# Statistical Learning in the Music Theory Classroom: Lessons from Teaching Classical Form and Galant Schemas

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This article argues that statistical learning can and should be harnessed as a core pedagogical strategy in the music theory classroom. Statistical learning describes the largely implicit process by which learners extract patterns and regularities from repeated exposure to structured stimuli. This mechanism is widely acknowledged as central to how listeners acquire musical style outside the classroom, but it has rarely been treated as a deliberate pedagogical resource within formal music theory instruction. By explicitly centering statistical learning, instructors can design pedagogies that are more effective and grounded in lived musical experience. The article begins by distilling pedagogically salient findings from the statistical learning literature. I show that a pedagogy centered on statistical learning involves not only immersive exposure, but also the use of naturalistic, cue-rich materials calibrated to balance novelty and familiarity, as well as assessments that emphasize prediction and judgment over knowledge reproduction. I then demonstrate the efficacy of these principles through two example lessons: one in which students sketch a two-part exposition in response to brief symphonic excerpts, and another in which students develop fluency with the Do-Re-Mi schema through a sequence of listening, composition, and comparative judgement tasks. Through these examples, I show how statistical learning supports the development of intuitive musical understanding while also furnishing a robust substrate for explicit analysis, evaluation, and creative practice.

Whenever I introduce sonata form, I always begin with the following prompt: "What happens when you go to a restaurant?" The decidedly nonmusical question catches many off guard. Trepidatiously, though, students trickle in a few familiar episodes like sitting down, eating food, and paying the check which the rest of the class fills in at an an-ever increasing pace. After a few short minutes, students have assembled a remarkably complex picture of restaurant experiences.[1] They grasp intuitively that eating at a restaurant involves hierarchically nested event sequences and interweaving long- and short-term goals: to eat food, for instance, one must first order that food, which means one has probably read a menu, which entails that one

1 Their sketch is typically substantially similar to the mental representation of restaurants sketched in Roger C. Schank and Robert P. Abelson, *Scripts, Plans, Goals and Understanding: An Inquiry into Human Knowledge Structures* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1977).

has previously acquired a menu to read, etc. With a sufficiently detailed sketch of the restaurant experience assembled, I conclude this prefatory exercise by asking students how they learned this complicated event structure. Did they get it from a textbook, or had they all taken "AP restaurant theory" at some point? No, they tell me, their understanding comes directly from their lived experience: they've gone to restaurants countless times throughout their lives, and so this event structure, down to its minutiae, is second nature to them.

This opening activity shows students that they possess a great deal of intuitive knowledge about *scripts*, our schemas or mental snapshots for, in Roger Schank and Robert Abelson's definition, the "predetermined, stereotyped sequence of actions that define a well-known situation."[2] This is a useful starting point because, as scholars like Robert Gjerdingen and Leonard Meyer have emphasized, much of our knowledge about musical form is packaged into scripts.[3] Sonata form in particular has received a great deal of attention for its highly scripted nature, its formulaic arrangement of conventional musical materials anchored to predictable cadential goals.[4] By beginning a unit on form with a discussion of restaurants, then, students are able to link a critical component of their everyday thinking—the ability to recognize a familiar event and predict what will happen within it—to the perceptual task of hearing a conventionalized musical form.

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2 Schank and Abelson, *Scripts, Plans, Goals and Understanding*, 41. While the term "script" has gained a strong foothold in music theory discourse, within the cognitive science literature, the term is just one of several describing schematic memory for events or scenarios. Other terms with synonymous meanings include "prototypical scenario," "structured event complex," and "event schema." See George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind* (Chicago: University of Chicago Press, 1987), 284-6 and 397; Jacqueline N. Wood and Jordan Grafman, "Human Prefrontal Cortex: Processing and Representational Perspectives," *Nature Reviews Neuroscience* 4 (February 2003): 142-3; Gabriel A. Radvansky and Jeffrey M. Zacks, *Event Cognition* (Oxford: Oxford University Press, 2014), 124-7; and Christopher Baldassano, Uri Hasson, and Kenneth Norman "Representation of Real-World Event Schemas During Narrative Perception," *Journal of Neuroscience* 38 no. 45 (2018): 9689-9699.

3 Robert Gjerdingen, *A Classic Turn of Phrase: Music and the Psychology of Convention* (Philadelphia: University of Philadelphia Press, 1988); Leonard B. Meyer's *Style and Music: Theory, History, and Ideology* (Chicago: University of Chicago Press, 1989).

4 Vasili Byros, "'*Hauptruhepuncte des Geistes*': Punctuation Schemas and the Late-Eighteenth-Century Sonata," in *What is a Cadence? Theoretical and Analytical Perspectives on Cadences in the Classical Repertoire*, ed. Markus Neuwirth and Pieter Bergé (Leuven: Leuven University Press, 2015), 222-229; James Hepokoski, "Sonata Theory, Secondary Themes and Continuous Expositions: Dialogues with Form-Functional Theory," *Music Analysis* 35 no. 1 (2016): 50.

But while the scripted nature of sonata form has featured prominently in recent scholarship, the key pedagogical takeaware is how such scripts are typically acquired—not through formal instruction, but repeated exposure. Most scripts, that is, arise from *statistical learning*: the intuitive, often unconscious process by which humans discern regularities and patterns from their experiences. "Just like you all have developed incredibly rich knowledge about how restaurants work through repeated experiences," I tell students, "we can imagine that eighteenth-century listeners picked up knowledge about how their symphonies worked through repeated listenings." Hence the day's central activity: in the vein of what Anjni H. Amin, following Sarah J. Bartolome, has called a "Virtual Field Experience," I immerse students in an eighteenth-century symphonic environment and invite them to inductively build a script for what they hear.[5] To stimulate statistical learning, I deliberately avoid many of the traditional strategies for introducing sonata form, introducing no new terminology and favoring brief encounters with many examples over in-depth analysis of a few. In other words, I trust that students don't need me to explain sonata form upfront; with attentive listening and sufficient exposure to a representative corpus, they are fully capable of learning its norms for themselves. I will provide more detail on this lesson later, but I note here that, having implemented this activity across a range of courses, I have found that beginning the study of sonata form with musical immersion and statistical learning consistently yields knowledge that is not only more detailed, but also more intuitive and approachable than what traditional methods typically produce. Whether conducted in the context of a graduate seminar, the undergraduate music theory core, or even an introductory music course for non-majors, the results are largely the same: no matter their degree of incoming knowledge, students leave the class with a rich understanding of sonata norms that feels every bit as immediate and intuitive to them as their every-day knowledge of restaurants.

For pedagogues, statistical learning seems almost too good to be true. The notion that simply exposing students to a large body of music enables them to automatically and unconsciously develop rich knowledge about it can feel like snake oil—or, as Elizabeth Margulis playfully puts it, "a TV commercial for a machine that 'exercises' your abs while you lie about and read."[6] Indeed, despite the strong backing of empirical

5 Anjni H. Amin, "Hindustani *Tāl*: Non-Western Explorations of Meter," in *The Routledge Companion to Music Theory Pedagogy*, ed. Leigh VanHandel (New York: Routledge, 2020), 78-84; Sarah J. Bartolome, "Virtual Field Experiences for Real Music Classrooms," *Music Educators Journal* 96 no. 1 (September 2009): 56-9.

6 Elizabeth Margulis, *On Repeat: How Music Plays the Mind* (Oxford: Oxford University Press, 2014), 106.

evidence and the fact that statistical learning is (obviously) a kind of learning, few educators have examined how the concept might be practically implemented in the music theory classroom.[7] Perhaps this stems from a perceived opposition between statistical and classroom learning, what we might colloquially describe as the difference between "street smarts" and "book smarts."[8] Statistical learning, that is, is often understood as the unguided, intuitive process by which we almost passively absorb patterns from our surroundings, often without being able to articulate just what it is that we've learned. Classroom learning, by contrast, is structured, explicit, and designed to teach articulable knowledge that we *cannot* easily learn on our own. Put simply, we typically see classroom instruction as beginning where statistical learning ends.

There are, however, good reasons to pay attention to statistical learning. For one, it is already happening, whether instructors are aware of it or not. Students experience a great deal of music in their theory classes, and this exposure not only increases processing fluency as they unconsciously internalize subtle event probabilities, it also legitimates that music, shaping their sense of what is or isn't worthy of curricular inclusion.[9] Music theory's "hidden curriculum"—its teaching of European superiority "indirectly through course material, examples, or pedagogical focus"—can thus be understood as a type of statistical learning: it is a tacit attunement to the statistical prominence of particular musical traditions within the academy.[10] Additionally, scholars in the field of second language pedagogy and applied linguistics have devised several classroom interventions that harness the power of statistical learning, calling attention to the myriad pedagogical reorientations that fall out of the experimental literature. They have shown that building pedagogies around statistical learning involves more than exposing students to a variety of examples, it also depends on

7 A notable exception, discussed later in the article, is Brian Edward Jarvis, "Hearing Harmony Holistically: Statistical Learning and Harmonic Dictation," *Engaging Students* 3 (2015): http://flipcamp.org/engagingstudents3/essays/jarvis.html.

8 As terms within the lexicon of African American Vernacular English, "book smarts" and "street smarts" are freighted with social significance as, respectively, knowledge that reinforces dominant social structures and knowledge that challenges those structures, see Beth Hatt, "Street Smarts vs. Book Smarts: The Figured World of Smartness in the Lives of Marginalized, Urban Youth," *The Urban Review* 39 (2007): 145-166.

9 David Huron, *Sweet Anticipation: Music and the Psychology of Expectation* (Cambridge, MA: MIT Press, 2007), 135.

10 Cora S. Palfy and Eric Gleason, "The Hidden Curriculum in the Music Theory Classroom," *Journal of Music Theory Pedagogy* 32 (2018): 79.

designing activities that emphasize comparative analysis, context-sensitive inductive reasoning, and prediction.[11] This work in turn provides several valuable starting points for music theory instructors to build pedagogies informed by statistical learning.

This paper aims to stimulate such work, first by distilling pedagogically relevant findings from the statistical learning literature, and then by detailing my own efforts to design classroom exercises informed by those findings. I begin with a pragmatically oriented summary of literature on statistical learning, briefly sketching what statistical learning is as a prelude to a more sustained exploration of how pedagogues can use it. Central to this discussion are four learning principles gleaned from the statistical learning literature by Luca Onnis: *integrate information sources*, *seek invariant structure*, *reuse learning mechanisms*, and *learn to predict*. Many of these principles have individually surfaced in music theory instruction already, but, I argue, their benefits multiply when combined into a structured pedagogical system. The remainder of the article outlines such a system by describing two classroom activities I've designed to cultivate statistical learning. The first is the exercise introduced above, an immersive listening activity designed to develop rich awareness of sonata norms. The second combines listening, model composition, comparative analysis, and peer revision to build robust knowledge of galant-style Do-Re-Mi melodies. I offer these exercises as models for a flexible pedagogical program that, powered by statistical learning, leads students through rich musical experiences to arrive at creatively applicable knowledge that is as intuitively grasped as it is richly textured. As I stress at the end of the article, however, these models are given both to spur future research and to invite critique, opening space to consider several questions about the pedagogical payoff of statistical learning that remain unanswered. In this respect, the theoretical and practical materials presented here are best understood as preliminary steps rather than a fully-realized system. It is a sketch outline of what a statistical learning approach to music theory pedagogy might look like, sketched with hope and optimism that future work might fill in, color, or redraw it as necessary.

11 For an overview, see Gaëtanelle Gilquin and Sabine De Knop, "Exploring L2 Constructionist Approaches," in *Applied Construction Grammar*, ed. Sabine De Knop and Gaëtanelle Gilquin (Boston, MA: Mouton de Gruyter, 2016).

## What is statistical learning and how can we use it?

Psychologists Roger Schank and Robert P. Abelson wrote their seminal *Scripts, Plans, Goals, and Understanding: An Inquiry into Human Knowledge Structures* at a time when experimental evidence on schema and script learning was still limited. Even so, they intuited that scripts were acquired rapidly and without special effort, an intuition revealed in a striking anecdote from Roger Schank:

> My daughter hana (age 4) was with me when we bought [a new car] and asked if I was going to get a new key chain. I asked her what she meant. She replied that when we had gotten our old car in Rhode Island (where it had arrived off the boat 2 years earlier) I had bought a new key chain. This was her only experience with getting a car and already the events in it were a script for her. When you get a new car, you get a new key chain. If people are building scripts at such an early age, it seems easy to imagine that the number they possess is great.[12]

This hunch—that mere exposure to similar stimuli leads rapidly to the development of schemas and scripts that serve as mental snapshots of their shared structure—has been largely borne out by research in succeeding decades, with initial support coming from the study of language acquisition and later research showing that the underlying mechanisms for such learning are domain general.[13] The concept of *statistical learning*, crystalized from these studies, holds that human beings are supremely sensitive to regularities in their environment, so sensitive, in fact, that they intuitively and unconsciously build mental representations around statistically significant aspects of their experience and the transitional probabilities among stimuli. For instance, if A (e.g., buying a car) frequently co-occurs with B (e.g., getting a new keychain), people will begin to expect B whenever they encounter A. Statistical learning is related to (and is often used synonymously with) *implicit learning*, a decades-older concept describing any learning that occurs without conscious awareness, learning which typically produces tacit, unconscious, and inarticulable knowledge.[14] Importantly for the pedagogical aims of this paper, however, studies suggest that statistical learning

12 Schank and Abelson, *Scripts, Plans, Goals, and Understanding*, 68.

13 Jenny R. Saffran, Richard N. Aslin, and Elissa L. Newport, "Statistical Learning by 8-Month-Old Infants," *Science* 274 no. 5294 (December, 1996): 1926-1928. Natasha Z. Kirkham, Jonathan A. Slemmer, and Scott P. Johnson, "Visual Statistical Learning in Infancy: Evidence for a Domain General Learning Mechanism," *Cognition* 83 no. 2 (March, 2002): B35-42.

