SUBSTANTIAL MUSICAL SIMILARITY IN SOUND AND NOTATION: PERSPECTIVES FROM DIGITAL MUSICOLOGY

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The rubric for substantial musical similarity arose in the judgment of *Arnstein v. Porter*.[1] The judge, Jerome Frank, aware of the frequency with which Arnstein's previous claims of copyright-infringement had been unsuccessful, denied his new request for a jury trial. Frank ruled that while a *copy* merited a hearing before a judge, only evidence of

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1. Arnstein v. Porter, 154 F.2d 464, 468–69 (2d Cir. 1946).

substantial musical similarity could justify the seating of a jury. He also held that a determination of similarity required the adjudication of "lay listeners."[2] The endless uncertainty to which this position has led is evident in an ever-rising number of music-copyright infringement suits.[3] The expanding variety in means of producing music continues to exacerbate this stalemate. The rapid development of digital media that underlies this variety has prompted a steady increase in the number of works seeking protection.[4] In combination, these phenomena suggest continued increases in claims without any corollary likelihood of establishing definitive rubrics for the adjudication of substantial musical similarity.

In parallel with efforts by the legal community to establish such rubrics, several areas of music scholarship are developing independent models of musical similarity for other purposes.[5] In these arenas, extensive acknowledgment is made of the coupling of new initiatives with rising technical capabilities.[6] Commercial interest arises from the growth of music-identification and music-recommendation applications in music- and video-streaming services.[7] Academic interest comes from a spectrum of sub-disciplines, which we examine herein. The need for cross-conversation between legal specialists and other parties with an extensive interest in musical similarity should be self-evident.

From the perspective of a specialist in digital musicology, many judgments of recent times seem entirely arbitrary and, in the aggregate, meaningless.[8] In 1946, the public knew music from live performance, from 78 rpm recordings, and from radio broadcasts.

2. Interested readers will find samples of disputed material, arguments, and decisions at Charles Cronin, *Music Copyright Infringement Resource*, http://mcir.usc.edu (last visited Mar. 14, 2018) [https://perma.cc/49Z7-ZTTG]. Gary A. Rosen traces Arnstein's *curriculum vitae* in UNFAIR TO GENIUS: THE STRANGE AND LITIGIOUS CAREER OF IRA B. ARNSTEIN (2012).

3. Rakesh Sharma, *Trends in Copyright Litigation*, INVESTOPEDIA (Aug. 20, 2015, 10:32 AM), https://www.investopedia.com/articles/investing/082015/trends-copyright-litigation.asp [https://perma.cc/6XZL-469J].

4. Charles Cronin, *I Hear America Suing: Music Copyright Infringement in the Era of Electronic Sound*, 66 HASTINGS L.J. 1187, 1193 (2015) (especially Section C).

5. *Id.*

6. *See id*. (especially Section C).

7. *Number of Spotify Monthly Active Users Worldwide from 2015-2017*, STATISTA (Feb. 2018), https://www.statista.com/statistics/367739/spotify-global-mau/ [https://perma.cc/V892-JWWD].

8. The lack of a common yardstick and the diversity of submitted media undermine the goal of uniformity. A decadal statistical profile of US copyright decisions based on musical content (as opposed to contractual issues) shows that since 1940 only eight were based exclusively on scores. From 1940 to 1999, scores and recordings in combination were submitted for 31 cases, while 18 involved recordings only. Since 2000, 46 decisions have been based exclusively on recordings, none on scores, and only two on other media (Eleanor Selfridge-Field, Music in the Eye, Ear, and Mind (forthcoming 2018).

Classical music,[9] vaudeville,[10] patriotic music,[11] and hymns[12] were among the most common genres in live performance. Recorded music presupposes a uniform process consisting of composition, publication (under contract), and recording (under license). Radio broadcasting broadened distribution channels but only as a caboose on the train. The rapid development of music technologies over the past century is carefully documented elsewhere.[13]

As standardized musical instrument digital interface (MIDI) hardware and software seeped into society, the ability to create new music became available to anyone with access to a MIDI-enabled instrument.[14] A user who could play by ear would not need to know how to read or write music. A tidal wave of audio-editing products continues to complement these activities.[15] Such products give garage bands abilities that made earlier generations of artists dependent on professional studios. Music-technology software is to recording what Photoshop is to the digital editing of photographs. With this democratic revolution in music production, the number of complaints of infringement has risen dramatically.[16] Owing to the transparency offered by Charles Cronin's *Music Copyright Infringement Resource*, anyone can hear (and in some cases see) the music of plaintiff and defendant while consulting synopses of arguments and judgments.[17] Anyone conversant with digital music technology can see that a substantial portion of pending claims may concern musical property that is partly mechanical in its gestation. Are these hybrid works entitled to full protection? Some cited works obviously contain pre-existing material.[18]

A number of these issues intersect in the "Blurred Lines" case.[19] Viewed against the background of evolving music technologies, the allowable materials in this case are not directly comparable. The Gaye

9. Annegret Fauser, *Music During World War II*, OXFORD UNIV. PRESS BLOG (Feb. 28, 2013), https://blog.oup.com/2013/02/music-during-world-war-ii/ [https://perma.cc/PH7V-73HS].

10. *History: Vaudeville and Broadway*, PBS (Dec. 2, 2008), http://www.pbs.org/wnet/makeemlaugh/comedys-evolution/history-vaudeville-and-broadway/31/ [https://perma.cc/LG3H-VSKH].

11. *See* KATHLEEN E. R. SMITH, GOD BLESS AMERICA: TIN PAN ALLEY GOES TO WAR (2003).

12. DAVID W. MUSIC & PAUL AKERS RICHARDSON, "I WILL SING THE WONDROUS STORY:" A HISTORY OF BAPTIST HYMNODY IN NORTH AMERICA 427–28 (2011).

13. *See* Cronin, *supra* note 4 (especially Section C).

14. Tom Bateman, *How MIDI changed the world of music*, BBC NEWS (Nov. 28, 2012), http://www.bbc.com/news/technology-20425376 [https://perma.cc/WM5U-Y42X].

15. John Twells, *The 14 Pieces of Software that Shaped Modern Music*, FACT MAGAZINE (Oct. 1, 2016), http://www.factmag.com/2016/10/01/the-14-pieces-of-software-that-shaped-modern-music/ [https://perma.cc/2EZ4-LCNE].

16. Sharma, *supra* note 3.

17. Charles Cronin, *Concepts of Melodic Similarity in Music-Copyright Infringement Suits*, 11 COMPUTING IN MUSICOLOGY 187, 187–209 (1998).

18. 17 U.S.C. 103(b) (2012).

19. Williams v. Bridgeport Music, Inc., No. LA CV13-06004 JAK (AGRx), 2015 WL 4479500 (C.D. Cal. Jul. 14, 2015).

estate's claim rested on a pencil transcription of "Got to Give It Up."[20] Pharrell Williams and Robin Thicke have created a cloud of registrations (thirteen at last count) for "Blurred Lines."[21] These iterations differ mainly by instrumentation. Members of the public may be more familiar with other instantiations of each work, including the original audio recording for Marvin Gaye and a video of "Blurred Lines" for Williams and Thicke.

The 2015 judgment in favor of the Gaye estate involved expert opinion that was not limited to the registered materials.[22] A particularly contentious issue was Williams' and Thicke's expressed intention of evoking Gaye's "style."[23] The Gaye family produced a digital "overlay" of the two works[24] to show segments that matched harmonically (but in which the "corresponding" segments do not align in their positions within the melody; see Figs. 3 and 4 in Section II.C). Some "sliding" of the two tracks (alignment of non-synchronous passages) would have been necessary for the demonstration.[25] As written, both pieces are in the same meter (4 4), which likens them to the preponderance of all American popular music in recent decades (the key varies with the arrangement). The court followed the growing but dubious trend of assuming equivalence between the lead sheet representing Gaye and the sound overlay.

The aim of this essay is to demonstrate why instantiations of a musical work in sound and notation are *not interchangeable* for legal purposes. They are each *different instantiations* of a musical work. We articulate their *non-equivalence* in adjudicating copyright infringement claims. Five main topics are considered. Part I will discuss notation; Part II will go into sound (audio) as a basis for evaluating musical content; Part III discusses cognitive issues; Part IV will explore social judgments in estimating musical similarity; and finally Part V will talk

20. *Id*. at *7.

21. Public Catalog, U.S. COPYRIGHT OFFICE, http://cocatalog.loc.gov/ (last visited Mar. 14, 2018) (search "blurred lines") [https://perma.cc/42N5-AAS8].

22. Yuntao Cui, *Williams v. Gaye: "Blurred Lines" Appeal Hearing Centers on Admissibility of Evidence About Original Sound Recording*, JOLT DIGEST (Oct. 31, 2017), https://jolt.law.harvard.edu/digest/williams-v-gaye-blurred-lines-appeal-hearing-centers-on-admissibility-of-evidence-about-original-sound-recording [https://perma.cc/HZT3-2TDH].

23. If we look to fashion trends instead of music, "style" generally refers to a constellation of features in a context in which the elements of these groups are constantly changing. Fennell and Monson offer the term "constellation" to describe feature similarities between the two musical works. In the vacuum of *only* these two works, this is arguably a reasonable description. Yet it is not a proof of intentional appropriation. In music, unlike fashion, the order of events is fundamental. In picking and choosing musical passages out of order, one can distort the continuity of its content. There may be no "intact" replication of the alleged model.

