The Power of Prediction: Ear Training and the Scientific Method

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Introduction

"Ear training can't be taught, but it can be learned." I no longer recall where I first heard this, but I think about it every time I make the claim that I *teach* ear training. It haunts me when I send my students to the practice room in hopes that drilling intervals will help them pass their next sight-singing quiz, knowing all the while that this is probably the worst way to approach the problem. And the results of the next quiz confirm my suspicion that I am on the wrong track. What is going on here? Surely, there is a better way. How can we help our students learn to listen? If we are unable to teach ear training, how can our students learn it?

In this article, I offer a pedagogical approach based on the scientific method; consider ear-training goals and objectives; and present three exercises from my classroom, while arguing for the power of prediction in the perception of music.[1]

The Scientific Method

Several years ago, I collaborated with a colleague in the Physics Department at Muhlenberg College. We designed a Physics of Music course that would be team-taught, music-centric, and experiential. For many of our laboratory activities, we employed the

[1] A note on the exercises: While the exercises that follow are appropriate for music majors and minors in first-year theory at the liberal arts college where I teach, they are easily adaptable to other levels, and I provide some suggestions for modifying the exercises. The pedagogical approach described below is transferrable not only to other levels of students but also to other domains both within and outside of music.

Prediction/Observation/Reflection (P/O/R) model of scientific inquiry.[2] The students, most of whom were music majors or minors, found P/O/R a user-friendly and effective method for structuring the experiments we performed in the Physics lab. Students who were initially intimidated by the formulas and calculations used in Physics of Music began to realize that a prediction could be qualitative as well as quantitative, that the outcome could be expressed verbally as well as numerically. The prediction also provided a roadmap (and motivation) for the experiment; the anticipation of their predicted outcome guided the students toward the conclusion of the activity.

Intrigued by this sequence and the results we were getting, I began to wonder if I could use it in my music theory classroom, especially in listening to music. Listening is often our first encounter with music. No one comes to this encounter empty-handed; all listeners bring some prior knowledge to the act. Even young children have likely been exposed to nursery rhymes, and for many of us, "Happy Birthday" is as familiar to us as our first names.[3] Can we harness this prior knowledge?

By mapping P/O/R onto the listening experience, the listener's prior knowledge is explicitly included in the process (*prediction*). In turn, the prediction helps the listener structure the experience: by giving her something to listen *for*, her powers of *observation* are increased. Finally, *reflection* on the results confirms or denies the accuracy of the prediction. Reflection leads to questions, discussion, and the creation of knowledge.[4]

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[2] This and similar sequences are found in a number of science textbooks. See, for example, Priscilla W. Laws, *Workshop Physics Activity Guide, Module I* (New York: John Wiley & Sons, Inc., 1996).

[3] Familiarity does not necessarily equate with understanding, however. Ask your students to sing Happy Birthday with solfege syllables and see how many of them start on "do."

[4] There are similarities between P/O/R and the learning cycle as explained by James E. Zull in *The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of*

I am limiting my discussion to music that possesses a tonal center; for this music, prediction plays the most important role in P/O/R. Tonal music tends to operate according to the parameters of functional harmony. Those parameters can be learned, and that knowledge, in turn, fuels prediction. The role of prior knowledge and prediction in the perception of music deserves additional attention for a moment.

Writing over sixty years ago in *A Composer's World*, Hindemith discusses perceiving music both intellectually and emotionally. At the intellectual level, the listener constructs schemata and compares what is being heard with what was expected. For the listener to be actively involved in this "parallel mental construction," he must have the opportunity to *predict* the course of the music.[5] And the listener's emotional reaction is dependent upon having experienced those feelings previously.[6] At both the intellectual and the emotional level, then, prior knowledge is recruited for the experience.

Peter Rabinowitz also discusses two levels of listening: the *technical*, "the usual fuel for musical analysis," as represented by the music notation, and the *attributive*, "a level that is extra-compositional (although not always extra-musical), and that *precedes* the act of listening itself." This attributive level is the sum of all our prior training and experience, and its formation continues to occur in a dynamic process, even as we listen. As music is

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Learning (Sterling, VA: Stylus Publishing, 2002). Learning occurs when the cycle is complete, and the same can be said for P/O/R. When the reflection refines the next prediction, knowledge is created.