14 Arthur S. Reber, "Implicit Learning of Artificial Grammars," *Journal of Verbal Learning & Verbal Behavior* 6 no. 6 (1967): 855-863. Bruce Torf, "Into the Wordless World: Implicit Learning and Instructor Modeling in Music," in *Music as Intelligence: A Source Book*, ed. Verna Brummett (Ithaca, NY: Ithaca College, 1997), 77–91.

is capable of producing explicit knowledge too, such as the ability to recognize previously experienced stimuli.[15] Given that musical style can be modeled in terms of statistical regularities and probabilistic event models—a central claim of musical schema theory—it follows that prolonged immersion represents a core pathway towards learning about a style by creating ample opportunities for students to engage in statistical learning.[16]

Alongside language acquisition, music was an early point of focus in statistical learning studies.[17] Since then, a robust literature on statistical learning in music has emerged that has been usefully summarized by scholars like David Huron, Pysche Loui, Elizabeth Margulis, and Robert Gjerdingen.[18] A dominant experimental paradigm looks like this: first, expose participants to stimuli with statistically structured patterns (the exposure phase), then, test participants on their ability to distinguish probable or familiar structures from improbable or unfamiliar ones (the test phase). For example, a research team led by Psyche Loui studied the statistical learning of novel musical grammars created using the Bohlen-Pierce scale.[19] They created two distinct finite-state melodic grammars, exposed participants to melodies from just one of those grammars for about 30 minutes, and then assessed their learning through both a recognition task (identifying if they had heard a melody previously) and a generalization task (judging which of two new melodies fit the grammar they had learned). Results showed rapid learning modulated significantly by the number of melodies in the exposure pool. A small exposure pool of 5 melodies promoted high

15 Phillip Hamrick and Patrick Rebuschat, "How Implicit is Statistical Learning?" in *Statistical Learning and Language Acquisition*, ed. Patrick Rebuschat and John N. Williams (Boston: Mouton de Gruyter, 2012), 365-381. Laura J. Batterink, Paul J. Reber, Helen J. Neville, and Ken A. Paller, "Implicit and Explicit Contributions to Statistical Learning," *Journal of Memory and Language* 83 (2015): 62-78.

16 Robert Gjerdingen, *Music in the Galant Style* (Oxford: Oxford University Press, 2007), 369-380.

17 Jenny R. Saffran, Elizabeth K. Johnson, Richard N. Aslin, and Elissa L. Newport, "Statistical Learning of Tone Sequences by Human Infants and Adults," *Cognition* 70 no. 1 (February, 1999): 27-52.

18 Huron, *Sweet Anticipation*, 63-72. Psyche Loui, "Statistical Learning – What Can Music Tell Us?" in *Statistical Learning and Language Acquisition*, ed. Patrick Rebuschat and John N. Williams (Boston: Mouton de Gruyter, 2012), 433-462. Margulis, *On Repeat*, 106-111. Robert Gjerdingen, "Musical Grammar," in *The Oxford Handbook of Critical Concepts in Music Theory*, ed. Alexander Rehding and Steven Rings (Oxford: Oxford University Press, 2015), 651–672.

19 These studies have been reported in several publications, the present discussion is based on findings reported in Psyche Loui, "Statistical Learning - What Can Music Tell us?" and 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 (June, 2010): 377–388.

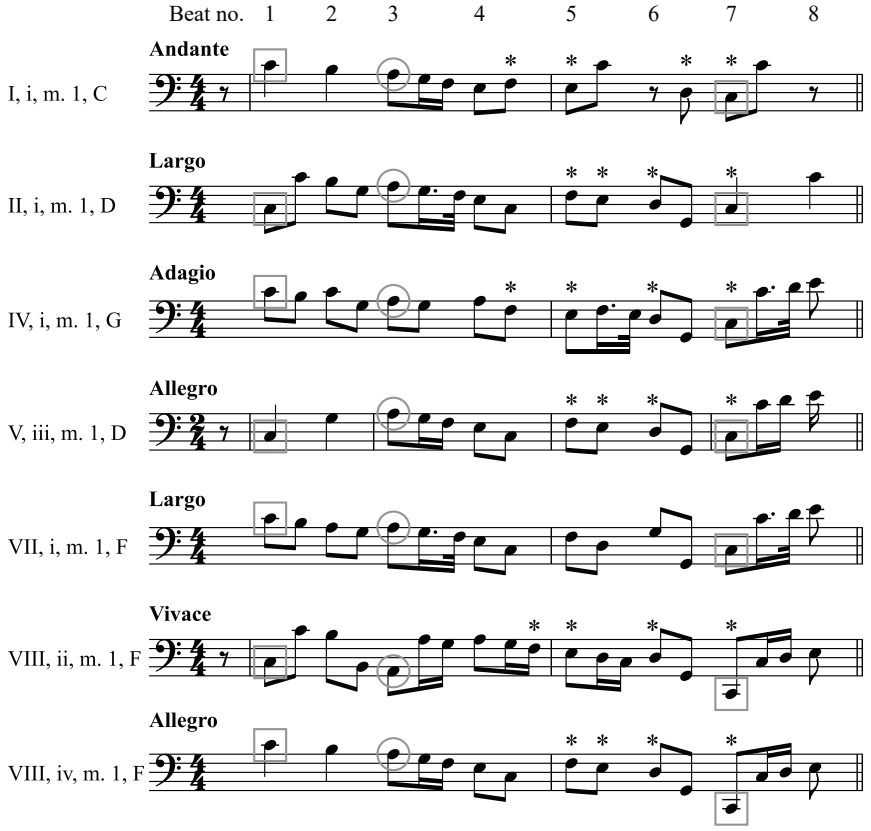
recognition but low generalization, whereas a large exposure pool of 400 melodies promoted exceedingly high generalization but low recognition. "Humans Rapidly Learn Grammatical Structure in a New Musical Scale," the title of their study reads. The viral marketing writes itself: you too can learn a new musical style in 30 minutes or less with this one weird trick!

How might statistical learning—and the experimental methods used to study it—be adapted for use in the music theory classroom? Returning to this article's stylistic focus, I'd offer Robert Gjerdingen's landmark, cognitively informed treatise *Music in the Galant Style* as a model for this translation. A book about the stock musical patterns or schemas that form the basic gestural vocabulary for eighteenth-century European court music, *Music in the Galant Style* conveys its subject by "present[ing] numerous musical examples—exemplars—that allow the reader to explore variants and stylistic changes typical of different decades and courts."[20] The exemplars come early and often—reckoned by the audio files on the book's companion website, some 401 musical examples litter the book's 480 pages—figuring Gjerdingen's monograph as an immersive space where galant musical practices may be learned statistically and (secondarily and subsequently) explicated in prose. This immersive pedagogical approach emerges early on in the book's opening example (reproduced as Example 1), in which the opening bass lines for seven movements from Pietro Locatelli's Op. 2 flute sonatas appear transposed to C major. By amassing disparate passages together and wiping away differences in key and tempo, Gjerdingen places their "obvious similarities" directly in the reader's path.[21] The boxes, circles, and asterisks on the figure highlight these similarities, sketching a bundle of features that, Gjerdingen suspects, would be abstracted through the process of statistical learning and packaged into a schematic prototype. And although Gjerdingen does supplement the example with a paragraph of descriptive prose, that paragraph feels redundant. What more needs to be said that cannot be seen, heard, and felt from the example itself? But, in fact, *Music in the Galant Style* relishes in precisely such redundancy: the two chapters that follow the book's introduction are devoted entirely to the two schemas displayed in the example—Romanesca in the first half of each passage and Prinner in the second, both of which are diagrammed in Example 2—providing readers with an additional 35 pages of prose and 38 musical passages for further immersion. "These schemata," Gjerdingen concludes, "were designed to be noticed by anyone who listened to enough

20 Robert Gjerdingen, *Music in the Galant Style* (Oxford: Oxford University Press, 2007), 15.

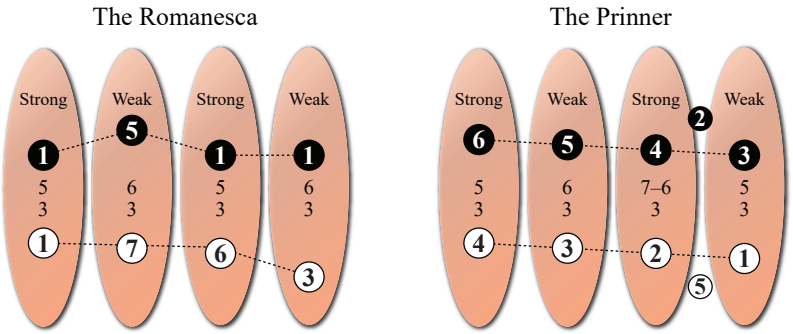
21 Ibid, 14.

of this music," and a reader of *Music in the Galant Style* who plays, sings, and listens to each of its examples cannot help but become acquainted with a sufficient body of examples to facilitate schematic noticing.[22] In this way, Gjerdingen builds the process of statistical learning into the structure of his book, allowing the galant style to speak for itself while granting readers the opportunity to pick up its vocabulary through sheer exposure.




**Example 1**
Reproduction of Gjerdingen's Ex. 1.1, "Locatelli, Op. 2, various opening basses (Amsterdam, 1732)."

22 Ibid, 15.




**Example 2**
Gjerdingen's schematic representations of the Romanesca (left) and Prinner (right) schemas.

But if exemplars speak for themselves, what, then, is the role for explicit instruction? Gjerdingen provides several models here as well. To begin, it should be said that the mere act of explaining a pattern renders it as explicit knowledge, which in turn makes that schema easier to retrieve, examine, manipulate, and discuss. But more often, Gjerdingen's prose prompts readers to enmesh a given schema within a broader conceptual network, demonstrating the rich connections that spin out from deep knowledge about a schema. The chapter on the Romanesca, for instance, provides quick biographies for key galant composers like Giacomo Tritto and Johann Schobert, introduces readers to the Italian *partimento* tradition and its basic principles, defines and explores several variants of the schema, connects peculiar features of its harmonization to galant solmization practices, and, in a summary discussion activity, presents three harmonizations of a bass line for readers to compare and evaluate with the aid of their newly-acquired knowledge. The great strength of *Music in the Galant Style* lies in its impeccable ability to communicate a dense, interconnected tangle of music-structural, cognitive, and social threads lucidly and approachably, an achievement made possible by Gjerdingen's trust in the pedagogical power of statistical learning.

For further pedagogical inspiration, music theorists might look to the field of second-language pedagogy, where educators are eager to capitalize on experimental research into statistical language learning to devise useful classroom interventions. For example, in a three-step model for teaching the pedagogically challenging English-language expression "get an idea across" to Spanish first-language students, linguists Francisco José Ruiz de Mendoza Ibáñez and María del Pilar Agustín Llach suggest

immersing students in "an ample selection of examples" so that the expression may be learned statistically, an activity that is flanked both by an initial explication of the construction's conceptual motivations (ideas are like objects, we can move them from person to person, and so we can *get* them from where they are *across* to where we are) and by a follow-up discussion where its syntactical and semantic subtleties are made explicit.[23] The statistical learning activity at the center allows students to abstract a rich, multilayered schema for the construction—since, as Gaëtanelle Gilquin and Sabine De Knop note, "the amount of input [i.e., exposure to naturalistic linguistic stimuli] seems to influence the level at which learners generalize: a more abstract level for learners who receive more input and a lower, more concrete level for learners who receive less input and more instruction"—while the instructor-guided discussions at the beginning and end provide conceptual scaffolding and opportunities for conscious reflection, respectively.[24]

Taking a broader view, Luca Onnis has articulated four pedagogical principles derived from the literature on statistical learning.[25] The first principle, *integrate information sources*, holds that students learn more effectively from naturalistic input presented in an information-rich context. Rather than isolating and drilling problem concepts (difficult phonemes or musical intervals, for instance), this principle advocates for embedding them in meaningful contexts that allow students to infer patterns that reduce ambiguity and infer appropriate choices. The second principle, *seek invariant structure*, advises instructors to use input that highlights consistent patterns across varied presentations, thereby allowing students to detect the underlying statistical regularities. This facilitates what cognitive linguists call *alignment*: the mental process of setting experiences side by side so their similarities and differences may be attended to.[26] Undergirding our very sense of analogy and similarity, alignment and the statistical learning it enables is, importantly, a domain-

23 Francisco José Ruiz de Mendoza Ibáñez and María del Pilar Agustín Llach, "Cognitive Pedagogical Grammar and Meaning Construction in L2," in *Applied Construction Grammar*, ed. Sabine De Knop and Gaetanelle Gilquin (Boston, MA: Mouton de Gruyter, 2016), 172–3.

24 Gilquin and De Knop, "Exploring L2 Constructionist Approaches," 11.

25 Luca Onnis, "The Potential Contribution of Statistical Learning to Second Language Acquisition," in *Statistical Learning and Language Acquisition*, ed. Patrick Rebuschat and John N. Williams (Boston, MA: Mouton de Gruyter, 2012), 203–236.

26 Dedre Gentner and Arthur B. Markman, "Similarity is Like Analogy: Structural Alignment in Comparison," in *Similarity in Language, Thought and Perception*, ed. Cristina Cacciari (Brussels: Brepols, 1995), 111–147.

general faculty, operating across language, music, vision, and many other forms of patterned perception. This leads to Onnis's third principle, *reuse learning mechanisms for different tasks*, which encourages instructors to design overlapping activities that engage shared, domain-general learning processes like alignment, pattern recognition, and prediction across learning tasks, rather than treating each task as requiring entirely separate instructional methods. The fourth and last principle, *learn to predict*, emphasizes that the fruit of statistical learning is an intuitively grasped schema that can be used to make useful predictions from partial information. As students' knowledge develops, instructors should regularly construct activities and assessments that engage their predictive abilities, encouraging them to reinforce and extend their understanding as they move toward fluency. In sum, a pedagogical model inspired by statistical learning would immerse students in information-rich, real-world stimuli tightly curated to expose regularities in the environment, and would likewise center instruction and assessment mechanisms around the twin tasks of making comparisons and generating predictions.