24. Eriq Gardner, *Marvin Gaye's Children Use Audio Mashup to Prove 'Blurred Lines' Is Infringing*, THE HOLLYWOOD REPORTER (Sept. 8, 2014, 3:33 PM), https://www.hollywoodreporter.com/thr-esq/marvin-gayes-children-use-audio-731178 [https://perma.cc/SYN8-TXHB].

25. Williams v. Bridgeport Music, Inc., No. LA CV13-06004 JAK (AGRx), 2015 WL 4479500 (C.D. Cal. Jul. 14, 2015).

about additional questions likely to arise in emerging technologies of music creation and performance.

I. NOTATION-BASED EVALUATION

Melody, harmony, and rhythm are the traditional parameters by which theorists evaluate musical works in the classroom. Expert testimony normally restricts its consideration to these three, with primary emphasis on melody, or on melodic fragments.[26] Harmony is rarely evaluated, primarily (it seems) to spare judges the difficulty of following musical arguments.[27] Most adults innately perceive and understand meter and coarse rhythmic patterns, but legal proceedings rarely mention rhythmic features.[28] For millennials, the most essential feature of popular music seems to be textual content (i.e. lyrics); the copying of which is so conspicuous that artists avoid it. Melody is accessible to the public by rudimentary means—humming, whistling, and cognitive abstractions of complex examples. In the rare instances when it is analyzed, melody receives the most scrutiny in court, but the analysis is usually literal and amateurish.[29] Attention rests on diluted descriptions of "key" phrases and particles of phrases that do not warrant the adjective "substantial."[30]

The *Music Copyright Infringement Resource*[31] offers a valuable overview of a century of cases reported with both the musical evidence presented and the arguments for and against the initial claim. Its existence demonstrates the low level of musical detail that is considered and the naiveté of judges. It demonstrates the tendencies to concentrate on trivial, inadequately characterized, or barely noticeable elements of the pertinent pieces. It is difficult to believe that in rejecting Arnstein's 1946 claim, the judge wished to prompt the mountain of trivia that subsequent cases have generated over the succeeding seventy years. To distance this consideration from this trivia, we here examine melody and accent in Section A, harmonic structure in Section B, and remedies used in music-similarity research in Section C to address ambiguity and uncertainty.

A. Melody and Accent

Two melodies that share the same pitches are distinguishable from one another by their accented tones. They are recognized by listeners partly on the basis of accentual patterns. Accent helps to

26. Debra Presti Brent, *The Successful Musical Copyright Infringement Suit: The Impossible Dream*, 7 U. MIAMI ENT. & SPORTS L. REV. 229, 248–49 (1990).

27. John R. Autry, *Toward a Definition of Striking Similarity in Infringement Actions for Copyrighted Musical Works*, 10 J. INTELL. PROP. L. 113, 140 (2002).

28. *Id*.

29. Brent, *supra* note 26 at 249.

30. *Id*.

31. Cronin, *supra* note 4.

differentiate melodic foreground and background notes.[32] In contents involving either two voices or voice and instrument, the accentual patterns may not coincide. A fundamental reason for avoiding arguments based on lists of consecutive notes *without coincident accentual information* is that the melodies so compared may not seem at all similar either to listeners or to score-readers (see Section III).

Arguments claiming that a composer's limitation to seven notes (*recto*: pitch names [A..G]) deprives composers of many choices are fallacious. The possibilities of melodic construction and variation, even when constrained by a common list of only a dozen tones, are innumerable. Verbal discussion may treat melody as one-dimensional both because we are incapable of singing multiple voices simultaneously and because we unconsciously simplify intricacies to enable memory. Individual notes within a melody can have several dimensions, among them direction (upward, downward) and diverse coupling of rhythm and pitch (half-note A versus quarter-note A). A string of consecutive notes (i.e. a melody) may contain shifting accents, changing harmonies, and nuances that vary with each repetition. In combination, differences of contour, length, and inflection produce a steady stream of phrases that are continuously used in new and unexpected ways. More significantly, combinatorial possibilities among them greatly extend the power of features that by themselves are less rich. As discussed in courtrooms, melodic description can amount to skeletal content divorced from its context. By analogy with incomplete sentences in literary works, impoverished expressions of a musical idea deserve no place in litigation. The expression of an idea assumes complete, not truncated, expression.

In the "Blurred Lines" case, this kind of melodic desiccation is a significant issue. No one could reconstruct "Got to Give It Up" from the melodic fragments presented in court (*see* Figure 1). The claim that a phrase taken to be significant "ascended" in both works likens both pieces to more than half the world's music.[33] In a repertory of thousands of works, broad-based statistics suggest that fifty-five to sixty percent of opening phrases ascend (before descending); forty to forty-five percent descend, then ascend.[34] A few melodies remain stationary in their initial bars.[35]

Figure 1 cross-references some of the melodic fragments used in the "Blurred Lines" case with a database of 20,000 musical pieces to reveal the number of instances in which a certain pitch pattern was

32. *See* Peter Q. Pfordresher, *The Role of Melodic and Rhythmic Accents in Musical Structure*, 20 MUSIC PERCEPTION 431-464 (2003).

33. Williams v. Gaye, 885 F.3d 1150, 1188 (9th Cir. 2018) (Nguyen, J., dissenting).

34. David Huron, *The Melodic Arch in Western Folksongs*, *in* COMPUTING IN MUSICOLOGY 10: AN INTERNATIONAL DIRECTORY OF APPLICATIONS 1995-96, at 6 (Eleanor Selfridge-Field ed., 1996).

35. *See id*.

used. If the key (governing tonality[36]) is C Major, each degree of the 8-note scale is numbered such that C=1, D=2, E=3, F=4, G=5, A=6, and B=7 (the eighth-note C is an octave above the first C). The example numbers used here follow those in court testimony.[37] Readers will see that, even in their brevity, the pairs do not exactly correspond. To make them comparable to each other, each series is limited to the first four (in one case, five) tones. Only in Ex. IIB and IIIB, both of which come from "Blurred Lines," does the same pattern recur.

Figure 1: Simple (scale-degree) melodic description of selected passages of "Got to Give It Up" and "Blurred Lines."

	Ex. IA Got to Give It Up	Ex. IB Blurred Lines	Ex. IIA Got to Give It Up	Ex. IIB Blurred Lines	Ex. IIIA Got to Give It Up	Ex. IIIB Blurred Lines
Pitch pattern, 4 (5) digits	5-6-1-2	3-5-6-1	6-1-2-1	6-1-1-1	6-1-2-1-1	6-1-1-1
No. of Matches in 20,000 items	38	26	4	11	0	11

This kind of analysis shows a naïve approach because it does not integrate information about rhythm or harmony.[38]

Phrase length is a bigger issue. More matches should occur between short passages than long ones. The likelihood of a match declines as search phrases become longer. If we were to take account of metrical context, note durations, and accent, considerable differentiation would begin to emerge, even in short samples.

To illustrate the differentiating value of extending extracts beyond a common starting point, we compare two familiar melodies that branch apart quickly. "Mary Had a Little Lamb" (1830)[39] and "An Irish Lullaby" ("Too Ra Loo Ra Loo Ral," 1913)[40] both start with phrases that can be described numerically as 3-2-1-2-3. However, they

36. In this discussion examples are transposed to the key of C to facilitate comparison. Any key can be a governing key. The musical examples shown in Figures 1 and 2 are in A Major. Thus A=1, B=2, etc. Arabic numerals are widely used in melodic discussion to designate scale degrees (to avoid the confusion that accrues in discussions based on pitch names).

37. Testimony of Defendant's Expert Witness Ingrid Monson, Pharrell Williams v. Bridgeport Music, Inc., 885 F.3d 1150 (9th Cir. 2018) (No. 213CV06004), 2015 WL 4742407.

38. Harmonic considerations, however, require longer passages for evaluation.

39. *Mary Had a Little Lamb*, WIKIPEDIA, https://en.wikipedia.org/wiki/Mary_Had_a_Little_Lamb (last visited Jan. 2, 2018) [https://perma.cc/QDH2-WKK2].

40. *Too Ra Loo Ra Loo Ral*, WIKIPEDIA, https://en.wikipedia.org/wiki/Too_Ra_Loo_Ra_Loo_Ral (last visited Jan. 2, 2018) [https://perma.cc/F2G9-C2JA].

are in different meters—4 4[41] and 6 8.[42] "Mary" continues 3-2-1-2-3-**3-3**, while "Lullaby" evolves as 3-2-1-2-3-**5**. Metrically, "Mary had a little lamb" is similar to a march,[43] while "An Irish Lullaby" is similar to a jig.[44] Listeners rarely recognize as similar two melodies that do not have the same meter and similar patterns of duration. Here the contours are similar, but the meters are different.

Not all the notes in each list of pitches make *equal* contributions to melodic identity. The ones that are accented (by falling on strong beats) or are held for longer durations are better remembered. Some intervening notes are simply there to make a melody smoother. The *cognitive weight* of each note (Section 3) merits evaluation.[45] Notes that continue a phrase may not be particularly significant, although they can differentiate one melody from another at a purely numerical level.[46] The majority of melodies that begin similarly are not the same after two measures.[47] They are almost never the same after four.[48] If we differentiate three *accentual* levels—**strong**, neutral, and *weak*—the opening passages of "Mary had a Little Lamb" and "An Irish Lullaby" become **3**-2-1-2-**3**-3-3 and **3**-2-1-2-**3**-5. Although both beginnings can be stated in summary to be 3..3 (the pitches of the two accented notes to the exclusion of non-accented ones), we would hardly consider the fleshed out melodies to be the same. We can show the differing continuations graphically (Figure 2), where we see the combinatorial effect of pitch and duration.

