their Aural Skills class, it is possible they would never before have even heard those patterns in a diatonically-tonal context.

Thus, an Aural Skills program should first determine whether students possess adequate schemata and monitoring skills. For those students who do not, their program should begin with extensive listening to and singing of appropriate well-known tunes in the desired musical grammar, to develop the requisite musical schemata.[56]

And herein lies the next roadblock.

Music-reading difficulties

All standard college-level Sight Singing texts I am aware of assume a certain level of music reading fluency, and begin with notated exercises to be sung. And once again, that is a valid pedagogy in many if not all music departments, at least to a certain extent. But where does this leave the student with minimal music reading and aural comprehension skills? If a student has never encoded the sound of a major scale, for example, seeing it notated will not help the student to reproduce it vocally, because the student does not have the prerequisite aural image. In this respect, our modern notational system is not so different from that of Guido

[56] This may need to occur in a remedial class; in a special section that meets more times a week than the other sections; in a summer session prior to the student's first full-time semester; or in some other arrangement determined by the faculty at each institution. Screening for placement could occur on the days students are auditioning for admission to the program.

d'Arezzo, or even from non-diastematic music, music *in campo aperto:* the notation is merely a reminder of the aural patterns and serves as a roadmap.[57] We may recall that Guido used "Ut Queant Laxis," the hymn to St. John the Baptist, to teach his students the respective positions of *ut, re, mi, fa, sol,* and *la* in the hexachord: he recognized that his students needed to bootstrap up from a known melodic pattern in order for his system of solmization and music reading to be effective.

When we ask underprepared students to read music notation (which they cannot do well) for the purpose of audiating, or hearing internally a musical pattern (which they cannot yet hear) so that they can sing it in rhythm (especially while conducting), we place an insurmountable barrier before them; many students give up before they have even begun. Consider again a reading analogy:

> [A] child must commit the forty phonemes of [the English] language to memory so that he is able to skip the mental "sounding out" phase and effortlessly jump to visualizing the whole word as he reads. . . . On the other hand, poor readers typically get stuck in the sounding-out phase because, for various reasons, they have not adequately learned their phonemes.[58]

The same applies to reading music. Students who have not yet encoded basic melodic patterns cannot sing them back fluently; they are stuck in the sounding-out phase. They should therefore not proceed in Aural Skills before having the correct aural images and a reasonably developed monitoring ability. Similar to the Suzuki method, or to the acquisition of any language, sound should precede symbol decoding—that is, singing from notation, or sight-singing, should be delayed until students can hear basic musical patterns and sing them back correctly, first on neutral syllables (to focus on monitoring), then solfège syllables (to attach functional significance). And, like Guido, we should start with music that is familiar to the students, to assist in the development of their schemata and monitoring ability.

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[57] The term *in campo aperto* means "in an open field," and refers to early neumatic notation in which there are no staff lines at all, just relative positions of neumes. See, for example, Richard H. Hoppin, *Medieval Music*, (New York: W.W. Norton, 1978), 59.

[58] Perlmutter and Colman, *Raise a Smarter Child*, 75.

This approach necessitates compiling and grading accordingly a body of music literature that can be used in Aural Skills classes, music that in one way or another pervades our culture, as does "Happy Birthday"[59] or "Twinkle, Twinkle, Little Star"— music to which most students will have had at least some exposure. This music may consist of children's songs, folk songs, movie music (for example, "Do-Re-Mi" from *The Sound of Music*), jazz standards, pop music, holiday songs, patriotic songs, and popular, well-known classical pieces (such as the "William Tell Overture," and Pachelbel's "Canon").[60] As Loui demonstrated in her above-discussed study, by using music that the students already know, musical patterns and principles can be extracted and learned much more readily than when trying to extract principles from unfamiliar repertoire, whose grammar and syntax has not been fully internalized. Well-known children's songs and folk songs are therefore ideal for establishing the basic scaffolding because they contain multiple iterations of standard tonal patterns, providing the repetition necessary for developing schemata.[61] When Holt and Kysilka discuss effective teaching strategies and say: "Patterns are repeated classification systems," they are describing schema formation.[62]