Many of these principles resonate consonantly with current instructional models for music theory. Echoing Onnis's call to integrate information sources, Gary Karpinski points out that "a preponderance of experimental evidence shows little connection between the ability to identify intervals acontextually and the ability to do so in a tonal context," and he therefore recommends attuning students to intervals by way of cue-rich scale degree qualia rather than drilling intervals in isolation.[27] This same principle likewise accords with the instructional methods advocated by Daniel B. Stevens, Philip Duker, and Jennifer Shafer, who argue that students develop richer, more holistic listening skills when asked to produce simplified reductions (like Stevens's "Do/Ti test") of richly-textured, real-world music than they do in more traditional, piano-centric dictation tasks.[28] Gjerdingen, as we saw above, also prefers real-world, information-rich stimuli, but his manner of presenting that information also shows Onnis's second pedagogical principle in action. By isolating the bass and transposing all passages of Example 1 to C major, that is, Gjerdingen eliminates non-pertinent information from view, thereby making it easier to spot what changes and

27 Gary Karpinski, *Aural Skills Acquisition: The Development of Listening, Reading, and Performing Skills in College-Level Musicians* (Oxford: Oxford University Press, 2000), 52. See also Timothy Chenette, "What Are the Truly Aural Skills?" *Music Theory Online* 27 no. 1 (May 2021).

28 Daniel B. Stevens, Philip Duker, and Jennifer Shafer, "Bending to Real Music: Harmonic Hearing in the Aural Skills Classroom," in *The Routledge Companion to Aural Skills Pedagogy*, ed. Kent Cleland and Paul Fleet (New York: Routledge, 2021), 334–350. See also Daniel B. Stevens, "Symphonic Hearing: Mastering Dictation Using the Do/Ti Test," *Journal of Music Theory Pedagogy* 30 no. 4 (2016): 111–175.

what stays the same from one passage to the next. When inducing statistical learning in a classroom setting, instructors must delicately balance the information they present, trusting students to sort out rich yet messy aural experiences while also taking steps to place the most pertinent information in their focus. Lastly, prediction has long been a central point of music-theoretical scholarship and pedagogy alike, but Onnis's fourth principal embraces all activities that develop students' ability to elaborate partial information into complete solutions based on the schemas they have built through exposure and discussion. Examples might include realizing an eighteenth-century *partimento* by matching a given bass to an appropriate right-hand part using the rule of the octave and other galant schemas, developing sight singing strategies that employ rehearsed formulas (what Crystal Peebles calls "singing mantras") to generate useful performance-guiding expectations, elaborating a short melodic idea into a complete and fully harmonized phrase, or piecing a scrambled phrase back into an appropriate order.[29] In all cases, the goal of these exercises is to encourage students to creatively and synthetically use information gained through statistical learning to make vital predictions, inferences, and judgements.

Though each of these principles is powerful on its own, their combined application holds even greater, though largely untapped potential. In this light, consider Brian Jarvis's implementation of statistical learning in an oral analysis task described in his 2015 article "Hearing Harmony Holistically: Statistical Learning and Harmonic Dictation." In this activity, students orally supply chord function labels (T for tonic, D for dominant, P for predominant, and C for chromatic) for each chord in a progression improvised at the keyboard by the instructor, who pauses to identify mistakes and, by "rewording" the progression (that is, substituting other chords in place of the problem chord), guides students toward an appropriate hearing. If a student mislabels a $I^6$ chord as P, for instance, the teacher might perform a $ii^6$ chord in its place to clarify the sonic mismatch between sound and student-generated label. For Jarvis, the exercise induces statistical learning because, in his words, "[students'] brains are sorting through the

29 For a pedagogical implementation of partimenti, see Job Ijzerman, *Harmony, Counterpoint, Partimento: A New Method Inspired by Old Masters* (Oxford: Oxford University Press, 2018). Concerning singing mantras as aids for sight singing, see Crystal Peebles, "Harmonic Schemas in Aural Skills Classes," in *The Routledge Companion to Aural Skills Pedagogy*, ed. Kent Cleland and Paul Fleet (New York: Routledge, 2021), 326–7. For phrase elaboration activities, see end-of-chapter exercises in William Caplin, *Analyzing Classical Form: An Approach for the Classroom* (Oxford: Oxford University Press, 2013) as well as Peter Schubert, "'See what an ass I am' Improvisation #1," YouTube, https://youtu.be/1roDODEf_po. Finally, about musical scrambles, see Alan Gosman, "Finding One's Place: Music Scrambles and Formal Function," in *The Norton Guide to Teaching Music Theory*, ed. Rachel Lumsden and Jeffrey Swinkin (New York: W. W. Norton & Co., 2018), 38–55.

continuous data and strengthening correct neurological connections or reevaluating incorrect ones," and, to facilitate this work, he recommends "constantly revisit[ing] progressions from the past" both within and between sessions.[30] In line with Onnis's second principle, Jarvis writes that "it is vital that variations are performed so that students' brains can start to learn exactly what is and is not a $V^4_2$, for example,"[31] and I would add that his "reworded" progressions facilitate precisely the acts of aligning and comparing information that serve as the domain-general engine of statistical learning.

However, three features of Jarvis's activity limit the efficacy of the statistical learning it aims to inculcate. First, the activity connects students only to the sterile plunk of the instructor's piano (and strictly to progressions they invent) rather than to the integrated textural, timbral, and rhythmic information of recordings and other naturalistic stimuli. Second, the labeling task engages students only reactively, eliciting no predictive or inferential behaviors. Third and lastly, because students respond orally to each chord, the task necessitates a significant lag between chords, potentially blocking students from hearing those chords as part of a larger context by straining their ability to hold multiple chords in their working memory. Here are some ways to attenuate these limitations. Recognizing that, in this specific case, the piano crucially facilitates the instructor's improvisations, the statistical learning process would benefit immensely from pairing this exercise with separate exposure to the target progressions in actual musical recordings, perhaps as a homework assignment. Within the activity itself, the instructor should ensure that the stimuli they perform are truly representative of the musical practice under consideration, taking care to shape their improvisations around the statistical regularities of relevant harmonic corpora.[32] (Otherwise, mistakes may arise not because students have faulty perceptions, but rather because students assimilate an anomalous stimulus from the instructor into a more normative form based on their personal, statistically-learned schemas for the style in question.) Prediction and inference could likewise be engaged in several ways. For instance, the dictation task could be "inverted" by presenting students with a partial stimulus (such as a bass line) and eliciting from

30 Jarvis, "Hearing Harmony Holistically."

31 Ibid.

32 See Christopher Wm. White and Ian Quinn, "Chord Context and Harmonic Function in Tonal Music," *Music Theory Spectrum* 40 no. 2 (Fall, 2018): 314–37 as well as Daniel Shanahan, John Ashley Burgoyne, and Ian Quinn, eds., *The Oxford Handbook of Music and Corpus Studies* (Oxford: Oxford University Press, 2022).

them a plausible harmonic analysis or melodic counterpoint.[33] In another adaptation, the instructor would perform a segment of the progression with one or more chords omitted, tasking students to use the surrounding cues to infer a plausible missing chord. As a bonus, since this revised activity does not require students to respond individually to every chord, it can be performed at a much quicker tempo, thereby encouraging students to enmesh what they hear in a cue-rich context. With these adaptations, Jarvis's singular statistical learning activity might become a blueprint for an entire pedagogical program, one that leads from immersion in rich sonic stimuli toward nuanced and creative applications of their resulting knowledge.

Let me now summarize what a pedagogical commitment to statistical learning entails. This commitment proceeds from the premise that students are extraordinarily capable of picking up on musical norms when they are exposed to a sufficient number of representative examples. It does not give instructors free license to overwhelm students by continuously flinging new material at them, but it does suggest that periods of immersion and wide exposure are important pathways to developing rich musical knowledge.[34] When implementing statistical learning in the classroom, instructors have at least three roles to play. First, behind the scenes, they craft the all-important exposure period by curating examples and controlling how they are presented. Second, via lecture and discussion, instructors provide students with preliminary conceptual scaffolding, amplify their immersion with cultural and historical context, and guide them toward explicit, articulable knowledge. Third, they design creative assessments that elicit, enrich, and extend their statistically-learned knowledge. The manner of exposure and assessment is carefully controlled. During the exposure period, instructors commit to placing information-rich, real-world examples in front of their students, while also shaping the experience in ways that spotlight pertinent regularities without overwhelming students' attentional resources. During assessments, on the other hand, students are evaluated on their ability not only to reproduce explicit aspects of their knowledge, but more importantly to use

33 An "inverted dictation" is an exercise devised by Daniel Stevens in which "students dictate music that they improvise while listening to a stimulus," see Daniel B. Stevens, "Inverting Dictation," *Engaging Students* 5 (2017) http://flipcamp.org/engagingstudents5/essays/stevens.html.

34 In this respect, I do not view my arguments as necessarily opposed to the "less-is-more" approach advanced in Brian Alegant, "On 'Scuba Diving,' or the Advantages of a Less-is-More Approach," *Engaging Students* 2 (2014). Rather, as I suggest later, broad exposure is most effective in the early stages of learning a concept, to be complemented by deeper analytical work later. My aim is not to endorse a blanket "more is more" approach, but to argue for the strategic use of sonic immersion to facilitate statistical learning at key points in the learning process.

their statistically-learned knowledge (in both implicit and explicit forms) to make sensitive predictions, inferences, assessments, and judgements. Hence, to instruct with statistical learning in mind is, above all, to center immersive experiences with musical practices, trusting students to develop richly-textured knowledge structures in response.

## Cultivating Sonata Knowledge

"On the occasions when I have had the opportunity to lead seminars in Sonata Theory," James Hepokoski reflects, "I have begun by selecting two or three exemplary movements by Mozart: listening to them and talking our way through every moment of them, section by section, with score in hand."[35] (2020, 24). Here, Hepokoski expresses what is unquestionably the first-level default norm for introducing sonata form: across textbooks and pedagogical scholarship alike, sonata form is routinely explicated alongside early deep dives into individual canonical workhorses—almost invariably piano sonatas—by Mozart, Haydn, and Beethoven.[36] Indeed, Gary Karpinski explicitly recommends repeated listening to a small number of works as a critical early step in developing an ear for musical form:

35 James Hepokoski, *A Sonata Theory Handbook* (Oxford: Oxford University Press, 2020), 24.

36 For Hepokoski, the first movement of Mozart's Sonata in B-flat, K. 333 is the point of entry. Textbooks like Caplin's *Analyzing Classical Form*, Jane Piper Clendinning and Elizabeth West Marvin's *The Musician's Guide to Music Theory and Analysis* (New York: W. W. Norton & Co., 2020), Steven G. Laitz and Michael R. Callahan's *The Complete Musician: An Integrated Approach to Tonal Theory, Analysis, and Listening* (Oxford: Oxford University Press, 2022), and Mathew Santa's *Hearing Form: Musical Analysis With and Without the Score* (New York: Routledge, 2023) introduce sonata form using, respectively, the first movement of Beethoven's Piano Sonata in F minor, Op. 2, no. 1, the first movement of Mozart's Piano Sonata in G major K. 283, the first movement of Beethoven's Piano Sonata in G minor, Op. 49, no. 1, and the first movement of Mozart's Symphony in G minor K. 550. Patricia Burt's focused analysis of Haydn's Piano Sonata in E-flat (likely Hob. XVI:52) is cited as a model first lesson on sonata form in Jennifer Snodgrass, *Teaching Music Theory: New Voices and Approaches* (Oxford: Oxford University Press, 2020). The third movement of Mozart's Piano Sonata in G major K. 283 is suggested as an initial example in Brian Alegant, "Listen Up!: Thoughts on iPods, Sonata Form, and Analysis without Score," *Journal of Music Theory Pedagogy* 22 (2008): 6. Finally, Clementi's Sonatina in G, Op. 36, no. 2 is the "first listening exercise" suggested by Thomas Childs, "Sonata-Allegro Form: Understanding the Drama," in *The Routledge Companion to Music Theory Pedagogy*, ed. Leigh VanHandel (New York: Routledge, 2020), 322. For an approach that unsettles the canonical center of such approaches, see Catrina Kim, "Locating the 'Sonata' in Fanny Hensel's *Sonata o Fantasia*," in *Modeling Musical Analysis*, ed. Kimberly Goddard Loeffert and John Peterson (Oxford: Oxford University Press, 2025), 27–38.

> To develop the skills needed to attend to these various parameters and use them in drawing conclusions about musical form, the need for repeated listening is crucial. Listeners cannot gain much sense of a work's form from one or even a few listenings. They must become intimately familiar with how the piece "goes" as they answer questions, create graphs, make lists of themes, and so on. In gaining this kind of intimacy with even only a handful of works, listeners can begin to learn to attend to salient formal details in unfamiliar works as well.[37]

But as Loui and colleagues have shown, generalization becomes easier when people are exposed to a large body of examples. David Huron concurs, arguing that theory pedagogues should facilitate statistical learning by providing at least thirty examples of any concept they teach.[38] A pedagogy of form inspired by statistical learning thus proceeds from a revised version of Karpinski's dictum, emphasizing the need to listen repeatedly not to a handful of works, but to a wide body. Such widely-cast listening activities provide students with rich, intuitive knowledge from which the narrowly-focused task of close analysis can later take shape. Hence, the goal of initial sonata exposure ought to shift away from understanding how a *piece* goes and toward understanding how a *class of pieces* go.[39]

This is the perspective from which my initial class session on sonata form, introduced briefly at the start of this article, proceeds. Scaffolded by a preliminary discussion about every-day, nonmusical scripts, students spend this class attuning to the norms of eighteenth-century sonata expositions by listening to, comparing, discussing, and diagraming a representative pool of symphonic excerpts. Importantly, while I ultimately teach sonata form through the lens of James Hepokoski and Warren Darcy's *Elements of Sonata Theory*, neither sonata form as a concept, nor any specialized terms or labels associated with its analysis are introduced at all during

37 Karpinski, *Aural Skills Acquisition*, 137.

38 Paraphrased ("[Huron] recommended that aural skills instructors provide at least thirty examples of a specific concept since students and humans, in general, tend to identify familiar objects faster than unfamiliar ones") in Morgan Markel and Nicholas J. Shea, "Report on the 2016 Workshops in Music Theory Pedagogy at the University of Massachusetts Amherst," *Journal of Music Theory Pedagogy* 30 no. 7 (2016): 251.