[5] Paul Hindemith, *A Composer's World: Horizons and Limitations* (Cambridge: Harvard University Press, 1952), 17.

[6] Ibid., 39.

processed through this level, it may serve to circumscribe the technical level by causing us to select certain technical aspects as important and to discard others as inconsequential.[7]

In "Listening as Discovery Learning," Alan Marsden describes the model of a system that *predicts* that certain musical patterns will occur, based on knowledge about music in a particular style, and learns in response to input from a particular piece. This is an implication/realization model where learning occurs when the implication is *not* realized as well as when it is. The model then revises its predictions accordingly. Sometimes, of course, composers play with our predictions, subtly altering a musical gesture to incorporate an element of surprise.[8]

Prediction and perception, then, are linked. The difficulty here is that these authors assume a great deal of prior knowledge, a certain level of musical sophistication that our first-year theory students are unlikely to possess. The question becomes how to expose our students to the knowledge that can form the foundation for intelligent, meaningful predictions. In discussing listening, music theory pedagogue Michael Rogers claims that students need a "basic repertoire of memorized patterns" in order to make "predictions based on the most fundamental structural processes and operations of pitch and time."[9]

Acquiring this repertoire begins with written theory and analysis. As Rogers says, "…ear training is primarily *mind* training."[10] For most students, their understanding of the concepts of written theory outpaces the development of their listening skills. But that

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[7] Peter J. Rabinowitz, "Chord and Discourse: Listening through the Written Word," in *Music and Text: Critical Inquiries*, ed. Steven Paul Scher (Cambridge: Cambridge University Press, 1991), 40-41.
[8] Alan A. Marsden, "Listening as Discovery Learning," *Contemporary Music Review* 4 (1989): 336-339.
[9] Michael R. Rogers, *Teaching Approaches in Music Theory: An Overview of Pedagogical Philosophies* 2nd ed. (Carbondale, IL: Southern Illinois University Press, 2004), 19.
[10] Ibid., 18.

conceptual understanding is the crucial first step in building a discerning ear. Integrating written work and ear training creates a feedback loop that supports both analysis and listening.[11] How can we frame our pedagogical approach to meld written work and ear training?

Goals and Objectives of Ear Training

To begin with, ear training is a misnomer. A better term is aural skills acquisition, which is not only more consistent with the idea that "ear training can't be taught" but also more descriptive of what actually happens. The distinction is important because it shifts the focus from teacher to student. We can provide guidance, but the skill is acquired only one way—by the efforts of the acquirer.

Think back to when you learned to ride a bicycle. You had training wheels, right? You got lots of instruction, probably from a parent concerned for your safety, but there was no substitute for getting on the bike and riding off on your own. My philosophy of aural skills training, then, rests on the acquisition piece. I have to supply my students with a set of training wheels, and I build those training wheels out of goals and objectives. As each objective is met, I can raise the wheels a little higher until they can be removed and my students can take to the road on their own. But ultimately, they have to do the work.

I acknowledge the difference between aural skills acquisition in a liberal arts college and a conservatory: most of my students will not go on to be professional musicians. But that does not mean my goals are less lofty; it simply means my goals are not the same as my colleagues at another institution. And goals must be meaningful to each instructor or we

[11] Integration can occur even if the two are taught in separate classes. For more on this, see Rogers, 16-19.

risk losing our credibility. We have to believe in what we are doing; if we do not, our students will quickly unmask us.

For aural skills, I have a single goal for my students: that they learn to connect sight and sound, a skill sometimes called audiation, or aural imagination. Bruce Benward calls this the "seeing" ear and the "hearing" eye.[12] My objectives, then, are in service of that goal.

As I create my objectives, I am mindful that it is the acquirer of the aural skills, i.e., the student, who needs my attention. So I ask myself what I want my students to be able to *do* at the end of the semester/academic year/college experience that they are unable to do now. A sampling of my objectives for the first year of aural skills reveals the following: I want my students to be able to sight-read diatonic melodies, transcribe part of a diatonic melody and provide a musically useful conclusion, and detect changes in a harmonic progression. The examples I provide below illustrate these three objectives. My goals and objectives provide guidance as I design classroom activities, practice sheets, and quizzes.[13] And my objectives are both attainable and measurable so the students can see their progress. A sense of accomplishment will keep them motivated.[14]

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[12] Bruce Benward, *Music in Theory and Practice*, 2nd ed., 2 vols. (W.C. Brown, 1981), I:ix, quoted in Rogers, 100.