41. Beats (here quarter notes) grouped by four.

42. Beats (here eighth notes) grouped by sixes.

43. The Editors of Encyclopaedia Britannica, *March*, BRITANNICA, https://www.britannica.com/art/march-music [https://perma.cc/7K65-2759].

44. Alan Ng, *Rhythm (Tune Type) Definitions*, IRISHTUNE.INFO, https://www.irishtune.info/rhythm/ (last updated Dec. 14, 2017) [https://perma.cc/8Y8J-534K].

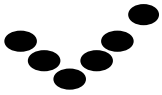
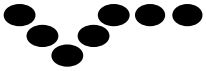
45. Emilios Cambouropoulos, *Melodic Cue Abstraction, Similarity, and Category Formation: A Formal Model*, 18 MUSIC PERCEPTION 347, 358 (2001).

46. *Id.* at 357-58.

47. *Id.* at 356-57.

48. *Id.*

Figure 2: Schematic view of similarities and differences that arise with melodic extension (Row 3) and in combination with duration when comparing "Mary Had a Little Lamb" and "An Irish Lullaby."

	"MARY HAD A LITTLE LAMB"	"AN IRISH LULLABY" ("TOO RA LOO RA LOO RAL")
PITCH (CONTOUR), 4-5 "digits" only		
PITCH (CONTOUR), 6-7 digits		
PITCH AND DURATION, 6-7 digits		

In sum, perception of similarity and difference will depend on the length of the example and on whether only pitch is considered or whether pitch and duration are examined in combination.

Where we to add a harmonic dimension to these schematic views, we would begin to find differentiation between our two sample melodies just beyond the point where our figures and illustrations stop in Figure 2. This is an important argument for requiring longer passages in copyright-infringement evidence. Beginnings can be deceptive not only in melodic discrimination but also in lyrics searches.[49] Similarity at the start does not indicate similarity throughout.[50] In fact, those who consciously seek to utilize a pre-existing work tend to cover their tracks by changing initial details (of text or music or both).[51] It pays to capture longer quotations when the aim is to demonstrate that the fundamental intent was to make a copy

49. Cambouropoulos, *supra* note 45 at 357-58.

50. *Id.*

51. John Walter Hill & Tom R. Ward, *Two Relational Databases for Finding Text Paraphrases in Musicological Research,* 23 COMPUTERS AND THE HUMANITIES 105, 107 (1989) (previously shown in folksong repertories, this principle is demonstrated in Roman monodies of the seventeenth century).

without acknowledgment. In all events, comparison of harmonic schemes is only viable when many consecutive measures of both pieces are available. Like accent, harmony is not "written" in notated scores but it is fully present in the complete score and adequately indicated in lead sheets.[52]

Complaints about a lead sheet serving as a master copy of "Got to Give It Up,"[53] whether or not it appeared downstream of a studio version of the piece, in no way deprives adjudicators of harmonic information. In fact, lead sheets facilitate comparisons of harmonic and melodic structure by identifying harmonic information synoptically.[54] In contrast to the succinctness of the Gaye lead sheet, the registered versions of "Blurred Lines" are full of "fillers"—rhythm tracks without pitch, repetitions of short passages, octave transpositions, and replication of entire sections.[55] These may characterize a specific arrangement, but they do not augment substance. The bare-bones lead sheet of "Got to Give It Up" conveys an adequate profile to identify the piece *per se*. It does not preclude enhancements in performance.

B. Harmonic Structure

In general, musicians think of harmonic structure as an entity.[56] Under the surface lie many details. Harmonic structure unfolds more slowly over musical time than melody.[57] Harmonic change, when it occurs, reinforces the significance of associated melodic pitches.[58] In this sense, harmony operates on a higher, but more abstract, level than melody. In musical comparisons, it can be a crucial tool for differentiation. Harmony is more difficult to adjudicate than other features of music because the roster of chords available for use is small by comparison to the enormous variety of pitch-duration-accent *combinations* that contribute to melodic definition.[59] However, each chord can assume several functions that depend on overall tonal context.[60] These functions are indicated by Roman numerals or, in lead sheets, by chord name.[61]

52. *Learn How To Read Lead Sheets: The Theory Behind Music's Most Versatile Pages*, MUSICNOTES, https://www.musicnotes.com/now/tips/learn-read-lead-sheets-theory-behind-musics-versatile-pages/ [hereinafter *Lead Sheets*] [https://perma.cc/M6Y5-EEDM].

53. Williams v. Gaye, 885 F.3d at 1183 (Nguyen, J., dissenting).

54. *Lead Sheets*, *supra* note 52.

55. Ashley Cullins, *"Blurred Lines" Appeal Brief Says Artists Can't Copyright a Groove*, HOLLYWOOD REP. (Apr. 26, 2017, 4:29 PM), https://www.hollywoodreporter.com/thr-esq/blurred-lines-appeal-brief-says-artists-cant-copyright-a-groove-997767 [https://perma.cc/H6Z2-QKMX].

56. *See* Jamshed Bharucha & Carol L. Krumhansl, *The Representation of Harmonic Structure in Music: Hierarchies of Stability as a Function of Context*. 13 COGNITION, 63 (1983).

57. DON MICHAEL RANDEL, THE HARVARD DICTIONARY OF MUSIC (14th ed. 2003).

58. *Id*.

59. *See* Claire Arthur, *Taking Harmony Into Account: The Effect of Harmony on Melodic Probability*, 34 MUSIC PERCEPTION 405 (2017) (providing an excellent systematic study of the role of harmony in melodic comparison).

60. *Id*. at 409.

61. *Id*.

Classical musicians have observed for decades that in popular music the same harmonic patterns recur from piece to piece.[62] Conventionally, chord roots are indicated by Roman numerals: I, II, IV, V, and VI (infrequently III and VII), following the Arabic numerals used to designate scale degrees (1..7) for melody.[63] Every chord is based on a particular scale degree (in guitar parts, each chord may be indicated by the name of its root, e.g. "G Maj" instead of the Roman numeral "V").[64] Much popular music of the past century relies on only three chords—I, IV, and V (sometimes expanded to include II and VI).[65] The degree of harmonic-pattern similarity within a complete repertory (all of the works of the Beatles, for example) may be greater than the specific correspondence between two pieces from different repertories.[66]

The establishment of substantial musical similarity by formal methods would ideally require composite measures of all the features so far named—melody, meter, accent, rhythm, and harmony. While the likelihood of coincidental similarity is great in any one-dimensional analysis (based on melody *or* harmony *or* rhythm), it is very small when all these features are combined. Yet no case in which multiple features have been evaluated in a synchronized fashion appears to exist in the annals of U.S. copyright litigation.

C. Remedies

1. Minimum Length Values (MLV)

In big-data projects, researchers acknowledge at the outset that the number of matches to be found in a large corpus will be inversely related to the length of the search-string (number of notes that define the melody).[67] The longer the string, the fewer the matches. Melodic

62. Imogen Tilden, *What pop music owes to the classical masters*, THE GUARDIAN (Jan. 24, 2013), https://www.theguardian.com/music/2013/jan/24/what-pop-music-owes-classical-masters [https://perma.cc/TSE9-2T3M].

63. Arthur, *supra* note 59.

64. The fact that individual tones of a chord (which consists of three or more pitches) can be distributed in various ways is ignored in evaluating harmonies. Aurally and cognitively, the basic character is the same irrespective of the inversion (arrangement of tones heard simultaneously).

65. Dave Carlton, *I Analyzed the Chords of 1300 Popular Songs for Patterns. This Is What I Found*, HOOK THEORY (June 6, 2012), http://www.hooktheory.com/blog/i-analyzed-the-chords-of-1300-popular-songs-for-patterns-this-is-what-i-found/ [https://perms.cc/CHR3-LRQA].

66. *See, e.g.*, *Secrets of the Beatles*, SEECHORD, http://www.seechord.co.uk/song-writing/secrets-of-the-beatles/ [https://perma.cc/Z9GX-2LED]; *see also, e.g.*, Aaron Krerowicz, *The 12 Bar Blues in Beatles Music, Part 2: Analyses*, FLIP SIDE BEATLES (Jan. 14, 2013), https://www.aaronkrerowicz.com/beatles-blog/the-12-bar-blues-in-beatles-music-part-2-analyses [https://perma.cc/6X45-ES2S].

67. *See* Craig Stuart Sapp, Yi-Wen Liu & Eleanor Selfridge-Field, *Search-Effectiveness Measures for Symbolic Music Queries in Very Large Databases*, ISMIR (2004), http://ismir2004.ismir.net/proceedings/p051-page-266-paper135.pdf [https://perma.cc/C8YV-WK6B].

quotations of four to six notes (as used in the "Blurred Lines" litigation and in myriad cases preceding it) are useless in a world populated by millions of pieces of music. Within the soundscapes of our musical culture, tens of thousands of pieces of music are available via notation, recordings, radio, television, film, and spontaneous performance. When a contested pair of works is silhouetted against the backdrop of this broader mass of music, the originality of the works of both plaintiff and defendant may be diminished. Therefore, methods of ranking pieces for degrees of similarity require *scalability*—the facility to uniquely identify instances no matter how large the pool of pieces becomes.