39 In this respect, my approach is consonant with Seth Monahan's strategy of "expos[ing] students to as many pieces as possible," see Seth Monahan, "Sonata Theory in the Undergraduate Classroom" *Journal of Music Theory Pedagogy* 25 (2011): 81. Though, importantly, Monahan does recommend "look[ing] closely at an initial example" when introducing a concept, and suggests the first movement of Mozart's Piano Sonata in A minor sonata K. 310/300d as an early point of focus. My strategy merely moves this emphasis on wide exposure to the head of the line: I believe that students' very first encounter with sonata form should have them comparing many examples to one another to bring their shared features into view.

this introductory session.[40] The day's operative prompt, I tell my students, is to sketch a script for "what happens in a symphony movement" that is every bit as detailed as their script for "what happens at a restaurant," and I therefore encourage them to come up with whatever labels they want for the musical features they perceive, recognizing that eighteenth-century listeners would have likely had a wordless—that is, implicit—understanding of these norms developed through countless concert-going experiences. Across the session, students are exposed to the corpus of expositions shown in Example 3, divided into three sets based on their position and function in the class, to be discussed shortly. The corpus consists exclusively of fast movements from eighteenth-century symphonies, since I find the propulsion and bombast of such movements useful for communicating the drama of sonata form. Far more crucial than genre, however, is brevity: with just one exception (the first movement of J. C. Bach's Grand Overture in D major, Op. 18, No. 6, shown as entry 30 in Example 3), the corpus contains no expositions longer than 1.5 minutes. The importance of this constraint cannot be overstated: because students will spend the class comparing the aural features of distinct movements without the aid of a score, it is vital (especially during the initial stages of the activity) that each excerpt is brief enough to allow its features to stick in their working memory. Accordingly, students begin the class confronting no more than 20 seconds of music per excerpt, with excerpts growing longer as students become increasingly fluent with sonata norms. The goal of the class is to help students develop an intuitive understanding of the two-part sonata exposition, with particular focus on the material leading up to the point of rhetorical articulation midway through an exposition that Hepokoski and Darcy call the *medial caesura* (or *MC*). This approach aims to build a solid foundation of readily accessible sonata knowledge grounded in direct engagement  preceding any exegesis of technical terms or close readings of specific pieces in later classes.

40 James Hepokoski and Warren Darcy, *Elements of Sonata Theory: Norms, Types, and Deformations in the Late-Eighteenth-Century Sonata* (Oxford: Oxford University Press, 2004).

| *Composer, Work (Recording Conductor)* | *Time to MC* | *Time to Exp. End* |
|---|---|---|
| **Set A: Initial encounters** (Play each excerpt up to MC) | | |
| 1.) Mozart, Symphony in G major K. 124, mvt. 1 (Pinnock) | 0:15 | 0:49 |
| 2.) Haydn, Symphony in C major Hob. I:32, mvt. 1 (Hogwood) | 0:16 | 1:00 |
| 3.) Haydn, Symphony in C major Hob. I:38, mvt. 1 (Hogwood) | 0:19 | 0:58 |
| 4.) Haydn, Symphony in D major Hob. I:4, mvt. 1 (Hogwood) | 0:19 | 1:04 |
| 5.) Gossec, Symphony in C SacG. 85, mvt. 3 (Sanderling) | 0:19 | 1:12 |
| 6.) Saint-Georges, Symphony in G major Op. 11, No. 1, mvt. 3 (Lamon) | 0:17 | 0:45 |
| 7.) Vaňhal, Symphony in C major Bryan C3, mvt. 3 (Grodd) | 0:13 | 0:31 |
| 8.) Erskine, Periodical Overture No. 17 in E-flat major, mvt. 1 (Lea-Cox) | 0:26 | 1:05 |
| 9.) Walpurgis, Overture to *Talestri*, mvt. 1 (Egarr) | 0:25 | 0:38 |
| 10.) Haydn, Symphony in B-flat major Hob. I:35, mvt. 4 (Hogwood) | 0:20 | 0:37 |
| **Set B: MC comparisons** (Play each excerpt up to MC) | | |
| 11.) Saint-Georges, Overture to *L'amant anonyme*, mvt. 1 (Lamon) | 0:23 | 1:03 |
| 12.) Mozart, Symphony in B-flat major K. 22, mvt. 1 (Pinnock) | 0:27 | 1:00 |
| 13.) Haydn, Symphony in A major Hob. I:21, mvt. 2 (Hogwood) | 0:21 | 0:54 |
| 14.) Mozart, Symphony in G major K. 129, mvt. 1 (Pinnock) | 0:29 | 1:16 |
| 15.) Mysliveček, Symphony in C major EvaM 10:C14, mvt. 1 (Ehrhardt) | 0:28 | 1:09 |
| 16.) J. C. Bach, Symphony in E-flat major Op. 6, No. 3, mvt. 1 (Halstead) | 0:23 | 1:06 |
| 17.) Agnesi, Overture to *Ulisse in campania* (Moretti)[41] | 0:17 | 0:35 |
| 18.) Sacchini, Overture to *La contadina in corte* (Bonynge) | 0:41 | 1:28 |
| 19.) Haydn, Symphony in C major Hob. I:9, mvt. 1 (Hogwood) | 0:30 | 0:44 |
| 20.) Mozart, Symphony in D major K. 385 mvt. 4 (Pinnock) | 0:30 | 1:06 |

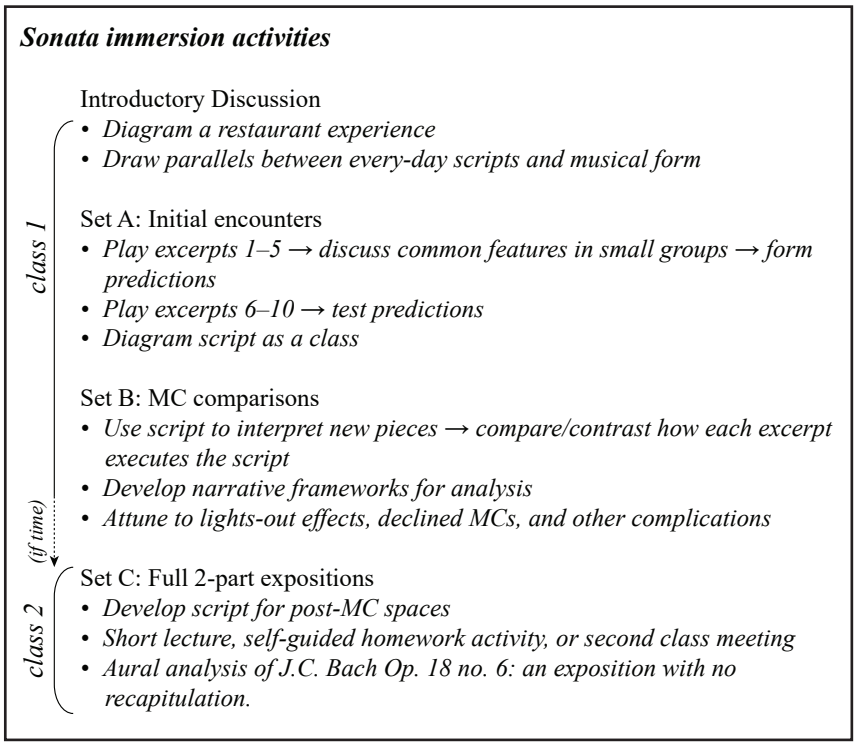
**Example 3**
Symphonic corpus for teaching 2-part exposition structure.
See Discography for complete recording information.

41 The recording in question, available on YouTube, contains a narration before the excerpt begins. Times for this excerpt are reckoned from the 24-second mark, when the piece begins.

| *Composer, Work (Recording Conductor)* | *Time to MC* | *Time to Exp. End* |
|---|---|---|
| **Set C: Full 2-part expositions** | | |
| *21.) [Replay 7, full exposition]* | | |
| *22.) [Replay 10, full exposition]* | | |
| *23.) [Replay 17, full exposition]* | | |
| *24.) [Replay 15, full exposition]* | | |
| *25.) [Replay 16, full exposition]* | | |
| 26.) Vaňhal, Symphony in C major Bry. C1, mvt. 1 (Mallon) | 0:30 | 1:14 |
| 27.) Mozart, Symphony in E-flat major K. 543, mvt. 4 (Pinnock) | 0:35 | 1:27 |
| 28.) Haydn, Symphony in E-flat major Hob. I:22, mvt. 4 (Hogwood) | 0:15 | 0:33 |
| 29.) C. P. E. Bach, Symphony in G major Wq. 182/1, mvt. 3 (Haenchen) | 0:21 | 0:57 |
| 30.) J. C. Bach, Grand Overture in D major Op. 18, No. 6, mvt. 1 (Halstead) | 0:54 | 2:50 |

**Example 3 (cont'd)**
Symphonic corpus for teaching 2-part exposition structure.
See Discography for complete recording information.

The division of Example 3 into three sets reflects a three-pronged division of class activities, diagrammed in Example 4. To begin, students listen to set A and build up a basic script for part 1 of a two-part exposition by comparing examples and abstracting shared features. Set B is then introduced alongside a pointed inversion of student orientation. Rather than extracting a generalized picture from the behavior of individual pieces as they did for set A, students are now tasked to use their generalized understanding to narratively interpret how each piece runs through, skips over, or playfully manipulates the sonata script. Finally, set C moves the boundaries past the medial caesura to expose students to the structure and narrative of an exposition's second half, culminating in a deformational capstone movement that hammers home the inherent flexibility of sonata form as a category. Before describing these activities in greater detail, I should note that the curation and selective presentation of excerpts is carefully controlled to inculcate knowledge of a two-part sonata exposition, even though not every example in the corpus adheres to this plan. For instance, Thomas Erskine's Periodical Overture in E-flat major features two half-cadential breaks (m. 18=I:HC, m. 30=V:HC) instead of one, and is perhaps




**Example 4**
Lesson structure for introductory class on sonata form.

therefore more profitably interpreted according to the Neo-Kochian, "resting point"-oriented perspective developed by Poundie Burstein than it is against Hepokoski and Darcy's two-part script.[42] The movement's first 19 measures, however, are sonically indistinguishable from the pre-MC spaces of a prototypical two-part exposition, and as such, I have chosen to include this usefully compact piece in set A, where its script-atypical features are kept out of student ears. This choice in turn reflects my decision to begin with a concept in mind (the two-part exposition) and shape the corpus so as to present that concept in as clear and effective a light as possible, an overfitting approach that is as central to pedagogy as it is anathema to corpus-based research.[43]

42 L. Poundie Burstein, *Journeys Through Galant Expositions* (Oxford: Oxford University Press, 2020).

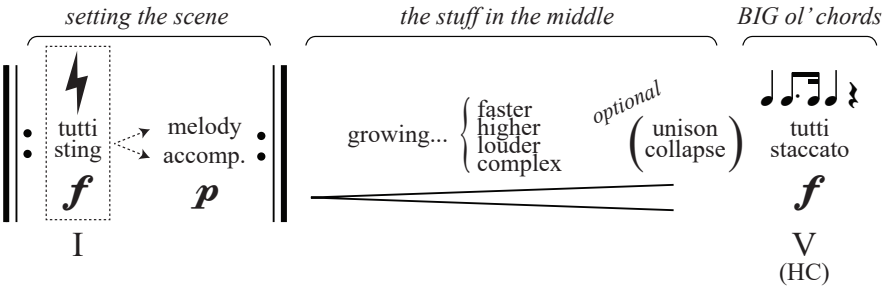
43 As Joshua Albrecht observes, corpus studies are most methodologically sound when they test a clearly defined a priori hypothesis against a corpus sampled in an impartial and systematic manner.