Additionally, it is best to use primarily songs with text (a feature of virtually all children's songs, folk songs, patriotic songs, and so on), because the processing of text engages a different part of the brain than does music alone, thereby bringing increased

[59] According to the 1998 *Guinness Book of World Records*, "Happy Birthday" is the most recognizable song in the English language, followed by "For He's a Jolly Good Fellow" and "Auld Lang Syne." The song's lyrics have been translated into at least 18 languages. *Guinness Book of World Records*, (Guinness Publications, 1997), 180. http://books.google.com/books?id=H-oSAQAAMAAJ.

[60] Many of these pieces appear in early method books, so students who have had any lessons on an orchestral instrument or on piano will have encountered a number of them already. I have included a selected list of such songs in Appendix 1 at the end of this article.

[61] There are many song book collections one could use for this purpose, including the two volumes of *Get America Singing . . . Again!* (Milwaukee, WI: Hal Leonard Corporation, vol. 1, 1997; vol. 2, 2000), a project of the Music Educators National Conference, edited by Pete Seeger (who was the Honorary National Chair of the *Get America Singing . . . Again* campaign).

[62] Holt and Kysilka, *Instructional Patterns*, 20.

brain power to the task.[63] Similarly, conducting should be taken up immediately because that engages the motor cortex as well. Conductor Peter Perret, citing the work of neuroscientist Joaquín Fuster, explains that "new tasks and concepts are learned efficiently when instruction involves frequency, intensity, cross-training [of brain hemispheres], and motivation and attention." He goes on to quote Fuster: "Contiguity, repetition, and emotional load seem to be the most decisive strengtheners of synaptic contact in the making of a cognitive network."[64] [65]

Another advantage of using such songs (as, for example, "Hot Cross Buns," "Mary Had a Little Lamb," "Lightly Row," "Jingle Bells," "Little Brown Jug," "America the Beautiful," "Auld Lang Syne," and "Battle Hymn of the Republic," to name just a few), is that many of them begin on *mi* or *sol* (whereas the beginning exercises in many sight-singing books begin solely on tonic), so students become accustomed to that immediately, as a normal course of events. And, because they already know the song, they automatically hear a tonic and tonal context in their head before they even begin to sing the text—they do not have to first establish a tonic and then find *mi* or *sol*, as they would in an unfamiliar song. It is a much more holistic process.

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[63] This continues to be an effective strategy when introducing more difficult topics, as, for example, chromatic passing and neighbor tones.

[64] Perret, *Well-Tempered Mind*, 136, quoting from Joaquín M. Fuster, *Cortex and Mind: Unifying Cognition* (New York: Oxford University Press, 2003), 11-16, 82. Fuster is Professor in the Department of Psychiatry and Biobehavioral Sciences at the School of Medicine, Director of the Cognitive Neurosciences Laboratory in the Neuropsychiatric Institute, and Member of the Brain Research Institute, at the University of California, Los Angeles. The term "emotional load" may be understood to refer to the level of emotional arousal being experienced by an individual.

[65] Pertinent to our discussion, a 1969 study that divided 144 sixth-grade children into two groups found that the "group which showed the greatest gain in accuracy of scale-singing was that which practised [sic] selected songs, rather than scales." Quoted in Graham F. Welch, "Poor Pitch Singing: A Review of the Literature," *Psychology of Music* 7, no. 1 (1979): 54-55. While there was no discussion of it in the study, perhaps the use of text in the songs and/or the use of engaging melodic patterns contributed to more robust learning than just singing scales.

A few simple examples illustrating this approach should suffice. As a beginning exercise, students could tap and sing, then conduct and sing, "Hot Cross Buns" (learning it by rote if they did not already know it). The simultaneous tapping/conducting and singing of text engages the motor- and text-processing parts of their brains (the so-called hemispheric cross-training referred to above),[66] thereby creating a more robust neuronal network than would be possible by singing just the pitches. Next, students should sing the song on a neutral syllable, allowing them to focus solely on singing the correct pitch, without the distraction of a text.