A long-standing rule-of-thumb in the global music-indexing collaboration, known as "RISM,"[68] is the requirement for a minimum of eleven consecutive pitches (plus indications of meter, duration, and articulation marks such as staccatos, dynamics signs, etc.) to discretely identify a unique melodic passage.[69] This protocol was adopted after early tests showed it was a bare minimum for locating a unique melody in a pool of 100,000 examples.[70] A robust solution to music-infringement claims would necessarily be a scalable one: it could not be overcome by the continuous appearance of new pieces.

In some cases, incidental matches are ignored in the heat of infringement arguments. Cronin has sometimes shown clusters of incidental matches in the course of discussing the degree of similarity between a plaintiff's and a defendant's works.[71] Yet courts do not consider the possibility that one of these incidentally similar pieces may be more similar to the target piece than the work claiming infringement. In his expert testimony for the defense, Sigmund Romberg produced a cornucopia of semi-matches (nine of them) for the melody disputed in *Hirsch vs. Paramount Pictures*.[72] He showed that all of them were derivable from a theme used in Johann Strauss' well-known operetta *Die Fledermaus* (1874).[73] The court concluded that it was difficult to "describe by words similarities or differences in musical compositions."[74]

68. REPERTOIRE INTERNATIONAL DES SOURCES MUSICALES, http://www.rism.info/en/service/opac-search.html [https://perma.cc/SY5N-X2YZ]. RISM is an international inventory of musical manuscripts from the seventeenth and eighteenth centuries with access to information about 1.5 million pieces. A further million remain to be added. RISM is the only collaboration of its size (sixty countries). Other similar collaborations are conceivable.

69. J. STEPHEN DOWNIE, EVALUATING A SIMPLE APPROACH TO MUSIC INFORMATION RETRIEVAL 33 (1999).

70. *Id*.

71. *See* Cronin, *supra* note 4.

72. *See* Hirsch v. Paramount Pictures, Inc., 17 F.Supp. 816 (S.D. Cal. 1937).

73. *Id*.

74. *Hirsch*, 17 F.Supp. at 818-19.

2. Combined Parameter Searches

In a recent study at the Center for Computer Assisted Research in the Humanities, a sample of 100,000 musical incipits (beginning phrases) from diverse repertories showed that nineteen consecutive pitches was the minimum number needed to find *unique* matches when searching by pitch alone.[75] Although ten to twelve consecutive pitches may be adequate to reliably distinguish individual works in a sample of 1,000 items, adequacy diminishes as further works are accrued.[76] Contrary to our expectations, *combination* searches (coarse melodic *change* coupled with coarse rhythmic *change*) offered the most efficient approach to unique answers (melodies without matches).[77] The combination of three pitches and three durations was adequate to find desired melodies without producing look-alikes.[78] What this result implies for copyright adjudication is that the combining of multiple musical factors (principally pitch and rhythm) would pinpoint valid similarities more effectively than the one-dimensional searches currently used.[79]

II. AUDIO-BASED EVALUATION

The most profound differences between sound and notation lie in the parameters by which each is evaluated. In place of feature-menu of melody, harmony, and rhythm, an audio file's conspicuous features are timbre, tempo, and dynamics. These describe the *sound* of the music *when performed* but not necessarily its *substance* as conveyed in notation. Timbres, tempos, and dynamics vary from one performance to the next.[80] No one performance necessarily represents the work in its totality better than another. By allowing scope for individual performers' expressive contributions, audio features may not fully reflect a composer's instructions. Artists often hold themselves above compositional indications. In the days of analog recording, tempo was unalterable without incidentally altering pitch, but in digital recording, tempos can be edited separately from musical content.[81]

75. Sapp et al., *supra* note 67. In our computer-based music theory classes, we discuss multiple levels of pitch resolution (the number of named tones within an octave). The levels are diatonic (one pitch per name or 7x1 to make 7 in all); chromatic (all pitch names plus a single sharp or flat for each, or 7x3 to make 21 in all); and enharmonic (all pitch names plus single or double sharp positions for each, or 7x5 to make 35 in all). To identify every written pitch and preserve its written form each of these numerals can then be multiplied by the number of octave (a piano keyboard has eight octaves, the range 1..8).

76. *Id.*

77. *Id.* at 8.

78. *Id.*

79. The pairing of pitch and harmony would be less efficient than that of pitch and rhythm because the numbers of pitches and rhythms roughly correspond to each other, while in any given work harmonic changes occur less often than pitch changes.

80. *The Elements of Music*, WESTERN MICHIGAN UNIVERSITY, http://wmich.edu/mus-gened/mus170/170notes/Ch1-elements.pdf [https://perma.cc/76A4-SFUJ].

81. *See* Jonathan Driedger & Meinard Müller, *A Review of Time-Scale Modification of Music Signals*, 6 APPLIED SCI. 1 (2016).

Tempo and dynamics are inclined to vary from one performance to the next and from phrase to phrase within a performance. Recording engineers (rather than composers or performers) may determine the sound details that best suit the situation.[82] While notation presents and circumscribes a composition, sound offers an interpretation of it. Both processes are "creative," but in distinctly different ways. In copyright infringement cases, *contingent issues* generate the most heated debates surrounding sound submissions. Those we discuss below are (II.A) the inherent conflict between the legal requirement for a tangible medium and the mutable nature of sound; (II.B) deceptive aspects of sound; and (II.C) the use of MIDI files as surrogates for both sound and notation.

A. Required Fixity Versus the Mutability of Sound

The fixed medium of shellac (later polyvinyl chloride) recordings preserved one performance of a work as captured by specific equipment on a single occasion.[83] The work so captured was not necessarily equivalent to a notated score.[84] In performance, works can be enhanced but they can also be reduced or simplified. In their time, recordings were a more immutable medium than today's digital sound files. Various layers of interpretation or "expression" can now adhere to a structure that was, or could have been, laid down in notation. Additionally, any performance varies with a performer's skill, mood, musical resources, and acoustical situation. A recording crystalizes an expression of serial authorship—that of a composer's music *as interpreted by* a performer.

It is customary today when indexing recorded content to provide an indication of total time elapsed in each movement, complete work, or digital track. Two different recordings of the same work are unlikely to clock in at exactly the same total times.[85] Performance time is ultimately subjective. The total-time metric has occasionally produced telltale evidence of unacknowledged copying of recordings.[86] This inconvenient truth emerged through comparative studies of

82. *See id*.

83. As an example, the U.S. Copyright Office provides guidance on the difference between the composition and sound recordings and filing both with the Office. *Copyright Registration of Musical Composition and Sound Recordings*, U.S. COPYRIGHT OFFICE, https://www.copyright.gov/register/pa-sr.html (last visited June 11, 2018) [https://perma.cc/3VMZ-C2JD].

84. *Id*.

85. For instance, Marvin Gaye's recording of "Got to Give It Up" is 11:52 in length (https://www.youtube.com/watch?v=9rIsGZ_ouA4) [https://perma.cc/H8BF-CR5S], while the Urban Knight's rendition is 3:54 (https://www.youtube.com/watch?v=dXFcrdr3eVw) [https://perma.cc/TC9A-H6WK]. Small discrepancies in total time indicate differences in tempo. Ones of this magnitude suggest radical differences of arrangement, for example, the exclusion of an introduction and/or elimination of repetitions.

86. *Style, performance, and meaning in Chopin's Mazurkas*, CHARM (AHRC RESEARCH CENTRE FOR THE HISTORY AND ANALYSIS OF RECORDED MUSIC), http://www.charm.rhul.ac.uk/projects/p2_3.html (last visited June 11, 2018) [https://perma.cc/NRM8-B2EP].

differences in elapsed time and dynamics profiles in a large collection of Chopin mazurka recordings.[87] A fine-grained detailed analysis found astounding parallels in the tempo curves (mapped changes of beat speed) of recordings by a London pianist, Joyce Hatto, and those of a little known Eastern European pianist, Ivan Indic.[88] The resemblance was not accidental. It revealed intentional copying by the recording engineer, who was the proprietor of the Concert Artist label that carried Hatto's works.[89] He happened to be Hatto's husband.[90] The engineer hid his replications by slightly altering tempos.[91] Other processes facilitated by digital recording are less blatant. For example, they also enable the aggregation of semi-automated (machine-generated) fragments of music with fully human inventions.[92] In the absence of a notated prototype, human and machine elements of composition in the same work may be difficult for the uninitiated to identify. Introductions, interludes, and accompaniment patterns are especially likely to be "canned" and distributed in firmware.[93] Fragments of soundtracks in a specified mood (happy, fearful, et al.) can be downloaded from the internet to convey emotional states in videos.[94] These trends are unlikely to abate: alterations can now be invoked before or after composition, publication, and recording. The copyright community is poorly equipped to appreciate the fluidity of musical content in the digital world.

An underlying dispute in the "Blurred Lines" debate has been the merit (with respect to copyright) of composing music entirely by ear. To those who consider notation the only foundation for definitive establishment of authorship, the idea of creating music on the fly and recording the result, whatever it is, can seem alien. Discussion of these divergent views is vital, but so too is acknowledgment that each is legitimate in many sectors of society, present and past, local and global. This dispute, and some of the ill will it generates, may simply

87. Nicholas Cook & Craig Sapp, *Purely Coincidental? Joyce Hatto and Chopin's Mazurkas*, CHARM (AHRC RESEARCH CENTRE FOR THE HISTORY AND ANALYSIS OF RECORDED MUSIC), http://www.charm.rhul.ac.uk/projects/p2_3_2.html (last visited June 11, 2018) [https://perma.cc/23A5-23GG].