Exposure to set A occurs in two phases. Initially, I play the first five tracks from set A (up to the medial caesura, indicated by the leftmost timestamp in Example 3) back to back without interruption, instructing students to write down any common features they hear on a blank sheet of paper. A 5-10 minute period of small group discussion follows during which students compare notes, generate predictions about future pieces, and test those predictions against the remaining five tracks in the set, which I play about halfway through the discussion period. At the end of this period, the class assembles their observations into a play-by-play script for part 1 of the exposition, which we diagram collectively on the board. These activities engage students in the central statistical learning activities of comparing features (sketching common elements) and generating predictions (anticipating what new pieces will do based on prior experiences), while also allowing them to codify their budding knowledge in explicit forms through discussion and diagramming. The fruit of these activities is a visual representation of the sonata script like the one shown in Example 5a, which was produced by students of a sophomore-level aural skills course. By setting this diagram against Hepokoski and Darcy's classic sketch of the sonata's "Essential Expositional Trajectory," shown in Example 5b, we begin to see just how much sonata knowledge may be grasped through such bottom-up, inductive activities powered by statistical learning.[44] Couched in labels of their own devising, these students not only picked up on Hepokoski and Darcy's three primary events for part 1 of a sonata exposition—P ("setting the scene"), TR ("the stuff in the middle," whose energy-gaining tendency they construed as "growing faster, higher, louder, [and more] complex"), and MC ("BIG ol' chords")—but also captured details like the common "back-and-forth" looping of "an initial forte basic idea [with] piano responses" within symphonic P modules and the dramatic textural strategy of collapsing into unison during the final drive to the MC. Notably, this last detail, which is present in exactly half of the excerpts in set A,

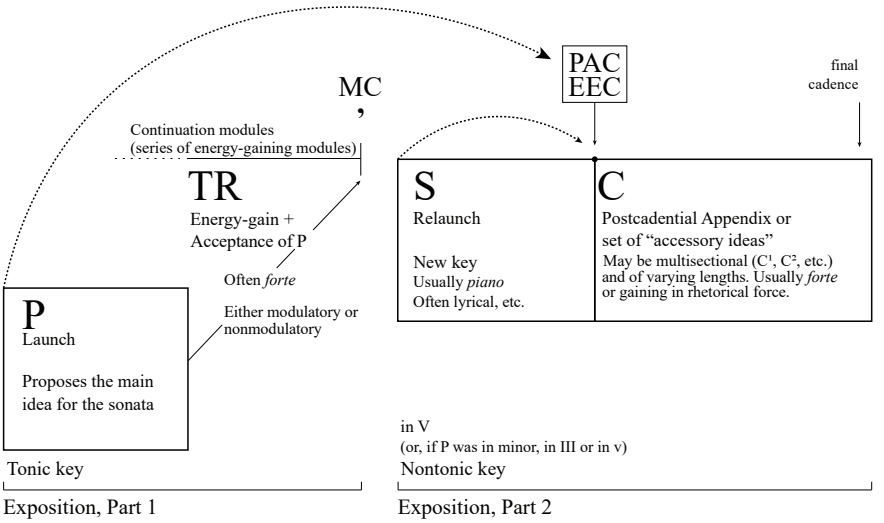
Joshua Albrecht, "Hypothesis Testing" in *The Oxford Handbook of Music and Corpus Study*, ed. Daniel Shanahan, John Ashley Burgoyne, and Ian Quinn (Oxford: Oxford University Press, forthcoming). In empirical research, selective curation amounts to confirmation bias, obscuring meaningful variation and ultimately compromising the study's validity. In pedagogical contexts, however, such selectivity plays a different role: it amplifies the features under consideration, sharpening students' perception and supporting the formation of a robust mental schema. Like a controlled experiment that isolates a single variable to illuminate its effects, a deliberately constructed exposure pool in the classroom enables students to abstract a structural prototype before engaging with more complex or atypical cases. This tradeoff between representational breadth and conceptual clarity is a necessary feature of instructional design—where the aim is not hypothesis testing, but the conceptual acquisition of durable musical concepts.

44 Hepokoski and Darcy, *Elements of Sonata Theory*, 17.

**a.)** In-class diagram based on set A




**b.)** Hepokoski and Darcy's "Essential Expositional Trajectory (to the EEC)."




**Example 5**
Two representations of the opening actions of a two-part sonata exposition.

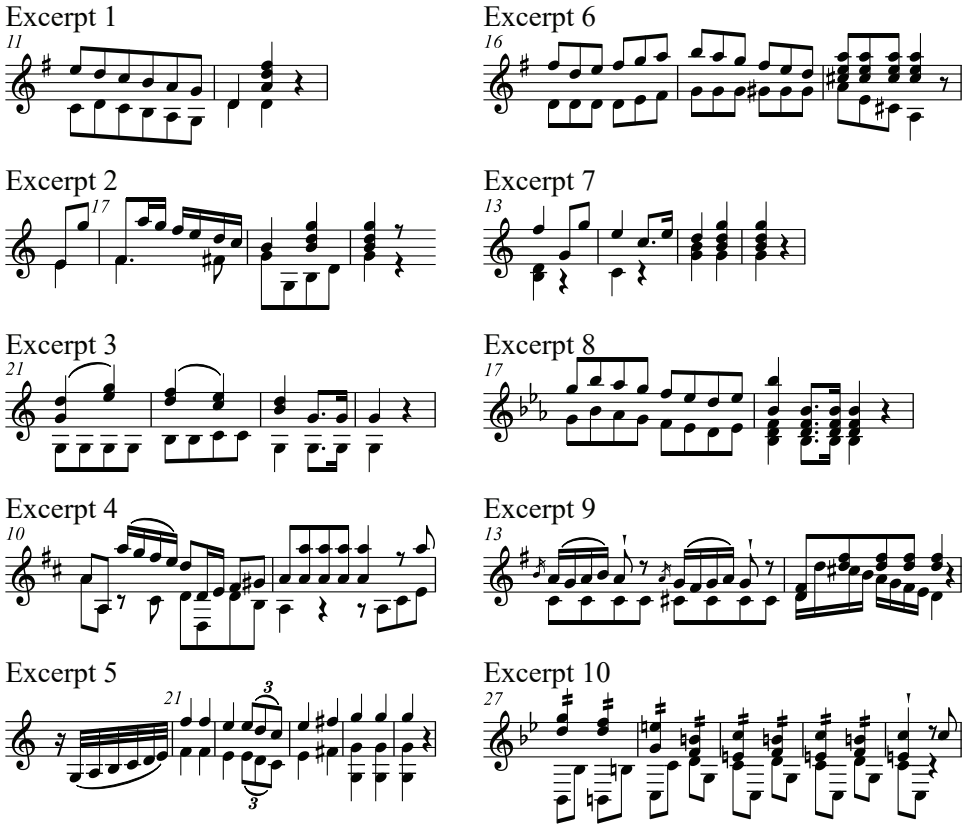
goes entirely unremarked by Hepokoski and Darcy, attesting to the power of statistical learning to bring salient information to mind that would likely be passed over in more traditional instructional methods.

To amplify this power, it is crucial that discussion remains multivalent throughout the class. While harmonic progression, tonal trajectory, and thematic design play an important role in sonata form, forcing the discussion to center these canonical topics too quickly can risk shutting out the full richness of student experiences, producing

information-poor scripts that may impede their ability to hear those very syntactical features. Instructors may, for instance, be tempted to define the medial caesura primarily in terms of its cadential content, emphasizing that students need to listen for a half cadence in order to identify this crucial sonata event. Though attractively succinct, this definition risks alienating students who struggle to hear half cadences in the first place. Instead, the instructor might ask students to consider the more holistic question "how do these excerpts end?" while playing the concluding actions shown in Example 6. Perceptive students often grasp the half-cadential content of these excerpts, but, crucially, those who do not are still able to attune to a host of shared rhythmic, textural, and articulative features.[45] Students in my general education music appreciation class, for instance, offered characterizations like "a lot of them them go like [singing a dotted rhythm] 'bah, ba, ba-dah'," "you kind of have these three loud chords that are all the same," and "they hammer out big forte chords followed by silence." These students have not been taught what a half cadence is, but they are nonetheless fully capable of hearing the medial caesura. Here we see the central benefit of centering integrated information sources over simplified models, for these easily perceptible rhetorical features can provide cues for perceiving syntactical components that may be less intuitive. That is, if a student struggles to hear half cadences but easily hears the "BIG ol' chords," they can be taught to bind these pieces of information together into a larger schema that powers a heuristic-oriented listening strategy: when you hear the "BIG ol' chords," assume that what you are hearing is a half cadence. This, in miniature, illustrates the central payoff of the whole class. By immersing students in an information-rich listening environment, students inductively learn a useful, multivalent set of cues that can guide them towards holistic ways of listening to cadential syntax and formal trajectory.

Once the class has sketched a sufficiently detailed script, I then engage students in the task of narratively interpreting new pieces (set B) against this script. I begin this second phase of the immersion activity by modeling the kind of interpretive game I want them to play: replaying the first excerpt from set A, the first movement of Mozart's Symphony in G major K. 124, I note several things that make this movement's journey through the sonata script special or unique—instead of a back-and-forth, loud-soft opening, Mozart launches with a forte motto in unison, TR doesn't so much grow in energy and complexity as it explodes forcefully into an energetic, full-

45 In one section, the perception of a half cadence had to be brute forced by prompting students to sing the roots of the starting and ending chords of excerpt 3 (the first movement of Haydn's Symphony in C major, Hob I:38) on solfege syllables.



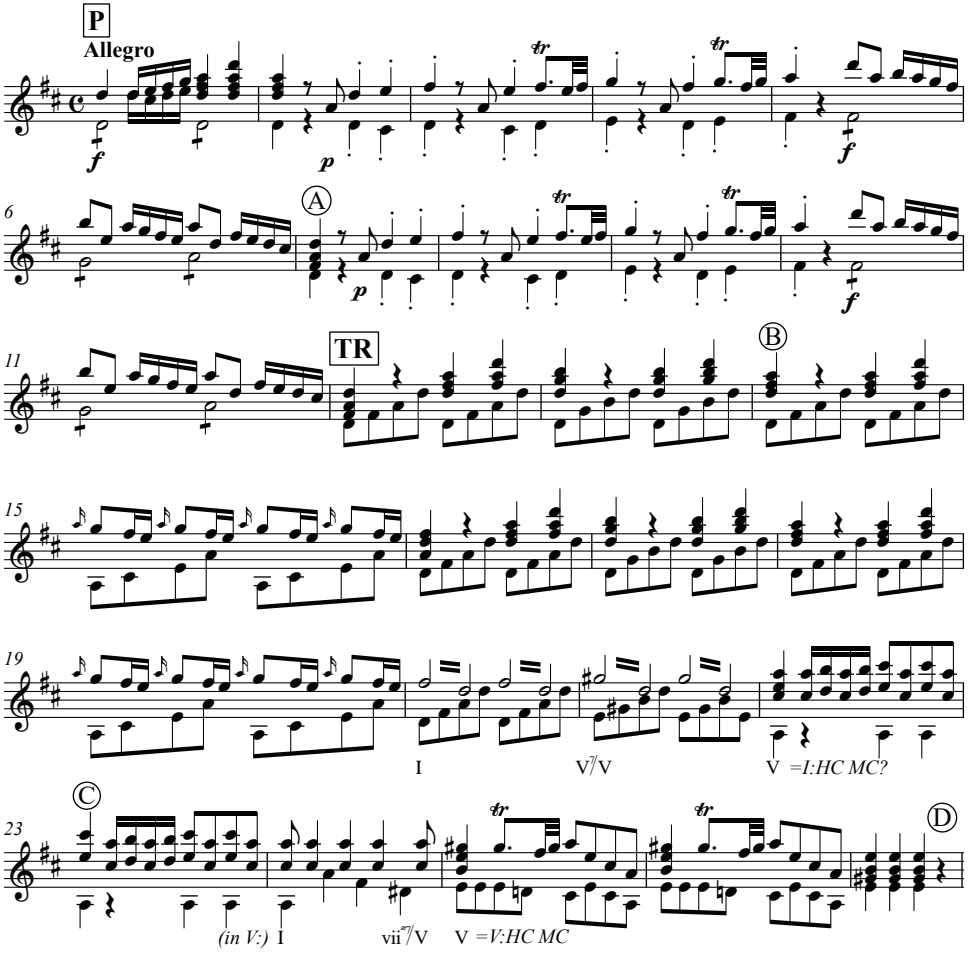

**Example 6**
Concluding actions for excerpts in set A.

bodied texture, and the perfunctory MC is approached with an extended crashing descent that zooms back into unison. I then ask students to compare this journey to the one staged in excerpt 11, the first movement from Joseph de Bologne's Overture to *L'amante anonyme*. Students note that this piece is similarly energetic from the get-go, launching with a vibrant texture much earlier than the Mozart example, and additionally observe that while both pieces feature *unisono* crashes into their respective HCs, Saint-Georges inserts an extra passage of chordal articulation over a dominant pedal preceding the MC break itself. At this point, I invite students to narrativize, concocting expressive microstories that capture these differences: excerpt 1 is explosive but unstable, some classes tell me, as though it had to work hard to sustain a full orchestral texture, meanwhile excerpt 11 was more heroic and joyous,

accomplishing its goals with ease and taking extra time to celebrate arriving at the HC. Through this exercise, students are not only introduced to the dialogic mode of interpretation that suffuses Hepokoski and Darcy's Sonata Theory, an orientation that students often find enjoyable in its own right, but they also reinforce and enrich their sonata script by explicitly attending to multiple pathways through standard events. Under the cognitive hood, such interpretations also imbue the script with a vital sense of narrative logic, helping to transform the script from a disconnected sequence of events (human memory for which is notoriously poor) into a logically connected story that is comparatively easy to remember.[46] To aid these crucial processes and enrich their narrative paradigms, the excerpts in set B are organized so as to illustrate increasingly complicated and evocative tracks through the sonata script: whereas excerpts 1 and 11 show the whole script accomplished with relative ease, excerpts 12 and 13 linger substantially on an overdetermined tonic before lurching suddenly to the HC, excerpts 14 and 15 take matters a step further and stage the MC as an achievement of intense textural or harmonic work requiring collective *unisono* heft (in 14) or a lengthy sequence (in 15), excerpts 16 and 17 expand the space between HC and MC through emphatic dominant locks amplified in the latter excerpt with a "lights out" effect, and the last three excerpts in the set all stage declined MCs in which an initial I:HC is abandoned for a V:HC, the last of which (excerpt 20) is again dramatized with minor-mode touches. Collectively, these excerpts convey the sense that each component of the sonata script is a task whose completion requires some (manipulable) degree of work, and by lavishing varying degrees of effort on different scripted events, individual movements are able to stake out unique narrative journeys through the script.