[13] A note about materials: Many fine ear-training manuals, sight-singing books, software programs, virtual keyboards, and apps for mobile devices are available. Most of these offer graded levels of difficulty. It may matter less what you use than how you use it; absent meaningful strategies, no rigorously-designed and carefully-authored resource will help your students. The Prediction/Observation/Reflection sequence can be applied to many existing examples and exercises.

[14] Sometimes students are unaware of how much progress they have made, so as we move through the semester, I ask them to look at the exercises we did at the beginning of the term. What seemed insurmountable when it was first introduced is now well within their capabilities. I call this a "pat-on-the-back" moment, and we celebrate how far we have come.

P/O/R in the Classroom

Exercise 1. Sightsinging

A colleague and friend of mine is fond of saying that sightsinging has very little to do with either sight or singing.[15] But it has everything to do with aural imagination, with matching the sound you make with the symbol on the score. And it can help the students with their evolving definition of tonality. Because I want them to hear tonally rather than intervallically, I use interval drill sparingly. Too much emphasis on intervals may interfere with the perception of long-range tonal motion. On the other hand, hearing tonally is likely to be facilitated by the use of scale degrees or solfege syllables (moveable "do") that reflect the function of each tone in the scale.[16]

This is an example of the interplay of written theory and listening skills. Tendency tones are explained in written theory. But only if they are reinforced aurally will the students develop a sense of melodic motion. I like to play a major scale on the piano, stop on the leading tone, and walk away. Before I have taken two steps, they are singing tonic, and it is only the second week of classes!

And choosing sightsinging examples that illustrate written concepts brings the written work to life. Join me in my classroom as we apply P/O/R to a sightsinging exercise that uses suspensions.

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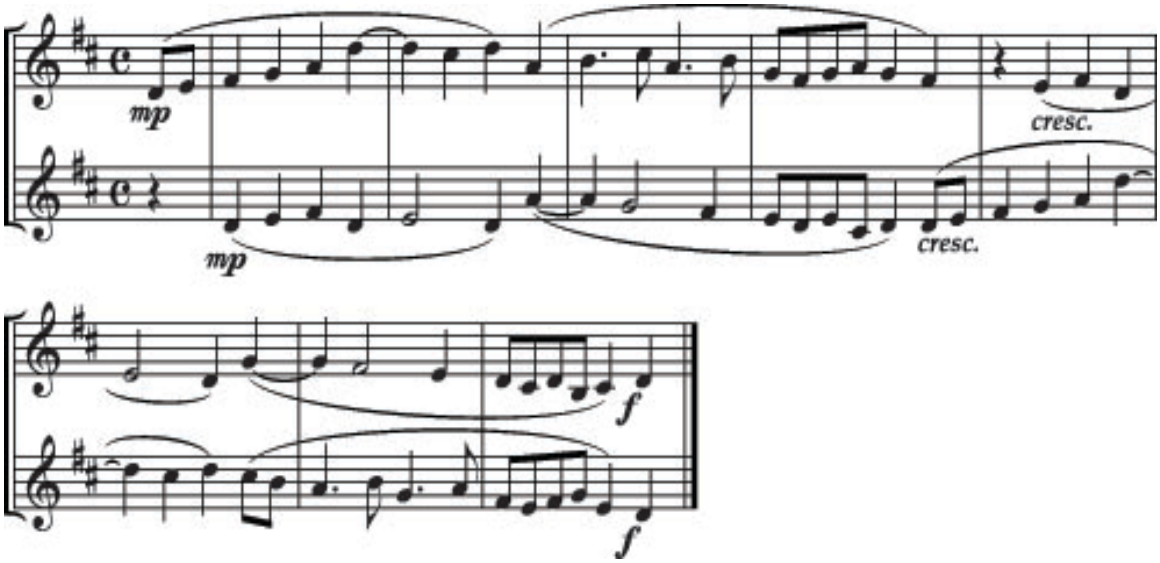
[15] Thanks to Dr. Toby Rush at the University of Dayton for this turn of phrase.

[16] We use both scale-degree numbers and solfege syllables at my institution. I have no preference, as I believe both incorporate tendency tones and tonal function, but solfege syllables are more "singable" and usually result in a more pleasing sound. If chromatic solfege is used, you have the additional benefit of a different syllable for chromatic inflections that heightens the sense of scale-degree functionality.