88. Among many accounts, the original research and visualizations of timing can be found in Cook & Sapp, *supra* note 87. *See also* Mark Singer, *Fantasia for Piano: Joyce Hatto's incredible career*, THE NEW YORKER (Sept. 17, 2007), https://www.newyorker.com/magazine/2007/09/17/fantasia-for-piano [https://perma.cc/D4AW-CYCW]; Mark Singer, *Joyce Hatto: Notes on a scandal*, THE TELEGRAPH (Nov. 10, 2007, 12:10 AM), http://www.telegraph.co.uk/culture/3669195/Joyce-Hatto-Notes-on-a-scandal.html [https://perma.cc/TG3W-42XD].

89. Cook & Sapp, *supra* note 87.

90. *Id*.

91. Identical time-stamps in the GraceNote database used by iTunes had already raised suspicions.

92. Yu-Siang Huang, Szu-Yu Chou & Yi-Hsuan Yang, *Generating Music Medleys via Playing Music Puzzle Games*, ARXIV, https://arxiv.org/abs/1709.04384 [https://perma.cc/YR3T-MB3V] (last updated Nov. 17, 2017).

93. *See* AURTURIA, BEATSTEP PRO (2017).

94. Search for "happy," BENSOUND, https://www.bensound.com/index.php?route=product/search&search=happy [https://perma.cc/X44K-WWVW].

be a surrogate for the sound-notation dichotomy. Both are legitimate but in different and somewhat incompatible ways. The hindrance may be in supposing that our existing copyright provisions are elastic enough to cover both situations. The growing divergence between their properties progressively distances the ideal of a universal law from reality.

In the realm of sound, jazz is the repertory that best epitomizes the ironies and contradictions in the relationship between music as notated and music as performed. Being improvised, jazz is not notated. However, conventions govern the general course of a performance. The procedural order may be discussed in advance. Students of jazz may learn common harmonic progressions and riffs from lead sheets, but professionals ignore notation altogether. The essence of jazz lies in its syntax, which allows musicians to "realize" many variations on a melody that may not be fully present aurally.[95] Jazz can be an eloquent parody on the notion of musical similarity. Melodies, harmonic progressions, and rhythmic patterns may be present only by implication. Yet audiences recognize its musical allusions. Jazz teases the listener to find a missing melody, or to imagine it from a harmonic or rhythmic skeleton. Apart from a few early cases concerning Tin Pan Alley pieces, it has been immune to infringement claims.[96] No piece is ever quite the same in two renditions. Jazz is a Teflon genre.

The legacy of improvisation plays a significant role in much popular music, including the work of Marvin Gaye, who composed only by ear.[97] The dynamic process of music-creation is tangentially pertinent to understanding some inherent differences between "Got to Give It Up" and "Blurred Lines." Gaye's work predated all digital tools in use today. Forty-five years on, Williams and Thicke (and countless peers) are immersed in a forest of sound tools that enable on-the-fly editing and rapid rearrangement. Yet the human element in Gaye is not diminished by digital accretions. It is sadly ironic, however, that our music-copyright framework remains bogged down in assumptions from Gaye's time.[98] Copyright's best known rubrics little suit an era in which any recorded performance is alterable in the studio (including a home studio) by repetition, addition, subtraction, re-

95. Annual Review of Jazz Studies, Vol. 2 128 (Edward Berger & Dan Morgenstern eds., 1983).

96. Cronin, *supra* note 4, at 1208–10.

97. Peter Kelley, *UW law professor leads group defending 'aural tradition' of creativity in famous 'Blurred Lines' copyright case*, UW NEWS (Jan. 12, 2017), https://www.washington.edu/news/2017/01/12/uw-law-professor-leads-group-defending-aural-tradition-of-creativity-in-famous-blurred-lines-copyright-case/ [https://perma.cc/5R4E-XFDM].

98. In the present context, I must set aside this enormous problem in the hope that better-qualified minds will address it. For now Robert Brauneis' *Musical Work Copyright for the Era of Digital Sound Technology: Looking Beyond Composition and Performance*, 17 TUL. J. TECH. & INTELL. PROP. 1 (2014) is a stimulating read, particularly for its careful parsing of the different kinds of relationships that are lumped together under the name of "sound" in recent music-copyright disputes.

orchestration, and changes in resonance, tempo, dynamics, and articulation. A modern studio recording may be an esthetically enhanced version of the featured work. Timbres and tempos can easily be altered, cosmetic blemishes removed. At face value, "Blurred Lines" and its convoy of copyright-protected iterations may attempt to cover a conspicuous share of foreseeable adaptations and arrangements. Yet this does not necessarily guarantee that in their totality these add up to a more novel work than the lead-sheet filing for Gaye's "Got to Give It Up" contains. Given the simplicity of the harmonic and rhythmic schemes in both works, an argument can be made for lead-sheet filings for most popular music. Lead sheets omit repetitions devoid of new authorship. They simplify evaluation.

If the public is confused about musical similarity, it may be partly because in combination commercial recording and phonorecord protections discourage multiple recordings of the same work. The identity of a popular work is generally known through a single recording, including the nuances of one underlying performance. In the public mind, a work and its performance are inseparable. It is for this reason that Shazam, given an audio sample, can "name any work in seconds" and Gracenote's Global Music Data Service can allow users to "connect with the music they love" on the basis of "standardized artist and recording IDs."[99] Some of that identifying information depends on elapsed-time metrics. The principal features that enable Pandora's Music Genome project to cluster works into similar "styles" (here meaning genres) are dynamic levels, tempos, timbres, and the like.[100] After grouping, these are correlated with individual listener profiles to create a virtual appropriate channel. Outside the realm of commercial containment, it is unlikely that two performances of the same piece would have identical tempo or dynamic changes, no matter how hard performers try to mimic a particular example.[101]

99. *Global Music Data*, GRACENOTE, http://www.gracenote.com/music/global-music-data/ (last visited Mar. 1, 2018) [https://perma.cc/A5A2-W2QX].

100. Although 450 attributes are claimed in Pandora publicity to exist, eight are itemized in its patent application. Its current concentration is on five genres or feature "clusters"—"pop/rock, hip-hop/electronica, jazz, world music, and classical"—each of which has many elements. In contrast to most services of a similar nature, Pandora Media has made extensive use of human listeners in refining and matching both "song" and listener profiles.

101. Important exceptions occur in studies by Daniel J. Levitin showing that college students conditioned by repeated listening can reproduce the pitch and tempo of specified pieces in response to seeing the jewel case of a CD containing their selections. *See* Daniel J. Levitin, *Absolute Memory for Musical Pitch: Evidence from the Production of Learned Melodies*, 56 PERCEPTION & PSYCHOPHYSICS 414 (1994); *also* Daniel J. Levitin, *Memory for Musical Tempo: Additional Evidence that Auditory Memory is Absolute*, 58 PERCEPTION AND PSYCHOPHYSICS 927 (1996).

B. Timbral Dominance, Masking, and Illusion in Music Perception

The field of psychoacoustics examines questions of detail in determining how our ears trick us. For any given work, what is performed and what is heard can diverge in surprising ways. Clever composers sometimes employ an instinctive knowledge of these tricks. Timbre is capable of masking other properties of music in listeners' minds.[102] We have found that when subjects are presented with identical passages of two pieces, but one is in equal temperament and the other in mean-tone temperament, listeners find the first to be modern in style, the second "old."[103] Listeners are confusing timbral detail with musical style (a big underlying issue in the "Blurred Lines" case). By ignoring the traditional rubrics of harmony, melody, and rhythm, listening-based expert testimony in music-infringement suits can be disconcerting. Yet psycho-acousticians have shown repeatedly that timbral characteristics can overwhelm other powers of musical discrimination.[104]

A generation of studies has explored other ways in which timbre tangles our perception of pitch and tempo relationships. Diana Deutsch's auditory paradox[105] established that registral interpolations can induce auditory illusions.[106] A series of experiments by Frank Russo and William Forde Thompson[107] explored situations in which smaller intervals were perceived to be larger after timbral modification. Auditory confusion was not reduced by musical training.[108] Listeners uniformly identified pitches accurately in isolation but "mis-heard" them when two tones were sounded simultaneously.[109] Under the rubric of "intensity," Zohar Eitan and Roni Y. Granot created a series of examples based on oblique relationships between pitch contours and gradual changes in tempo and dynamics.[110] Their aim was to diverge from the common clichés of the gradual ascent of pitch in combination with a crescendo and, conversely, the descent of a scale or melody with a decrescendo. Each of their feature pairings was unusual.[111] They established that *perceived*

102. Stephen Lakatos, *A common perceptual space for harmonic and percussive timbres*, 62 PERCEPTION & PSYCHOPHYSICS 1426, 1437 (2000).

103. *Id*.

104. *Id*.

105. Diana Deutsch, *An Illusion with Musical Scales*, 55 J. ACOUSTICAL SOC'Y AM. 518 (1973).

106. Some notated examples of the experimental data can be found at Diana Deutsch, *Scale Illusion*, U. CAL. SAN DIEGO, http://deutsch.ucsd.edu/psychology/pages.php?i=203 (last visited Mar. 9, 2018) [https://perma.cc/EC7R-MGX7]. *See also* Diana Deutsch, *Illusions for Stereo Headphones*, AUDIO MAGAZINE (1987) (her more recent work which looks at the effect of stereo headphones on listeners' perception of complex audio material).