Due to time constraints, it is not typically possible to work through every excerpt in set B except in extended seminar-style meetings, and so I have often found it useful to either pare down the set to four or five useful excerpts to be discussed by the full class or else to divide students into small groups that work through a handful of excerpts and then present their analyses to their peers. In either case, I cap the class's exposure to set B with a predictive listening exercise oriented around one of the three excerpts (18, 19, or 20) that feature a declined MC. Example 7 shows a reduced and annotated transcription of Antonio Sacchini's Overture to *La contadina in corte* (excerpt 18), the

46 Concerning event cognition in general, Radvansky and Zacks write that "One of the clearest findings in memory research is that people have notoriously bad memory for temporal information per se (e.g., Friedman, 1993). However, causal information is readily encoded.... Causal connectivity provides the backbone for event models to extend out in time and provides a forward order bias in retrieval." Radvansky and Zacks, *Event Cognition*, 36.




**Example 7**
Sacchini, Overture to *La contadina in corte* (1765); reduced transcription annotated with formal labels and stopping points for prediction exercise (circled).

excerpt I use most frequently for this activity. I inform students that I will play the excerpt four times, always starting at the beginning but stopping further and further into the excerpt on successive iterations (stopping points are marked as A, B, C, and D on Example 6). I instruct them to judge at each stopping point whether the following statement (written on the board) is true: "if the excerpt had continued for one more second, we'd probably hear the [MC]," substituting [MC] with whatever term they created for this event earlier in the class. Predictably, students rate this statement as

"false" at stopping points A and B, with a spike in "true" ratings occurring at stopping point C. The class, that is, is supremely confident that the MC will occur at m. 24, a confidence that renders the ensuing MC rejection all the more surprising. For the final playthrough, I ask the class to test their prediction against what the piece actually does, after which I solicit their technical and narrative explanations of the excerpt's surprising ending. Their script-based expectations primed, students easily hear the music "sidestep" the MC, "pulling the rug out from under us" and "swerving" onto a new chord. Many note that the final chord still feels like a half cadence and (often with some guidance) are led from that observation to hearing a key change, moving from a I:HC to a V:HC. To extend these ideas, I add that this is the overture to a comic opera, an observation that students quickly spin into comedic narratives in which the music "slips on a banana peel" and "crashes" haphazardly into a new key. The importance of this activity lies in showing students how the script they've built generates useful expectations that serve as a basis for composer-audience communication. By listening ahead with conventions in mind, they come alive to the dramatic twists and turns a sonata can take, inducing a shift from what Hepokoski describes as "'conformational form': form understood as conforming to a model" to form construed as a "dialogue with an intricate and subtle network of piece-appropriate norms and guidelines (rules of the game) both for constructing compositions (the concern of the composer) and then for grasping how the composer was likely to have wished us to construe [...] the individual piece under consideration."[47] One primary advantage of the statistical learning approach to sonata instruction advocated here is that it allows instructors to cultivate this dialogic mode of listening alongside student knowledge of sonata form components themselves.

Exposure to sets A and B exhausts many of the benefits of statistical learning, as well as (typically) the majority of class time. By this point, students have largely gotten the point that sonata form consists of a rich, multivalent sequence of musical actions that serves as a dialogic network against which individual pieces chart unique, meaningful journeys. Accordingly, the complete sonata expositions of set C form a supplementary group that can serve a number of functions; filling out any remaining class time with guided listening, structuring a self-guided immersion exercise conducted for homework, or serving as points of entry for the next class meeting. For this reason, half of the examples in set C are recycled from previous

47 James Hepokoski, "Sonata Theory and Dialogic Form," in *Musical Form, Forms, & Formenlehre: Three Methodological Reflections*, ed. Pieter Bergé (Leuven: Leuven University Press, 2010), 72.

sets, allowing students to reinforce their existing knowledge with previously-heard music before dropping them into a new action space. Likewise, most of the examples provide relatively straightforward illustrations of basic post-MC strategies, especially the vectored trajectory of part 2 towards a V:PAC—Hepokoski and Darcy's *essential expositional close* (or *EEC*)—its two-fold division into pre-EEC (S) and post-EEC (C) zones, and the use of either new or familiar thematic material to launch S. If I have five or ten minutes to spare, I will conclude class in a more traditional lecture-oriented mode, playing a few of the recycled excerpts explicitly seeded with a few points of focus. For instance, I might offer a statement like "If the opening of a symphony barrels towards a HC, the music that comes next barrels towards a PAC in the dominant key" and illustrate that concept with especially compact examples like the finales of Vaňhal's Symphony in C major Bryan C3 (excerpt 21) or Haydn's Symphony in B-flat major Hob. I:35 (excerpt 22), although excerpts 21–25 could all serve as examples here.

If time is short, on the other hand, I have students continue the statistical learning activity outside of class for a homework assignment, tasking them to listen to excerpts 21–29 and extend their visual diagrams to capture the new musical spaces contained therein, which we discuss during the next class. As with set B, the new pieces within set C progressively ramp up the drama and complexity of post-MC spaces: the monothematic excerpts 26–28, for instance, include a relatively straightforward S with a multi-module C space (excerpt 26: S begins at 0:30, $C^{1}$ at 0:47, $C^{codetta}$ at 1:10), a dramatic S that overcomes a lights out effect (excerpt 27: lights out in S consequent at 0:39), and a lightning fast S that explodes out of a texturally obscured MC and that encounters a lights out effect within the final build up to the EEC (excerpt 28: S begins at 0:16, lights out at 0:23). Finally, excerpt 29, from the finale of C. P. E. Bach's Symphony in G major Wq. 182 no. 1, challenges students to grapple with multiple MC candidates: the clear i:HC MC effect at 0:20 leads into sequential material that immediately negates the dominant key before producing a (syntactically viable, but texturally less clear) V:HC MC at 0:31.[48] Both this excerpt and the capstone excerpt 30, the first movement of J. C. Bach's Grand Overture in D major Op. 18, No. 6, are meant to be unpacked with instructor guidance in the following class, driving home the point that every single feature of the sonata is negotiable. After reviewing their homework, the bulk of their second day with sonata form is given over to an aural analysis of excerpt 30. As a self-contained exposition, this excerpt is lengthy and dramatic, but reasonably clear—MC at 0:54 (swift unisono approach after an

48 Thanks to L. Poundie Burstein for bringing this example to my attention.

obstinately overdetermined tonic, compare excerpts 12 and 13); lights out at 1:06 swerving into a tragic, wrong-key EEC candidate (in ii!) at 1:12; P intrusion at 1:23 corrects the mode and initiates a circle of fifths charge back to the dominant key; cadential progression at 1:37, repeated twice (first attempt is evaded) to arrive at the EEC at 2:21. But the real pedagogical value of excerpt 30 lies in what follows (and what does not follow) the exposition: this movement contains no recapitulation and no ESC. Instead, the movement ends a mere 47 seconds after the exposition on a I:HC. I thus find excerpt 30 useful not only for assessing my students on their ability to wield their new sonata script to make sense of extended and dramatic spaces, but also to drive home the point that even those aspects of sonata form that they may have picked up in prior classes—its tripartite division into exposition, development, and recapitulation—are fundamentally negotiable and inessential. "A restaurant typically has doors," I tell them, "and yet I can recognize a restaurant even if it had no doors. Similarly, a sonata typically has a recapitulation, but I can recognize this movement as a sonata even though it ends shortly after its exposition." Here, at the end of their initial exposure to sonata norms, students must confront the contingent and dialogic nature of all schematic perception: the point is not to assign labels, but to notice how a piece engages our knowledge of sonata conventions in creative ways. As an open-ended question at the end of this (typically, second) class, I leave students to ponder the expressive implications of leaving a sonata incomplete in this manner.[49]

As the starting point for sonata education, this statistical learning approach does leave some holes in student understanding. Aside from the obvious need to introduce standardized terminology and consider sonata form's many other components, perhaps the most glaring hole is the fact that the event models constructed by students in this exercise are trained exclusively on adjacent musical segments, and thus, arguably, inculcate no "long term" listening attitudes. These limitations, however, are easily

49 I hesitate to apply the word deformational to this example, however, since Parisian opera overtures in the 1770s are often structured as a quasi-Type 3 sonata whose development section is written over by a slow movement, as in the overture to Piccinni's *Roland*. (It is possible that this may be a precursor to the 19th-century Two-Dimensional Sonata as theorized in Steven Vande Mortele, *Two-Dimensional Sonata Form: Form and Cycle in Single-Movement Instrumental Works by Liszt, Straus, Schoenberg, and Zemlinsky* (Leuven: Leuven University Press, 2009).) In this respect, it is notable that J. C. Bach's Op. 18 is a posthumous amalgamation of earlier orchestral movements, and the first movement of Op. 18 No. 6 is an altered version of the initial Allegro from *Amadis de Gaule*. However, in Op. 18 No. 6, this movement is stitched together with unrelated slow and concluding movements, destroying the Type 3 resonances of the original *Amadis de Gaule* overture. As such, Op. 18 No. 6 genuinely consists of an expositional proposition with no recapitulatory answer: its structure of promise is forever unfulfilled.

rectified by turning the class toward more traditional sonata form lessons in later classes, like those devised by Seth Monahan for teaching Sonata Theory.[50] What is essential about this first lesson is, on the one hand, that it has given students a bed of statistically learned knowledge from which later knowledge can sprout and, on the other, that it has given them agency over that knowledge by allowing them to name and organize it collectively. No matter their starting knowledge, I have found that students profited immensely from the immersive exercise, quickly gaining fluency with sonata norms and acquiring a new, demystified understanding of musical form bound up with their everyday experiences.

## From exposure to fluency: learning the Do-Re-Mi

Students in my "Principles of Eighteenth-Century Music Theory" course—a 16-week course aimed at first-year music majors that, in modular fashion, students select from a menu of courses that also includes analogous courses devoted to jazz and American popular music[51]—acquire speaking fluency in the European galant style through an intensive, immersive semester centered on *partimenti*, the rule of the octave, source readings, schemas, and *Formenlehre*, culminating in a capstone minuet composition project.[52] In this capstone project, students organized themselves into duos, trios, and quartets. Each group was tasked both with learning an eighteenth-century minuet and trio movement and with composing a new minuet and trio movement of their own. In the vein of a similar minuet project designed by Janet Bourne, students put on a minuet recital in lieu of a final exam in which each group performed both their eighteenth-

50 Monahan, "Sonata Theory in the Undergraduate Classroom."

51 On the modular curriculum model, see Megan Lavengood, "Bespoke Music Theory: A Modular Core Curriculum Designed for Audio Engineers, Classical Violinists, and Everyone in Between," *Engaging Students* 7 (2019).

52 Ijzerman's *Harmony, Counterpoint, Partimento* served as a textbook for the roughly half-semester unit on partimento realization. I taught the eighteenth-century The Rule of the Octave through lesson plans adopted from Olga Sanchez-Kisliewska, "The Rule of the Octave in First-Year Undergraduate Theory: Teaching in the Twenty-First Century with Eighteenth-Century Strategies," *Journal of Music Theory Pedagogy* 31 (2017): 113–122. Source readings by eighteenth-century theorists like Joseph Riepel, Johann Philipp Kirnberger, and Heinrich Christoph Koch were largely excerpted from Wye J. Allanbrook, ed., *The Late Eighteenth Century*, Vol. 5 of *Strunk's Source Readings in Music History*, ed. Leo Treitler (New York: W. W. Norton & Company, 1997). Although no textbook readings were given for the unit on form, my lectures distilled information from Caplin, *Analyzing Classical Form*. Finally, the capstone minuet composition assignment was substantially inspired by Stefan Eckert, "'So, you want to write a Minuet?'—Historical Perspectives in Teaching Theory," *Music Theory Online* 11 no. 2 (June, 2005).

century and newly-composed movements for a panel of expert judges composed of faculty across the school of music, from whom composer identities were hidden.[53] As they listened, these judges attempted to discern the "authentic" minuets from those composed by students by rating the stylistic convincingness of each minuet on a scale from 1 to 5. A substantial portion of each group's grade rested on these ratings, on students' ability to fool the judges into thinking that their own composition was the product of eighteenth-century hands. And so, students had to develop immense fluency with the galant style, grasping not only its coarse outlines, but also myriad fine details of melodic, rhythmic, contrapuntal, harmonic, and textural behavior.

Inspired by Bruno Alcalde's methods for teaching pop song composition, I prepared students for their final project by engaging them in a weekly cycle of immersive listening, model composition, peer feedback, and guided reflection arrayed around different components of the minuet composition task.[54] This section describes one such iteration of this cycle trained on the composition of opening melodies, focusing specifically on how students learned the four-part "paired" variant of Gjerdingen's Do-Re-Mi schema. The aim was for students to acquire compositional (or "speaking") fluency with galant opening gambits, which, Gjerdingen and Bourne note, entails "learn[ing] all the subtle collostructions and prefabs" associated with the patterns in question.[55] Example 8 outlines the specific activities employed for this purpose.

The process of learning the Do-Re-Mi began with the self-guided immersion and composition assignment shown in Example 9. The assignment asked students to create opening melodies for a galant minuet by synthesizing two pieces of musical information. The first piece was rhythmic in nature: students began by paging through a 317-example corpus of four-bar minuet incipits compiled by Joseph Fort to find a compelling rhythmic shape for their melody, which they identified and copied onto a one-line rhythm staff.[56] Onto this rhythmic model, they then mapped the second piece of information; a named melodic schema—Gjerdingen's Meyer, Aprile, Do-Re-

53 Janet Bourne, "Outside the Classroom: Community-Engaged Learning Projects in Music Theory," *Engaging Students* 5 (2017). Unlike my project, Bourne's students performed for and were evaluated by residents of a retirement center who had been taking a class on Mozart.

54 Bruno Alcalde, "A Student-Centric Approach to Composing Popular Music in the Theory Classroom," *Engaging Students* 6 (2018).

55 Robert Gjerdingen and Janet Bourne, "Schema Theory as a Construction Grammar," *Music Theory Online* 21 no. 2 (2015): 5.4.3.

56 Joseph G. Fort, "Incorporating Haydn's Minuets: Towards a Somatic Theory of Music," (PhD. diss, Harvard University, 2015), 281–312.