Once the desired tonal patterns have been learned aurally, moveable-do solfège syllables or scale degrees should be substituted for the song's lyrics, so that students consciously encode the associated functional syllables or scale degrees with the melodic cells (in this case, *mi*, *re*, *do*, and *do*, *re*, *mi*).[67] In the early stages, the instructor should sing the song on solfège syllables and have the students echo-sing it.[68] Eventually, the students should determine the syllables themselves and progress directly from singing the text to singing on functional syllables. Students should be monitoring their output carefully right from this beginning stage; it is critical that these patterns (and all subsequent patterns) be encoded correctly.[69]

[66] Other physical actions, such as the use of Kodály hand signs, may also be incorporated. Kodály adapted his hand signs from John Spencer Curwen, who himself borrowed from an earlier music teaching system known as Norwich Sol-fa, devised by Sarah Glover. An informative and accessible online site for information about Kodály is the *Classics for Kids* site: http://www.classicsforkids.com/teachers/training/handsigns.asp.

[67] We should bear in mind that this may well be the first time these students engage in any formal musical activity in which they are consciously associating pitches with scale degree functions, especially where sound precedes symbol. If students had prior experience singing in a choir or playing in a band or orchestra, they likely read from a score but never knew what their part sounded like before someone sang or played it for them, or they themselves played the notes on their instruments.

[68] We should remain mindful of the fact that having memorized the melody of a simple children's song, even with syllables attached, does not mean a student understands the actual mapping of syllables to pitches, as we saw from the experiments described above (Loui et al., "Humans"). There needs to be a sufficient number of exemplars, sung with syllables, for each pattern to be encoded.

[69] If students are having difficulty, they can try singing with the piano, or singing along with the instructor. The instructor should also model

Finally, students should look at a notated version of the song while singing it on solfège syllables, thereby attaching a visual representation to their now-accurately-encoded aural representation. This now engages both the text-processing and the more abstract symbol-decoding parts of their brains, in addition to the auditory and motor cortices. It is helpful to repeat this exercise in several keys so students practice associating this aural image to several notated versions, increasing their fluency reading in different keys. After completing several examples this way, students can be given short exercises to practice the newly-introduced melodic cells, and finally be given similar patterns to sight-sing in various keys.[70]

Similarly, to learn, for example, "la" in relation to "sol" in a melody, one can first practice singing "Twinkle, Twinkle Little Star," "Shortnin' Bread," "Looby Lou," "Frére Jacques," or "Happy Birthday" (or other similar songs) before incorporating that pattern into an unknown piece. For ascending and descending tonic triads, one can first practice "Taps" and "Row, Row, Row Your Boat," and so on. At a somewhat more advanced level, students can sing "Sailing, Sailing," or the beginning of "White Christmas," for an introduction to chromatic neighbor tones.[71] Even if students have never thought explicitly about the tonal patterns comprising these melodies, likely those tonal patterns or schemata are encoded and can be called upon

how to reproduce pitches accurately, by pointing out things like repeated notes, notes returning after a few intervening pitches, and so on.

[70] I have used this approach with great success in a trailer section of Aural Skills 1, in which almost all the students had already failed the course, and almost all came into the course with very weak skills. By the end of the semester, these students, overall, performed better than any Aural Skills 1 course I have taught, and none of them failed. (One class even adopted "Shortnin' Bread" as its theme song.) I also employed a similar methodology in the dictation component of this class.