Music is playing as the students arrive for class. They talk quietly because they know that the topic of the day is embedded in the tune for the day. We have been learning about stepwise non-chord tones, and today we will talk about suspensions. Together we list the features of suspensions, I notate examples at the board and play them at the piano, and the students work a few of the exercises in their workbooks. To strengthen the connection between written skills and aural skills (and to invigorate the students for the remainder of the 75-minute class), we take out our sightsinging books and turn to this example:[17]



The students correctly anticipate that the example will contain suspensions. They go on to make additional *predictions*: that each suspension will involve a tie or a repeated note, that it will likely occur in the top voice, that it might be hard to sing because of the dissonance. Some of them will be able to locate the suspensions in the score. We then sing the duet, first one line at a time and then the two voices together. The students *observe*,

[17] Reprinted from *A New Approach to Sight Singing, Fifth Edition* by Sol Berkowitz et al. Copyright © 2011, 1997, 1986, 1976, 1960 by W.W. Norton & Company Inc. Used with permission of the publisher. This example is no. 49 on p. 221.

both visually and aurally, how the suspensions operate in this example. Finally, we *reflect* on what happened. Was the suspension prepared and how? Was it hard to hold onto your part when your partner was singing what sounded for a moment like a wrong note? Did the suspension resolve down? By step? Was this what you expected?

Most students have heard suspensions before today's discussion, even if they had no label for them, so there are usually few surprises in this example. Their predictions play out, and they delight in each dissonance and its resolution. But P/O/R has given them a method to employ for their next sightsinging example and a heightened sense of tension and release that is now available to them for future predictions. The next example encourages creativity while calling on pattern recognition.

Exercise 2. Melodic Dictation

The likelihood of any student having a future encounter with a dictation quiz is slim, so taking dictation is not the objective. But the ability to transcribe a melody is a useful skill for our students, whether they want to cover a popular song by their favorite artist or are arranging for their *a cappella* group or pep band.[18] As the flip side of sightsinging, dictation is another way to connect what we hear with what we see. And the possibilities for prediction are plentiful.

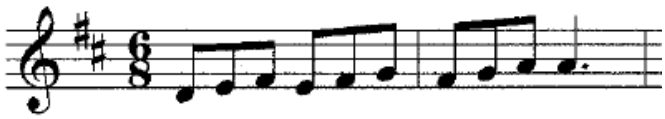
As Rogers says, "One of the most important principles in dictation is the concept of intelligent guessing. It is in this area that the use of both mind and ear become especially well coordinated. Where actual hearing fades out (from lack of attention, lack of perceptual

[18] A discussion of copyright issues is beyond the scope of this article, but we talk about intellectual property and I remind my students that they may one day be the beneficiaries of the protections that copyright law provides.

acuity, failure of memory[19], or complexity of the music), the mind can often take over by making *predictions* [emphasis mine]. . . Analysis and experience with dozens of similar patterns (this is where *thoughtful* drill and repetition can play a role in acquiring a storehouse of knowledge) will help to discover what must have happened in those blanks on paper and in the memory."[20]

I find that students have more difficulty with rhythm, particularly compound meter, than with pitch when taking dictation, so my response to Rogers' call for "*thoughtful* drill and repetition" returns me to the bicycle analogy I used earlier. I give my students a set of training wheels: a handout of some of the most common rhythmic patterns in music. I allow them to refer to it when we first begin dictation exercises, giving them time to construct the mental models that will help them later on. We encounter this example as one of our first dictation exercises, so the training wheels are still very much in evidence.

I play this for my students:



We work through this part of the exercise together. As with most dictation at this point in the semester, we are in groups at the boards so the students have the support of their peers as they work to develop this skill. The students will sketch out the rhythm above the staff and notate the most important pitches, usually tonic and dominant. I then

[19] For a discussion of the role of short-term memory and expectation in melodic dictation, see Gary S. Karpinski, *Aural Skills Acquisition: The Development of Listening, Reading, and Performing Skills in College-Level Musicians* (Oxford: Oxford University Press, 2000), 65-77.
[20] Rogers, 116.

ask the students to sing the melody back to me using scale degrees, and once they can do that, I ask them to notate it. Their instincts tell them that the tune is incomplete, so I ask them to imagine how this melody might continue. Can they employ Rogers' "intelligent guessing" to *predict* the second part? They notate some possibilities. (I will leave it to you to imagine those possibilities.)