***Do-Re-Mi Activities***

(Preparatory Homework) Writing Opening Melodies (Exx. 9–10)
*Students immerse themselves in Do-Re-Mi melodies (and other schemas) and compose one themselves*

*in-class activities*

1. Do-Re-Mi exposure
*Students listened to a 3.5 minute YouTube video containing 13 Do-Re-Mi exemplars*

2. Comparative Judgement (Exx. 11–12)
*Homework responses evaluated for stylistic convincingness*

3. Analytical Discussion (Ex. 13)
*Students identify distinguishing features of "authentic" Do-Re-Mi melodies*

4. Peer revision (Ex. 14):
*Homework responses infused with features identified in activity 3*

...

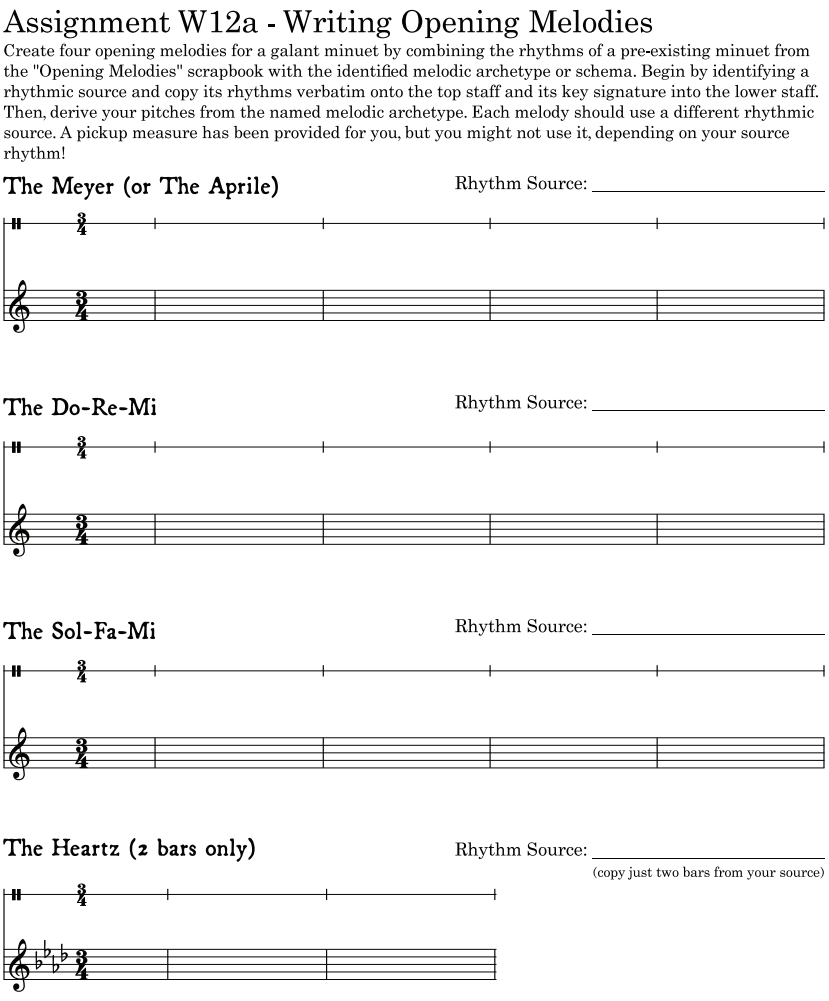
Final project compositions (Ex. 15):
*Students use their new knowledge to compose convincing minuet melodies.*

**Example 8**
Pedagogical sequence for teaching the Do-Re-Mi schema.

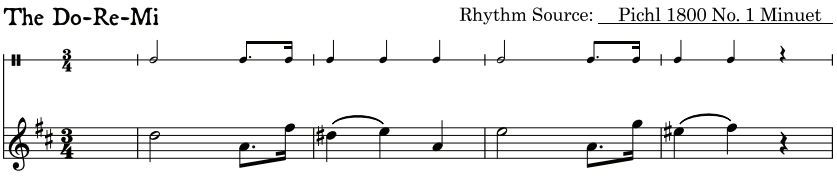
Mi (4-bar paired variant), and Sol-Fa-Mi (4-bar paired variant) schemas, as well as John Rice's Heartz schema—that they picked up through statistical learning.[57] In a prior class, I used class time to immerse students in examples of the Meyer and Aprile schemas and to walk them through composing the first of their four minuet melodies, but students had to pick up the remaining schemas outside of class by immersing themselves in exemplars I provided. For the Do-Re-Mi, students were given an "inspiration scrapbook" containing scores and audio for exemplars of the pattern

57 Gjerdingen, *Music in the Galant Style*; John A. Rice, "The Heartz: A Galant Schema from Corelli to Mozart," *Music Theory Spectrum* 36 no. 2 (Fall 2014): 315–332.

taken from minuets by Mozart, Wodiczka, Galuppi, and Martinez as well as a video created by John Rice with additional audio examples. In addition, students were given an instructor realization of the entire assignment as a model for their own work. Example 10 shows the Do-Re-Mi I composed for this purpose, modeled rhythmically on a minuet by Václav Pichl. Mirroring a naturalistic language acquisition task, then, the assignment asked students to abstract core features from the "native speech" of actual galant melodies and then to "speak back" a melody of their own.



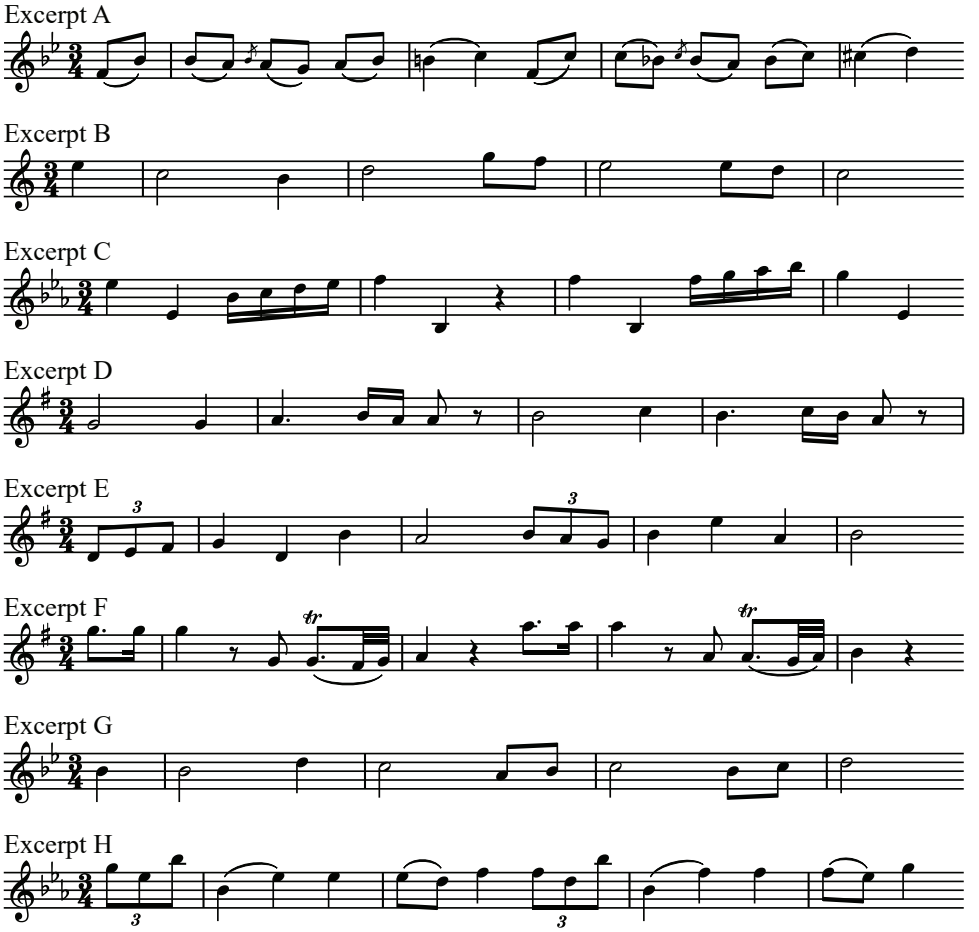

**Example 9**
Melodic composition assignment




**Example 10**

Do-Re-Mi melody composed by the author as a sample assignment completion.

With this preparatory composition assignment submitted, the following class meeting then engaged students in a comparative judgment activity that combined the central exposure-and-test paradigm of the statistical learning literature with the adjudication format of the approaching minuet recital. Structuring about thirty minutes of class time, this activity was divided into four parts. First, students were exposed to a three-and-a-half-minute YouTube video containing 13 galant exemplars of the Do-Re-Mi, re-establishing—or, for those who had completed the assignment without consulting the provided examples, establishing for the first time—the schema's aural features. Second, students evaluated the randomized set of eight Do-Re-Mi melodies shown in Example 9 for stylistic convincingness, four of which were taken from Fort's minuet corpus and four of which were drawn from student completions of the preceding assignment. Specifically, students completed a form that asked, for each excerpt, "How convinced are you that this excerpt was written in the Classical period?" using a scale from 1 to 9 where 1 indicates "very unconvinced" and 9 "very convinced." Third, after revealing to students which excerpts were student compositions and which were not, the class discussed what musical features helped to distinguish stylistically convincing from unconvincing Do-Re-Mi realizations. Fourth and lastly, the class then used those observations to collectively revise the compositions of their peers, bringing their contours into better alignment with eighteenth-century norms.




**Example 11**
Eight Do-Re-Mi melodies, four from Fort's Viennese corpus and four from student completions of Example 10, order randomized.

A summary of student responses to the evaluation task is shown in Example 12. Against a mean convincingness rating of 5.43 across all examples, Classical-era melodies (excerpts A, C, F. and H; mean = 6.86) ranked consistently higher in stylistic convincingness than student-composed melodies (excerpts B, D, E, and G; mean = 4). These results speak to the nebulous state of student knowledge at this point in their education. On the one hand, in line with empirical findings in the statistical learning literature, students have abstracted enough information from the music they

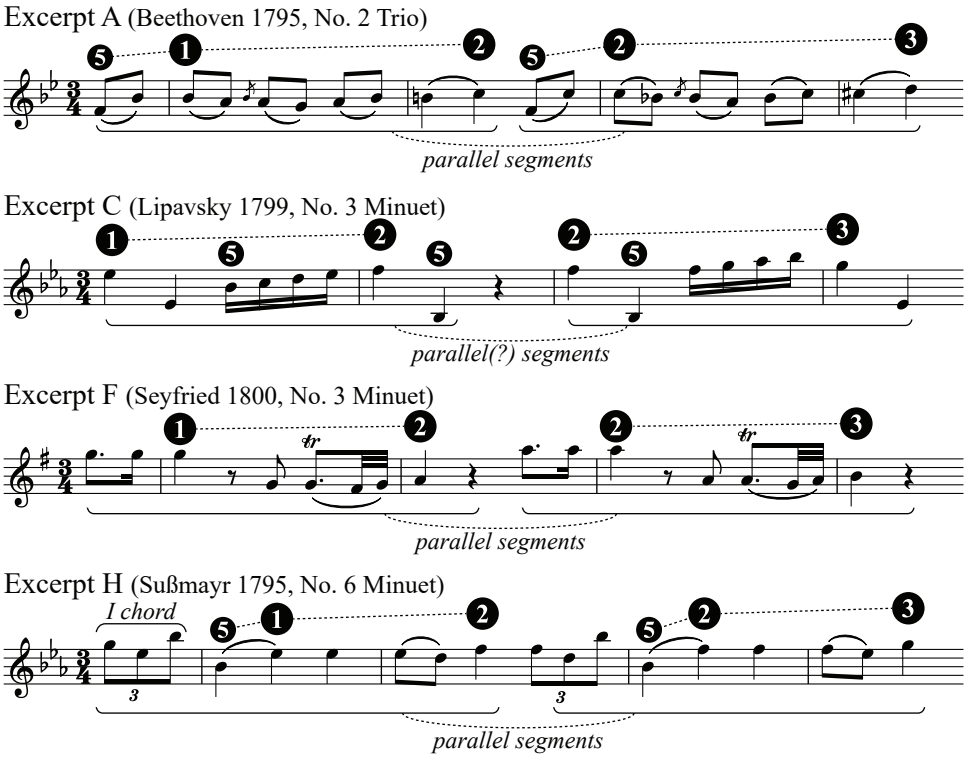
"How convinced are you that this excerpt was written in the Classical period?"

| Excerpt | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| Rating | 6.81 | 4 | 7 | 4.24 | 3.67 | 7.38 | 4.10 | 6.24 |

Scale: 1 = "Very unconvinced;" 9 = "Very convinced."