[71] I have had success introducing chromatic notes in this way, whereas in the past, chromatic notes have always been a terrible struggle for many students. In one class, I had a number of singers who were fans of Broadway musicals, so I used "Bibbidi-Bobbidi-Boo," "Do-Re-Mi," and "Sixteen Going on Seventeen." These students could all sing the melodies quite accurately, so attaching the new solfége syllables was akin to learning a new set of lyrics to a melody they already knew, without even realizing it was chromatic. "Night and Day" also worked well because many of the students sang and played in jazz ensembles and were familiar with this song. Thus, the anxiety that typically accompanies the introduction of chromatic notes was significantly reduced.

easily and used as archetypes for learning future songs. And for those students who might not already know them, these songs can easily be taught by rote precisely given their simplicity, brevity and repetitions.

And brevity leads to the final point.

It is the manipulation of information in short-term, or working memory (i.e., the explicit learning of tonal patterns with functional syllables) to form new relationships with information in long-term memory (previously-learned songs containing those patterns) that creates new knowledge: we build upon extant neuronal networks to create newer, more complex networks.[72] When teaching, we are working to make the various tonal patterns become part of our students' long-term memory, so we must resist the temptation to overload working memory (which can hold 7 ± 2 pieces or chunks of information[73]), or we are shoving out pieces of information as quickly as we are shoving more in. The more one tries to hold in working memory, the less ability one has to focus on what is most important.[74] We need to help our students build a firm foundation, and that requires concentrated attention on their part; thus, we need to allow our students to work with small chunks of information, in order to solidify each one in turn.

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[72] Zull, *Art of Changing the Brain*, 185.

[73] George A. Miller, "The Magical Number Seven, Plus Or Minus Two: Some Limits on our Capacity for Processing Information," *Psychological Review* 63, no. 2 (1956): 81-97.

[74] Zull, *Art of Changing the Brain*, 184, and footnote 2, p. 201. See also Jenny R. Saffran, Richard N. Aslin, and Elissa L. Newport, "Statistical Learning by 8-Month-Old Infants," *Science* 274, no. 5294 (1996): 1926-1928.

Conclusion

When incoming students have limited training and exposure to common-practice music, they often have underdeveloped musical schemata for that sophisticated musical vocabulary, grammar, and syntax. We should therefore choose teaching materials that do not depend upon a great deal of familiarity with that Classical repertoire, but rather, materials that are familiar to the students and that can coexist with that repertoire: materials that can teach the patterns, grammar and syntax of Classical music, as well as some of the more popular musical genres that students will continue to encounter (many of which share that vocabulary, grammar, and so on, though not explicitly enough for many students to recognize without guidance). These materials will build a foundation to support more sophisticated learning.

To provide that support, the chosen materials should meet the following criteria:

1. the music should be well-known to the students, so that it has been previously encoded;
2. the musical examples should be relatively short, so as not to overload working memory;
3. the music should contain short, repetitive melodic patterns to satisfy the need for both brevity and repetition;
4. the music should possess text so as to engage linguistic processing as well as audio processing for cross-hemispheric training.

As shown above, children's songs, folk songs, patriotic and holiday songs, and some popular music, can serve as the perfect exemplars for inculcating the basic musical patterns and grammar that are the goals of both the Aural Skills course, and the people teaching it.

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Appendix 1

What follows is a selection of songs that may be used to support the approach discussed in this paper.[75] Many other such songs could be used as well.

I have arranged the songs into two basic groups: songs whose melodies are completely diatonic, and songs whose melodies contain some chromaticism (whether decorative chromaticism, chromaticism outlining secondary dominants, modal borrowing, and so on).

For the melodies listed in the diatonic group, some portions of the melody may be appropriate at a beginning level, while other portions may not be, such as when the harmonization contains secondary dominants that would tend to obscure the sense of tonic. Thus, one may choose to use just a phrase, or just the verse, and so on, to practice a specific melodic pattern. For instance, the melody for "Pop Goes the Weasel" is completely diatonic, and the first four measures (the first two lines of text) are ideal as an example outlining the tonic triad (with a passing tone, *re*, between *do* and *mi*). However, the B section of the song contains secondary dominants, so would not be appropriate at this level, but could be used at a more advanced level.