At this point, the groups offer their compositions to the class for performance. We *observe* by playing and singing several examples, and each group votes on a favorite and justifies that choice.[21] The *reflection*, a discussion of the top and bottom vote-getters, reveals something about the students' understanding of compound meter and melodic sequences, but it also tells them something else: that they have an innate awareness of what it takes to bring this melody to a satisfying conclusion. The term "musically meaningful" begins to acquire significance for them.[22] They are now able to predict the future course of a passage of music, and they are better prepared for the moments when a composer will either fulfill or frustrate their expectations.

Exercise 3. Harmonic changes

This exercise is a variation on error detection.[23] It vividly illustrates the connection between written theory and aural skills by demanding that the students draw on their knowledge of the logic of harmonic progressions and the riches of the pre-dominant area.

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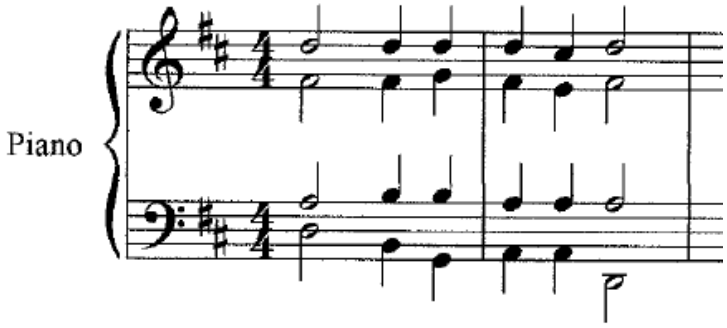
[21] You may get some examples that simply do not work, but these can create "teachable moments" as you talk about why. As I stated earlier when discussing Alan Marsden's article, learning occurs not only when the expected happens but also when it does not.

[22] I revisit this exercise later in the theory sequence to illustrate antecedent and consequent phrases.

[23] For more on the skill of error detection, see Stacey Davis, "Error Detection in the Aural Skills Class: Research and Pedagogy," *Journal of Music Theory Pedagogy* 24 (2010): 37-67.

I give my students the following progression:



I tell them I will be making changes in this progression, and their job will be to identify where and what the changes are. To *predict* what I will do, the students begin by analyzing the progression with Roman numerals. They are amused by my obsession with deceptive cadences, so they predict that vi instead of I will follow V. And most of them will turn their attention to the pre-dominant area and predict that the IV chord will be transformed into a ii chord. They may also anticipate the addition of a seventh to the dominant. If this example occurs when they are expanding their harmonic vocabulary, they may predict chromatic chords: a secondary dominant, a borrowed ii^{o}, or even a German augmented sixth.

I play the original as they are analyzing it and again after they have made their predictions. Then I play the changed version, and they *observe* what I have done. The deceptive resolution is obvious; the new pre-dominant less so. To help them isolate and compare chord qualities, I once again play the original progression followed by the changes. As we *reflect*, the power of prediction becomes apparent. While the changes are relatively easy to detect—neuroscience tells us that the brain thrives on change—the specifics of the change may not be so obvious. But even the students who struggle to hear

chord qualities can make a solid prediction based on their understanding of the logic of harmonic progressions. And to further underscore that point, I will return to this type of exercise later, but this time I will not play the original. The only thing I will play is the changed version. Their ability to "hear" the changes will be completely dependent on a robust prediction.

Conclusion

Prediction/Observation/Reflection, then, is a means to an end. The ear senses; the mind perceives. By beginning with prediction, P/O/R links the perceptual with the conceptual by marrying listening skills to written theory. And it has the further advantage of being adaptable to a variety of situations: it works from short, simple pairs of cadence chords to long, complicated structures replete with chromaticism.

I began this article with a quote: "Ear training can't be taught, but it can be learned." My reader understands by now that I am in no way abdicating my responsibility as a teacher. I believe that my job is to empower my students so they will embrace their roles as acquirers of aural skills. The payoff is not only an "A" in music theory. It is also a lifetime of hearing music, not just sound; of finding joy and meaning in the listening experience; and of understanding the power of prediction to affect our perception of the music we hear.

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