107. *See* Frank A. Russo & William F. Thompson, *An Interval Size Illusion: The Influence of Timbre on the Perceived Size of Melodic Intervals*, 67 PERCEPTION & PSYCHOPHYSICS 559 (2005).

108. *Id*. at 566 (Fig. 5).

109. *Id*.

110. Zohar Eitan & Roni Y. Granot, *Intensity Changes and Perceived Similarity: Inter-Parametric Analogies*, 11 MUSICAE SCIENTIAE 39 (2007).

111. *Id*.

similarity was greatest when dynamic volume was increasing and pitch was rising.[112] Findings of this kind suggest that while a sound deposit may establish the unique identity of an individual musical work, its contents as determined by listening may not exactly correspond to the content of the notated version.

C. MIDI: A Surrogate for Notation and Audio

By dint of its ubiquity, the establishment of the Musical Instrument Digital Interface (MIDI), a hardware protocol to enable electronic keyboards to communicate with computers (1983),[113] led quickly to the establishment of the Standard MIDI File Format (SMF),[114] a MIDI digital file format (1988) for keyboard input and output. The principal features of music that can be captured in notation are pitch and duration. Each is adapted to suit the hardware protocol.[115] Pitch is represented by key number;[116] duration by elapsed time in milliseconds; "timbre" by track number; and "dynamics" by key pressure. Vis-à-vis standard musical notation, MIDI has some notorious drawbacks. It cannot discriminate between enharmonic pitches (those expressed as either sharps or flats in notation),[117] that is keys with more than one contextual name (C#, Db). Software must compute an interpretation that accords with literate music notation. The hardware protocol can measure duration in milliseconds, but discrimination of quarter and eight notes (for notation) is another matter of software interpretation. Software tweaks can dampen MIDI's robotic tempo regulation but the result rarely sounds entirely like a live performance. MIDI is a wonderful tool, but it is not an engine of esthetic pleasure. It is widely used because of its numerous utility functions in generating music notation and enabling arrangement of a

112. *Id.*

113. *The Complete MIDI 1.0 Detailed Specification*, MIDI ASS'N, https://www.midi.org/specifications/item/the-midi-1-0-specification (last visited Aug. 6, 2018) [https://perma.cc/3MCK-XAAY].

114. *Standard MIDI Files (SMF) Specification*, MIDI ASS'N, https://www.midi.org/specifications-old/item/standard-midi-files-smf (last visited Aug. 6, 2018) [https://perma.cc/8ME2-DTWU].

115. *See* Eleanor Selfridge-Field, BEYOND MIDI: THE HANDBOOK OF MUSICAL CODES 41–69 (1997).

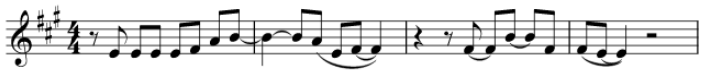
116. The octave mapping varies somewhat from one manufacturer to another. In most cases, Middle C is key number 60.

117. Enharmonic pitches play different harmonic roles in tonal music. This reflects the fact that before equal temperament, C# and Db did not correspond to the same frequencies. Early keyboards sometimes had split black notes in which one section of the key produced a sharp, the other a flat.

composition.[118] The use of MIDI is widespread in classrooms and studios as well as homes.[119]

The stature of MIDI files in a legal framework has been examined by Cronin, but it remains somewhat indeterminate.[120] MIDI files represent music but are not precisely the equivalent of either recordings or scores.[121] With MIDI, the devil is in the details. The telltale residues of MIDI seem to be present in the notated materials prepared by Finell and Monson for the Gaye family in the "Blurred Lines" trial.[122] Among the short examples of melodic fragments they showed, the enharmonic status of one or two pitches appears not to have been correctly interpreted[123] (because their concentration on short segments omits musical context, one can question whether their perceived "constellation" of similar features lies more in their re-assembly or in Gaye's original material). A re-transcription of one key passage appears (at greater length than they provided) in Figure 3.

Figure 3: Marvin Gaye, "Got to Give It Up," Bars 8-11.[124]



This passage, which follows a rhythmic introduction, illustrates several features that carry through the whole piece: persistent syncopation, a relatively static five-note span (with the third note consistently omitted), and melodic inversion at phrase endings (Gaye avoids exactly quoting himself).

118. MIDI sometimes provides an intermediate layer between live sound and written notation. For refined work, its limitations can be crippling, but for short pieces, rehearsals, teaching, and a quick impression of new or unfamiliar works, it is immensely valuable. It is widely used as a tool for composition. It can easily support multi-track composition, the testing of arrangements, and rehearsals of the music-minus-one variety in which a live soloist practices his or her part in a quasi-digital performance based on previously stored digital scores.

119. Tom Bateman, *How MIDI Changed the World of Music*, BBC NEWS (Nov. 28, 2012), https://www.bbc.com/news/technology-20425376 [https://perma.cc/3UJC-DZAS].

120. Cronin, *supra* note 2.

121. Rory Seydel, *What is MIDI?: 11 Things You Need to Know About Music's Most Powerful Tool*, LANDR (Nov. 11, 2016) https://blog.landr.com/what-is-midi/ [https://perma.cc/5QLL-57XW].

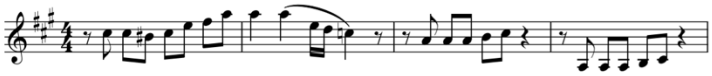
122. Report or Affidavit of Judith Finell, Pharrell Williams v. Bridgeport Music, Inc., 885 F.3d 1150 (9th Cir. 2018) (No. 213CV06004), 2014 WL 12725877; Expert Report of Ingrid Monson, Pharrell Williams v. Bridgeport Music, Inc., 885 F.3d 1150 (9th Cir. 2018) (No. 213CV06004), 2014 WL 12725878.

123. Provided with sharps, flats, or naturals as required by the grammar of written notation.

124. Robin Thicke, *Blurred Lines*, MUSICNOTES, https://www.musicnotes.com/sheetmusic/mtd.asp?ppn=MN0118109 (last visited Mar. 1, 2018) [https://perma.cc/VS8T-U4BQ]. In quoting Gaye's music, I consulted both the commercial sheet-music distributed by MusicNotes and the registered lead sheet. The two slurs (dictated by the lyrics in Bars 9 and 11) are absent in the lead sheet.

The structure of "Blurred Lines" is more elaborate but, because of numerous repetitions, not necessarily more substantive. This piece has several sections, of which Bars 25-28 (Figure 4) correspond to the example given in the expert opinion. However, this passage occurs after a rhythm section with a three-note chromatic phrase (Bars 2-9), then a passage with new rhythmic and melodic material (Bars 10-17). What follows (Bars 18-25) is a passage that partly repeats the second segment but launches into the disputed material starting at Bar 25.

Figure 4: Pharrell Williams and Robin Thicke, "Blurred Lines," Bars 25-28.



Williams and Thicke make much of registral change (a common device for variation) in their repetitions. In combination, these extended examples show that representative passages of allegedly "common" material do not fully coincide. They do share similar contours.[125] Williams and Thicke employ a broader range of pitches. Phrase patterns, phrase lengths, and other melodic details diverge.

III. COGNITIVE ISSUES IN ESTIMATES OF MUSICAL SIMILARITY

Considerations of timbre, tempo, dynamics and other features of performance touch only on local change in the course of performance. In assessing the whole of a composition, other factors come into play. Some of these lie within the realm of music cognition. One claim of this field is that cognitive factors facilitate more accurate assessments of what listeners *think they hear* than note-by-note comparisons based on scores.[126]

From one individual to the next, human perception is not one-hundred percent synchronous. Auditory illusions aside, we do not all hear the same things in a single performance or recording.[127] "Mood" and "genre" are the two most commonly discussed traits of music in commercial efforts to sell recordings and streaming services.[128] At Sony Labs in Paris, Jean-Julien Aucouturier and François Pachet asked listeners to match "similar" passages from sampled audio

125. Huron, *supra* note 34 (showing that melodic contours characteristically rise, peak, and fall across repertories from diverse parts of the world).

126. Stefan Koelsch et al., *Untangling Syntactic and Sensory Processing: An ERP Study of Music Perception*, 44 Psychophysiology 476, (2007).

127. Stefan Koelsch & Walter A. Siebel, *Towards a Neural Basis of Music Perception*, 9 Trends in Cognitive Sci. 578, (2005).