Conversely, some of the melodies listed in the chromatic group have phrases or sections that are entirely diatonic, and those portions would be perfectly suitable at an elementary level. For instance, one may wish to use just the first two phrases of "Deck the Halls" (through the first "fa, la, la" refrain) for basic scale-wise motion, while holding off on the third phrase ("Don we now . . .") until chromatic notes and secondary dominants are introduced.

A final note: In choosing songs, I consider my current students, and try to align my choices with their musical experiences as much as possible, particularly for more advanced examples. Thus, I have included in the list "Sweet Adeline" as a chromatic example including secondary dominants. Initially, that may seem an odd choice, but we recently had a number of students involved in Barbershop singing, so I used that melody with them.

[75] In cases where two or more songs share the same melodies, or very similar melodies, I have listed them together. These songs may also be used for melodic and harmonic dictation.

I. Diatonic Songs	
A Tisket, A Tasket (It's Raining, It's Pouring; Rain, Rain, Go Away)	Jingle Bells
All the Pretty Little Horses	Lavender's Blue
All Through the Night	Lazy Mary
Alphabet Song (Baa, Baa, Black Sheep; Twinkle, Twinkle Little Star)	Lightly Row
Amazing Grace	Little Brown Jug
America (My Country 'Tis of Thee)	Looby Lou
Amsterdam (Once There Were Three Fishermen)	Mary Had a Little Lamb (Merrily We Roll Along)
Au Clair de la Lune (Pierrot)	Michael, Row the Boat Ashore
Auld Lang Syne	Morning Has Broken
Battle Hymn of the Republic (The Ants Came Marching)	Old King Cole
B-i-n-g-o	Old MacDonald
Do Your Ears Hang Low	On Top of Old Smokey
Down by the Station (Eensy Weensy Spider)	Over the River and Through the Woods
Farmer in the Dell (Bow Wow Wow)	Pop Goes the Weasel
For He's a Jolly Good Fellow (The Bear Went Over the Mountain)	Reuben and Rachel
Frére Jacques	Row, Row, Row Your Boat
Ghost of John	Shortnin' Bread
Gilligan's Island (TV Theme)	Simple Gifts
Go Tell Aunt Rhody	Skip to My Lou
Good King Wenceslas	Scarborough Fair
Greensleeves	Shortnin' Bread
Happy Birthday	Supercalifragilisticexpialidocious (*Mary Poppins*)
Heigh Ho, Nobody Home	Taps
Hot Cross Buns	This Old Man (*Barney* song)
Hush Little Baby	Three Blind Mice
I Have a Dog	Wheels on the Bus
I Saw Three Ships	Yankee Doodle

II. Songs Containing Chromatic Notes	
A Spoonful of Sugar (*Mary Poppins*)	Night and Day (Cole Porter)
A Whole New World (*Aladdin*)	Norwegian Woods (The Beatles)
All of Me	One Hand, One Heart (*West Side Story*)
America (*West Side Story*)	Over the Rainbow (*Wizard of Oz*)
America The Beautiful	Sailing, Sailing
Bibbibi-Bobbidi-Boo (*Cinderella*)	Sesame Street (TV Theme Song)
Chim Chim Cher-ee (*Mary Poppins*)	Seventy-Six Trombones (*The Music Man*)
Crazy (Willie Nelson)	Sixteen Going on Seventeen (*The Sound of Music*)
Deck the Halls	Somewhere (*West Side Story*)
Do-Re-Mi (*The Sound of Music*)	Sound of Music, The (*The Sound of Music*)
Down by the Riverside	Star Spangled Banner
Flintstones (TV Theme Song)	Sunrise, Sunset (*Fiddler of the Roof*)
For the Longest Time (Billy Joel)	Sweet Adeline
Frosty the Snowman	Take Me Out to the Balgame
Glow Worm	Tonight (*West Side Story*)
Hey Jude (Beatles)	White Christmas
Maria (*West Side Story*)	Yankee Doodle Boy

Appendix 2

Figures 1 and 2 (including their respective captions) from Psyche Loui, David L. Wessel, and Carla L. Hudson Kam, "Humans Rapidly Learn Grammatical Structure in a New Musical Scale," *Music Perception* 27, no. 5 (2010): 377-388. © 2010 by the Regents of the University of California. Published by the University of California Press, and used by permission.