**Example 12**
Mean student-generated ratings of stylistic convincingness
for the eight excerpts shown in Example 9 (N = 22).

have heard to reliably distinguish grammatical (that is, stylistic) from ungrammatical (unstylistic) musical utterances. On the other hand, they are collectively unable to employ that same knowledge to "speak" the style fluently—that is, to make new melodies that *are* stylistically convincing. The explicit analytical discussion that followed this task worked to bridge this gap. I began discussion by revealing the eighteenth century compositions and noting the accuracy of the class's judgements, then prompted a comparative discussion with the following question: "What are the giveaways or tells that distinguish an authentic eighteenth-century Do-Re-Mi from one of ours?" Example 13 summarizes student observations in response to this question as a set of analytical annotations overlaid on the Classical-era examples, illustrating the salient features they felt were central to their grammaticity. The class's first observation was of the paired nature of all the eighteenth-century examples; each authentic example consists of a two measure segment that is (largely) repeated up a step in measures 3 and 4, producing a tightly-knit, repetitive structure exhibited by none of the student compositions. Relatedly, students noted that, with the exception of excerpt G, their peers always placed scale degree $\hat{3}$ on the downbeat of m. 3, whereas Classical-era examples paired a move from $\hat{1}$ to $\hat{2}$ in the first two measures with a parallel move from $\hat{2}$ to $\hat{3}$ in the final two. Sharpening their focus, I then asked the class what notes are emphasized in the eighteenth-century melodies besides the titular Do, Re, and Mi. Students began by noting prominent embellishing tones like the accented chromatic passing tones and suspensions on the downbeats of m. 2 and 4 in excerpts A and H, respectively, as well as the chordal leaping patterns in excerpt H emphasizing tonic (mm. 1-2) and dominant (mm. 3-4) harmonies, but they also observed that these embellishments were not used consistently. They did note, however, the frequent appearance of what Gjerdingen calls the "Adeste Fidelis variant" of the Do-Re-Mi, in which the schema's focal scale degrees rock back and forth with a low $\hat{5}$, as in excerpts

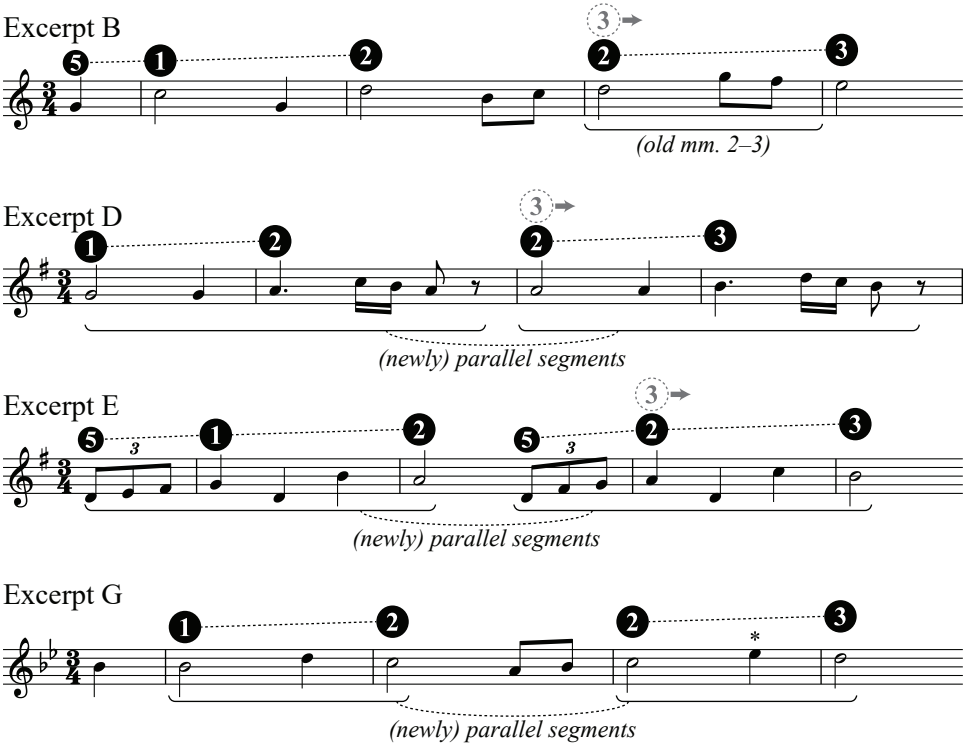



**Example 13**
Classical-period Do-Re-Mi excerpts annotated with student observations (excerpts identified according to their designation in Fort's minuet corpus).

A, C, and H.[58] By thus analyzing the evident structures that powered their intuitive judgments, students activated a useful bundle of explicit knowledge that could then be carried into composition tasks. Students learned, that is, that writing a convincing four-bar Do-Re-Mi involves constructing a parallel pair of two bar segments moving $\hat{1}$-$\hat{2}$ and $\hat{2}$-$\hat{3}$, embellished by descents to $\hat{5}$ and arpeggiations of local I or V harmonies.

Rounding out this exercise, students used their newly explicit knowledge to workshop their peers' compositions into the more stylistically convincing shapes shown in Example 14. Common revisions included deferring $\hat{3}$ until the downbeat of m. 4 in order to retain $\hat{2}$ at the downbeat of m. 3 (excerpts B, D, and E) as well as creating parallel segments by repeating material from mm. 1-2 in mm. 3-4 (excerpts

58 Gjerdingen, *Music in the Galant Style*, 85.

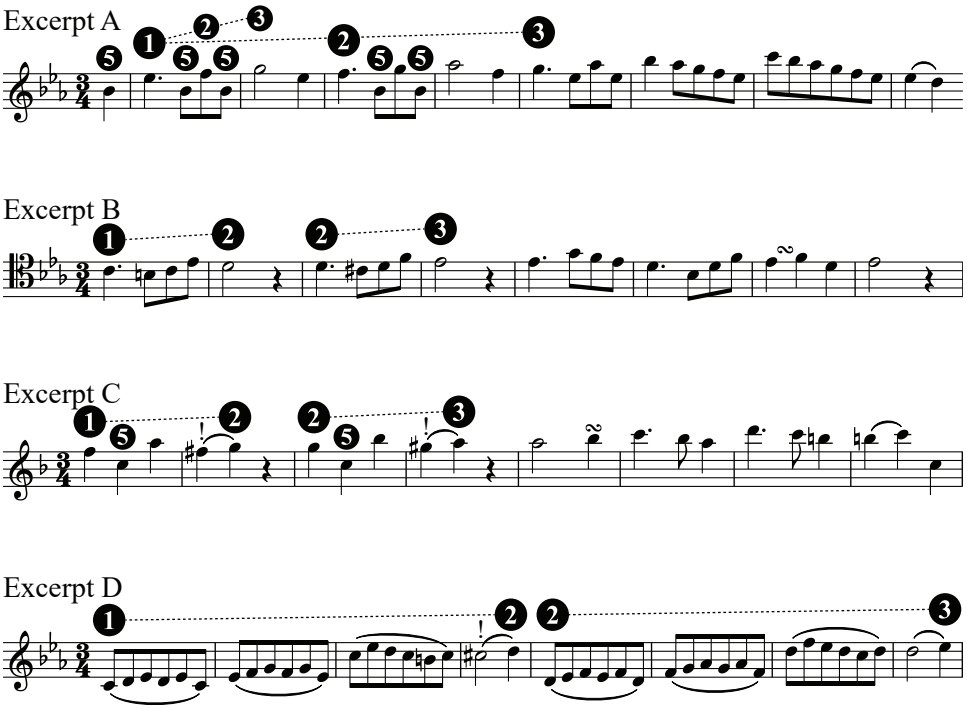



**Example 14**
Class revisions to student-composed Do-Re-Mi excerpts.

D, E, and G). In revising excerpt B, students changed the opening measure to feature alternating leaps to and from $\hat{5}$, pushed the original mm. 2-3 (which initially carried the resolution of $\hat{2}$ to $\hat{3}$) one measure later, and constructed a new m. 2 that features a chordal leap down to $\hat{7}$ that connects to the following measure via a passing tone. For excerpt D, students seized upon the embellished falling third $\hat{4}$-$\hat{3}$-$\hat{2}$ in m. 4 as a motive, pulling the figure verbatim into m. 2, which then transformed mm. 1-2 into a segment that could be repeated up a step to complete the pattern. Excerpt E, in contrast to the previous melodies, had a quite convincing first half, so students worked to create a parallel paired segment that was like the opening measures to a low $\hat{5}$ and that arpeggiated a V chord in m. 3. Finally, recognizing that excerpts E and G were based on the same rhythmic model, Leopold Koželuch's fourth minuet for the 1793 *Gesellschaft*, I gave students leeway to make a rhythmic alteration (contrary to assignment instructions) to the already quite convincing excerpt G: their revised

version replaces the two eighth notes at the end of m. 3 with a quarter note (marked with an asterisk) in order to replicate the upper-third melodic embellishment of m. 1. Notably, this upper third embellishment, though noted by Gjerdingen as a common diminution of the Do-Re-Mi, was not a feature of the Classical-era excerpts in the set and was therefore not explicitly discussed by the class. In spite of this, excerpts D, E, and G were all revised in ways that emphasize or newly create precisely this embellishment pattern. This suggests, perhaps, that students had statistically learned the upper-third embellishment from either the provided inspiration scrapbook (where it is quite common) or from their other encounters with galant music, and employed this knowledge as an implicit component of their compositional process, couched, perhaps, as an intuition that such an embellishment "feels right" for the pattern at hand.

Collectively, these activities stage a cognitive translation of implicit, statistically learned hunches about a style into explicit, compositionally actionable knowledge, moving students ever closer towards true fluency with galant practice. While none of the student-composed Do-Re-Mi melodies workshopped in this meeting made their way into any of the students' final projects, several groups wrote new melodies that demonstrate a totalizing command over this melodic schema. All four compositions that open with a Do-Re-Mi are excerpted in Example 15, a convincing set of melodies that not only incorporate the schema's characteristic paired structure (excerpts B, C, and D), leaps to $\hat{5}$ (excerpts A and C), and even the over-third embellishments (excerpts A, B, C, and D) that were never explicitly discussed in class, but that also strike out in artful ways by incorporating accented chromatic passing tones (excerpts C and D, marked with an exclamation point), nesting the pattern on different hierarchical levels (excerpt A), and extending the pattern into an 8-bar unit with parallel 4-bar segments (excerpt D). These compositions, reflecting the combined efforts of twelve students composing and revising together in four distinct groups, attest to a profoundly rich body of stylistic knowledge acquired through statistical learning, nurtured by explicit discussion, repeatedly put to work in both evaluative and creative tasks, and refined through both instructor and peer feedback.




**Example 15**
Four Do-Re-Mi melodies from student final projects.

## Paths Forward

Statistical learning provides a particularly powerful means of shaping the early phases of learning, providing students with a breadth of lived experience to ground new concepts or sharpen existing categories. But, as I have shown, statistical learning has more to offer pedagogy than the mere idea of sustained exposure. Rather, as a more general proposition, statistical learning compels us to construct learning paradigms and assessments that make students come alive to cue-rich musical environments, perceive the variant and invariant structures in that environment by aligning and comparing information, and thereby learn to make nuanced predictions about the music under consideration. From this perspective, statistical learning asks us to approach even workhorse concepts like cadences from new pedagogical perspectives, treating them not reductively in terms of a harmonic progression with a melodic component, but rather—following scholars like Felix Diergarten and Frank Lehman —as a complex

web of parameters and attributes toward which students must (and can) become sensitive through focused, guided exposure.[59] As a consequence, statistical learning also suggests skirting abstract, style-neutral definitions in favor of ones that ground concepts in specific styles, genres, idioms, or practices; to make students aware that a cadence looks different for a galant composer than it does for a 20th century film composer, for instance. Framed in this way, statistical learning offers lessons even for teaching styles for which students likely already have significant passive exposure, such as American popular music. Above, I mentioned Bruno Alcalde's approach to teaching popular music composition as an inspiration for my lessons on the Do-Re-Mi schema, and these lessons could just as easily be hooked back into units on popular music or songwriting.[60] For although students in that context would likely begin with a much larger body of statistically learned knowledge acquired passively throughout their listening lives, I suspect that they would face a similar disconnect between discerning well and "speaking" (i.e., composing or improvising) well, a disconnect that might be usefully remediated through the discussion and peer revision activities described above.

Summarizing empirical research into the perception of musical form, Richard Ashley advises scholars to "seek to understand the ways [listeners] use their everyday musical experiences to understand new works, and to better understand how they comprehend musical works in their 'mother tongues.'"[61] By now, empirical research has well established statistical learning as a central mechanism by which these "everyday musical experiences" give rise to comprehension in natural settings. Yet in spite of this robust literature, very few studies have examined the effectiveness of statistical learning in instructional settings, especially in music classrooms. That is, while we have a good idea about how statistical learning works in the largely inattentive, undirected, and uninstructed context of informal learning settings, comparatively little empirical research has interrogated how the attentive, purposeful, and instructed context of classroom learning alters its effects. This gap between

59 Felix Diergarten, "Beyond 'Harmony': The Cadence in the Partitura Tradition," in *What is a Cadence? Theoretical and Analytical Perspectives on Cadences in the Classical Repertoire*, ed. Markus Neuwirth and Pieter Bergé (Leuven: Leuven University Press, 2015), 59-84; Frank Lehman, "Hollywood Cadences: Music and the Structure of Cinematic Expectation," *Music Theory Online* 19 no. 4 (December 2013).

60 Alcalde, "A Student-Centered Approach to Composing Popular Music."

61 Richard Ashley, "Musical Structure: Form," in *The Routledge Companion to Music Cognition*, ed. Richard Ashley and Renee Timmers (New York: Routledge, 2017), 188.

laboratory research and pedagogical application is significant. In the field of second language pedagogy, for instance, early enthusiasm for research on casual language learning led to decades of classroom practice based on poorly-grounded evidence—practices that de-emphasized corrective feedback and explicit instruction in favor of immersion-style teaching wholly in the target language at slightly above students' comprehension levels. This consensus is now widely regarded as flawed.[62] So while the pedagogical interventions described here are grounded in the emerging literature surrounding statistical learning in classroom language instruction, I caution readers that consensus within this nascent field is sure to change in the coming years. (From a different perspective, this also presents an exciting avenue for theory pedagogues to contribute their own studies to an emerging interdisciplinary conversation.) Hence, the approaches and interventions described in this article should be regarded as a tentative set of initial steps for bringing statistical learning into the music theory classroom, steps that (anecdotally) show great promise but which remain untested. They thus offer not only practical models ready to implement in one's own teaching, but also a set of test cases ready to be scrutinized under the empirical microscope. I share them as an invitation: to harness the promise of statistical learning, to test its potential in real classrooms, and to build the evidence that will shape the future of music theory pedagogy.

62 See Nina Spada, "SLA Research and L2 Pedagogy: Misapplications and Questions of Relevance." *Language Teaching* 48 no. 1 (January 2015): 69-81.

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