128. GOOGLE PLAY, https://play.google.com/store/music?hl=en (last visited June 12, 2018) [https://perma.cc/AW7E-DHVZ].

recordings.[129] Their focus was on extracts in which timbres were similar but other musical features were different.[130] Timbral similarity was such a dominant factor in judgments that listeners were often satisfied that two examples were "similar" even when the genres from which they came were incongruent.[131] When listeners rated the similarity of samples from a large pool of works spanning both classical and popular genres, they sometimes produced pairings that crossed the boundary between those two domains.[132] Overwhelmingly, the "best" matches underscored similarity in mood.[133] Factors that contribute to impressions of mood include tempo, overall timbral quality, and dynamics. Some subjects found one passage from Beethoven's Romance for Violin and Orchestra, Op. 50, No. 2 (F Major) to resemble the Beatles' "Eleanor Rigby."[134] Others found the same passage of Beethoven to be similar to a recording by Gene Kelly of "Singing in the Rain."[135] Still others found similarity where classical musicians would expect to find it—in excerpts from different works by the same composer.[136]

In the sound-notation debate, Jamie Lund has found a bias *against* musicians in the Lay Listener Test.[137] Her approach is systematic, and although her statistics are limited, the idea has potential for further development.[138] Her online Music Copyright Project website is a one-stop shop for those seeking to test their own susceptibilities to bias.[139] In listeners' judgments of human versus machine composition (where each example is presented in both human and machine performances), listeners find human performance a persuasive indicator of "human" composition.[140] The writings of Olufunmilayo Arewa have sought, in their turn, to introduce elements of diverse *cultural* perspectives and

129. Jean-Julien Aucouturier & François Pachet, *Finding Songs that Sound the Same*, PROCEEDINGS 1ST IEEE BENELUX WORKSHOP ON MODEL BASED PROCESSING AND CODING OF AUDIO (2002).

130. *Id*.

131. *Id*.

132. *Id*

133. *Id*.

134. *Id*.

135. *Id*. at 4–5.

136. For example, between the Schubert piano pieces Op. 90, No. 2, in Eb Major and Op. 90, No. 4, in Ab Major.

137. Jamie Lund, *An Empirical Examination of the Lay Listener Test in Music Composition Copyright Infringement*, 11 VA. SPORTS & ENT. L.J. 137, 173 (2011); Jamie Lund, *Fixing Music Copyright*, 79 BROOK. L. REV. 61, 106 (2013).

138. *Id*.

139. Jamie Lund, *Music Copyright Project*, JLUNDLAW, http://www.jlundlaw.com/p/music-copyright-project.html (last visited Mar. 1, 2018) [https://perma.cc/WGV4-HDTY].

140. The reader can get a general sense of the issues of judgment involved by downloading and listening to the examples of "synthesized" composition. David Cope, *Virtual Music: Computer Synthesis of Musical Style*, THE MIT PRESS, https://mitpress.mit.edu/books/virtual-music (last visited Mar. 1, 2018) [https://perma.cc/6YH3-FUWR].

their impacts on cognition and perception into music-copyright discussions.[141]

Another aspect of cognitive studies in music, again pertinent to judging musical similarity, concerns methods of differentiating foreground and background in individual works. This exploration has been stimulated by the widely noted work of Fred Lerdahl and Ray Jackendoff on "generative grammars" of music, which in turn involves structural analysis.[142] Lerdahl's work is distinctive in looking at temporal organization hierarchically, with a view towards examining changing relationships between foreground and background in music. In related work, the psychologist Carol Krumhansl has explained at length how listeners "organize, interpret, and remember" musical events in such a way that their psychological constructs "amount to something greater than the sum of the individual features of the work."[143] Her findings have prompted numerous studies of individual differences in listening approaches, as well as differences between listeners with musical training versus those without.[144] Lerdahl and Krumhansl have recently produced a synthesis of their views.[145] Their study of "Modeling Tonal Tension" is rife with implications for music litigation through its exploration of attentional mechanisms that could cause listeners to *believe* that one passage is similar to another even when, to a score-reader, the two may not be similar.[146] The comparison of "Mary Had a Little Lamb" and "An Irish Lullaby," as shown in Figure 2 (Section 1.1), gives a simple example of foreground-background elements in metrically different schemes. When we listen to music, metrical structure is inseparable from melodic and harmonic analysis.[147] Assessment of these features and methods of analysis depend on access to notated music.

Among efforts to assign variable weights to individual notes within a melody (with reference to placement, accent, harmonic role, rhythmic value, and/or pitch extreme), Daniel Müllensiefen and Klaus Frieler experimented with a scheme to assign cognitive weights to elements of melodies based on audio analysis.[148] This work depended on the responses of two groups of "expert listeners" to examples from

141. *See* Olufunmilayo B. Arewa, *Copyright and Cognition: Musical Practice and Music Perception*, 90 ST. JOHN'S L. REV. 565, 565–78 (2016).

142. *See* FRED LERDAHL & RAY JACKENDOFF, A GENERATIVE THEORY OF TONAL MUSIC (1983).

143. CAROL L. KRUMHANSL, COGNITIVE FOUNDATIONS OF MUSICAL PITCH 90–101 (1990).

144. *Id.*

145. Fred Lerdahl & Carol L. Krumhansl, *Modeling Tonal Tension*, 24 MUSIC PERCEPTION 329, 329–36 (2007).

146. *Id.*

147. Regarding possibilities for harmonic analysis in a systematic context *see* Craig Stuart Sapp, *Computational Methods for the Analysis of Musical Structure* (2011), STANFORD DIGITAL REPOSITORY, http://purl.stanford.edu/br237mp4161 [https://perma.cc/2KAV-HLQ7].

148. Daniel Müllensiefen & Klaus Frieler, *Cognitive Adequacy in the Measurement of Melodic Similarity: Algorithms vs. Human Judgments*, 13 MUSIC QUERY: METHODS, MODELS, AND USER STUDIES COMPUTING IN MUSICOLOGY 147 (2004).

a large corpus of audio files.[149] The Müllensiefen-Frieler approach is comprehensive with respect to musical features (raw and contoured melodies, interval matches, fuzzy rhythmic matching, and essential harmonic features). Noting that people often search selectively for a short sequence of tones in a pool of longer examples, Müllensiefen and Grill raised the question of whether or not individual pieces in audio repositories should be segmented prior to storage.[150] This, they believe, would facilitate phrase-matching,[151] which in turn could increase or decrease the number of matches.

From these numerous experiments, we conclude that sound is more prone to variations in perception, cognitive filtering, and fluctuations in attention than notation, which, while subject to artistic license, is not subject to cognitive or perceptual accommodation. Legal discussions of music copyright usually ignore these aspects of musical experience, although it is difficult to devise mechanisms to accommodate them. The simplest means of rectification could be to limit infringement discussions to written materials, as was the case until 1976. Alternatively, establishing separate provisions for sound-based and notation-based copyright registrations would have the benefit of clarifying the nature of each protected musical work. This would be advantageous only if infringement claims were limited to pieces registered in the same domain. If such a system had been in effect in 2013, the "Blurred Lines" case could not have taken shape as it did.

IV. SOCIAL VERSUS ALGORITHMIC JUDGMENTS OF MUSICAL SIMILARITY

A final area of divergence between academic investigation and legal assumption arises from the myth of a future push-button test for music infringement. Efforts in this direction have disclosed many obstacles. The fundamental one is that from one community to another, there is no agreement on *what constitutes* musical similarity. Pertinent factors include these: (IV.A) stylistic drift in the same pieces over time, (IV.B) variability of collective judgments, (IV.C) personality correlates of similarity judgments, (IV.D) the correlation of algorithmic and human evaluations of similarity, and (IV.E) the boundary paradox in judgments of similarity.

A. Stylistic Drift

In a famous study of 1975, George List found that in Hopi society the notion of musical similarity depended entirely on the societal

149. *Id.*
150. *Id.* at 24–25.
151. One argument for this procedure would be to prevent false-positive results in which a "match" involves notes from consecutive phrases because phrase segmentation was ignored.

function of a piece of music.[152] Musical features played no role in community assessment.[153] Similarity meant that "only a general relationship must be maintained."[154] To the anthropological eye, such contradictions of common expectations can occur in mainstream society as well. Communities decide what kind of music is appropriate for weddings, graduations, and other highly valued ceremonies. For individual titles associated with certain kinds of ceremonies (e.g. "Pomp and Circumstance" for graduation processions), detailed studies show that the music itself can change incrementally. In notation-based examinations, meter and mode are the only consistently preserved features.[155]

In certain communal situations, understandings of musical identity sharply conflict with sanctioned views of repertories in our existing legal framework. For example, in her research a century ago on the music of numerous North American tribal groups, Frances Densmore encountered an attitude unfamiliar to university researchers.[156] Some tribes considered their music, irrespective of its medium, to be collective cultural property and, as such, inappropriate for use by others.[157] Her field recordings remain confined to archives.[158] For other societies similarly inclined to reserve access to their arts for themselves, YouTube poses an intriguing challenge. Its infrastructure is widely used by cultural diasporas, many of them too detached from the cultural norms of their birthplaces to imagine that elders may not approve of online reuses involving either direct copying of relatively ancient recordings or, conversely, arrangements of traditional music for rock bands.[159] It is a fascinating phenomenon that, while serving to broaden our notions of what music is, begs much thinking about

152. George List, *Hopi Melodic Concepts*, 38 J. OF THE AM. MUSICOLOGICAL SOC'Y 143 (1985).

153. *Id.*

154. *Id.* at 152.

155. In Eleanor Selfridge-Field, *Social Cognition and Melodic Persistence: Where Metadata and Content Diverge*, ISMIR 2006, PROCEEDINGS 7TH INTERNATIONAL CONFERENCE ON MUSIC INFORMATION RETRIEVAL, VICTORIA, CANADA (Oct. 8–12, 2006), http://ismir2006.ismir.net/PAPERS/ISMIR0625_Paper.pdf [https://perma.cc/F95H-GN4N]. Five pieces handed down from generation to generation over centuries were time-sampled for feature-stability. The Morris Dance and the Londonderry Air stood out among them. The second (also known as "Danny Boy") had a more complicated history in two senses. First, as known today it consist of two independent songs that were coupled more than 200 years ago. Second, its titles (including "O Mary Mine," "From Rocks and Glens," and "Would God I Were") and lyrics are numerous. Mass media of the past century have helped to stabilize features of these treasures.