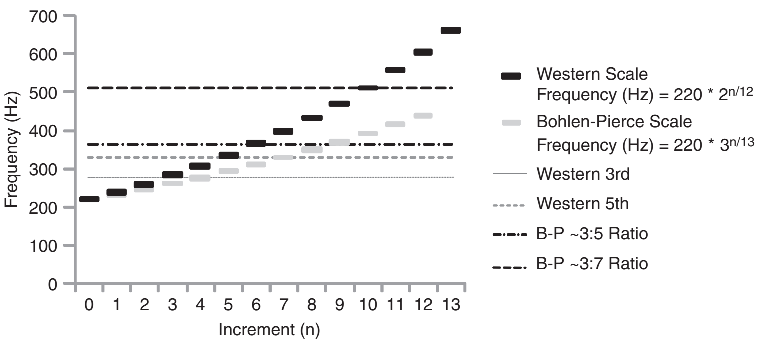

FIGURE 1. Frequencies along the Bohlen-Pierce scale compared to the Western scale. One cycle of each scale is shown in the figure. The starting point of the two scales is the same (220 Hz) and both scales are equal-tempered, thus making them analogs of each other except for the intrinsic differences in base and recurrence ($2^{n/12}$ vs. $3^{n/13}$). The horizontal dotted and dashed lines represent major third and perfect fifth intervals in the Western scale and approximate 3:5 and 3:7 intervals in the Bohlen-Pierce scale.

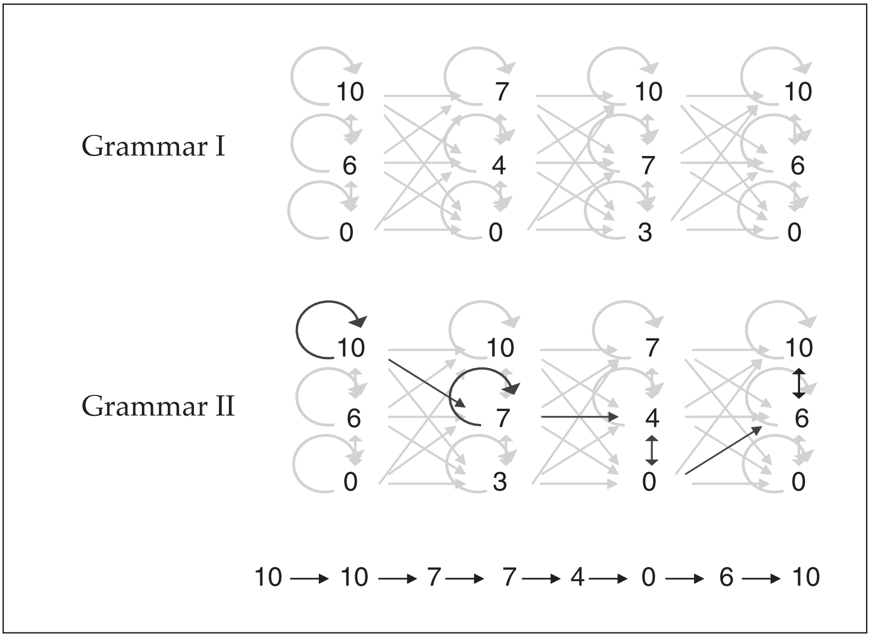

FIGURE 2. (A) A diagram of the finite-state grammar illustrating the composition of melody from harmony. Each number represents n in the Bohlen-Pierce scale formula in Figure 1a. Legal paths of each grammar are shown by the arrows. (B) The derivation of one melody from one of the two grammars. Dark arrows illustrate the paths taken, whereas light arrows illustrate other possible paths that are legal in the grammar. The resultant melody is shown at the bottom of the figure.

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