156. *See* Frances Densmore, SMITHSONIAN INSTITUTION ARCHIVES, http://siarchives.si.edu/research/sciservwomendensmore.html [https://perma.cc/8SL2-2D7P]; *Folk Recordings Selected from the Archive of Folk Culture*, THE AMERICAN FOLKLIFE CENTER, http://www.loc.gov/folklife/folkcat.html#AFSL22 [https://perma.cc/N3YF-885V].

157. *Id.*

158. *Id.*

159. *See* MAXIMILLIAN C. FORTE, INDIGENOUS COSMOPOLITANS: TRANSNATIONAL AND TRANSCULTURAL INDIGENEITY IN THE TWENTY-FIRST CENTURY (2010).

pending conflicts between intellectual and cultural property involving music.

B. Variability in Collective Judgments of "Similar" Pieces

A riveting finding concerning social agreement on questions of musical similarity has recently emerged from similarity studies at the Austrian Research Institute for Artificial Intelligence (OFAI).[160] The OFAI's interest grew in parallel with efforts to develop tools for the automatic assessment of similarity in audio files.[161] At the lab's website,[162] which is oriented towards "perceived acoustic similarity," one will find both a simple open-source tool and a link to a proprietary one. An interactive browser, *FM4 Soundpark*,[163] enables users to judge the similarity of songs by "newcomer bands" broadcast by an Austrian public radio station. Also on offer is a library (*Musly*) of tools for the computation of audio similarity.[164]

The associated research of Arthur Flexer and Thomas Grill specifically focuses on popular music.[165] Their retrospective meta-analysis of data and results from the cumulative results of annual MIREX contests rests on nine consecutive years of finite projects by researchers in locales scattered across the globe.[166] Flexer and Grill make musical similarity the centerpiece of music-information retrieval and few would disagree with that.[167] However, they note the lack of conclusions one can draw from the results of any single year's competition.[168] In an effort to link sound-based and notation-based assessments, their work is based partly on audio listening and partly on algorithmic evaluation of symbolic (notation-derived) data.[169] Their results show that the *level of agreement* between listeners and artificial agents in judgments of similarity rarely exceeds sixty percent and tends to hover closer to fifty percent.[170] They note, however, that their tests of similarity perform differently for each repertory.[171] Their strategies consider such musical features as "timbre, melody,

160. *Music Similarity and Recommendation*, AUSTRIAN RES. INST. FOR ARTIFICIAL INTELLIGENCE, http://www.ofai.at/research/impml/technology/musly.html [https://perma.cc/LW98-5JEP] (last visited Mar. 1, 2018).

161. *Id.*

162. *Id.*

163. *Soundpark*, FM4 – ORF, http://fm4.orf.at/soundpark (last visited Mar. 1, 2018) [https://perma.cc/T5K6-N2PT].

164. Dominik Schnitzer, *Audio Music Similarity*, MUSLY, http://www.musly.org/ (last visited Mar. 1, 2018) [https://perma.cc/XHQ3-PTFX] .

165. Arthur Flexer & Thomas Grill, *The Problem of Inter-Rater Agreement in Modelling Musical Similarity*, 45 J. OF NEW MUSIC RES. 239 (2016).

166. MIREX, run annually by the International Society for Music Information Retrieval, seeks (*inter alia*) to identify the best algorithm for determining music similarity. It began in 2006.

167. Flexer & Grill, *supra* note 165.

168. *Id.* at 248-49.

169. *Id.* at 242–44.

170. *Id.* at 246–48.

171. *Id.* at 248.

harmony, tempo, rhythm, lyrics, mood, etc."[172] Listeners state whether two melodies are similar or not.[173] Flexer and Grill believe that their subjects mentally extract the features of similarity that later inform their evaluation.[174] These extracted features then find their places in hierarchical relationships where they are prioritized as they would be in human cognition.

C. Personality Correlates of Similarity Judgments

An unexpected result in one recent study indicates that user preferences in genre selection may reflect personality more than personal aesthetic considerations.[175] Greenberg et al. show that empathetic individuals are more likely to listen to sad ("negative valence") music than non-empathetic ones.[176] Twenty-six genres were included in their study, which binned subjects into five categories defined by personality traits (neurotic, extraverted, open, agreeable, or conscientious) of group members.[177] Almost 4,000 subjects participated.[178] Music was rated by five characteristics—mellowness, unpretentiousness, sophistication, intensity, and contemporaneity.[179] Their pursuit of neural correlates of musical preferences makes fascinating reading, but its details describe procedures too cumbersome for present purposes.[180] However, their work gives some notion of what a controlled study of social agreement on musical "mood" or "style" might look like.[181]

D. Algorithmic Versus Human Judgments of Musical Similarity

The likelihood that a push-button solution for assessing musical similarity will ever be achieved seems slight. Our *Themefinder* project, which originated in 1996, was an experiment in how users approach the task of searching for music, but it has long attracted the interest of music-copyright lawyers and reviewers in the U.S. Copyright Office.[182] Our two decades' compilation of searches shows no dominant pattern.[183] While being ample, the underlying database (20,000 items in the public view and 100,000 in a restricted version) and its search resources barely scratch the surface of the world's music. It purposely

172. *Id*. at 240.
173. *Id*. at 248.
174. *Id*. at 249.
175. David M. Greenberg et al., *Musical Preferences are Linked to Cognitive Styles*, 10 PLOS ONE 1, 14 (2015).
176. *Id*. at 14.
177. *Id*. at 1.
178. *Id*.
179. *Id*.
180. *Id*.
181. *Id*.
182. THEMEFINDER, http://themefinder.org/ (last visited May 22, 2018) [https://perma.cc/2BDP-4UG2].
183. *Id*.

does not include any music composed after 1923 (the cutoff adopted by those who find searching for copyright status of thousands of works to be impractical). *Themefinder* supports melodic searches at five levels of generality/precision.[184] It offers filters for meter, mode, and key.[185] We assume that most users *cannot* recall specific pitches accurately, so the preferred searches of most of them concentrate on intervallic patterns or directional change. The more general the description, the greater the number of potential matches, but a match of melodic contour (resulting from a high degree of generalization) is not nearly sufficient to support a claim of substantial musical similarity.

The database approach of Robert Cason and Daniel Müllensiefen seeks to test unique features of a sought monophonic song against those of all the entries.[186] For each match candidate the procedure can "grey out" features that are ubiquitous in the database.[187] As an originality test, this approach isolates features not widely shared.[188] It accommodates the British copyright framework, which is articulated in greater detail than the U.S. apparatus.[189] British copyright law specifically allows adjudication when a *substantial part* of a protected work is suspected of plagiarism.

Long before cases such as *Arnstein v. Porter*, the U.K. judgment in *Austin v. Columbia Gramophone* called for proof of "substance … determined by the ear as well as the eye."[190] In this view, notation and sound are considered to be co-dependent manifestations of a musical work.[191] Arguments for and against the use of line drawings of melodic contour have occurred in U.K. courts ever since.[192] Robert J.S. Cason and Daniel Müllensiefen espouse a perceptual-assessment scheme for *segments* of the disputed content in which a vector assigned to each feature reflects its overall weighting in a database of more than 14,000 popular songs.[193] Their modular approach, which has a long history in the study of folksong migration,[194] is also favored in certain music-

184. *Id.*

185. Developed by David Huron and Andreas Kornstaedt in 1996–97, with countless improvements, enhancements, and extensions by Craig Sapp over most of the intervening years.

186. Robert J. S. Cason & Daniel Müllensiefen, *Singing from the Same Sheet: Computational Melodic Similarity Measurement and Copyright Law*, 26 INT'L REVIEW OF LAW, COMPUT. & TECH. 1, 25–36 (2012). *Themefinder* begins in the same way but does not progress to a grey-out stage. The Cason and Müllensiefen database concentrates on popular music, *Themefinder* on classical and traditional music.

187. *Id.*

188. *Id.*

189. *See* the frequently updated work of Justice Richard Arnold, PERFORMERS' RIGHTS (5th ed. 2015).

190. Austin v. Columbia Gramophone Co. [1923] Mag. Cas. 398 (Eng.).

191. *Id.*

192. Francis Day & Hunter v. Bron [1963] Ch. 587 (Eng.); Malmstedt v. EMI Records [2003] EWHC (Ch) 162, E.C.D.R. 15 (Eng.); Coffey v. Warner/Chappell Music [2006] EWHC (Ch) 449, E.M.L.R. 2 (Eng.).

193. *See* Jeremy Aregood, *Blurring the Line: Examination of Technological Fact-Finding in Music Copyright Law*, 16 J. MARSHALL REV. INTELL. PROP. L. 115 (2016).

194. *Id.*

information retrieval tasks.[195] Although the legal community considers the restriction of their work to monophonic examples a limitation,[196] decisions so rarely consider distinctive rhythms or harmonies that one is inclined to wonder how often the difference would matter in U.S. litigation.

Query-by-humming systems were once intended to allow user-controlled adjudication of musical similarity. Some are sound-based, others notation-based.[197]*Tunebot,*[198] a relatively recent one, gives access to a database of monophonic renditions of popular and traditional songs.[199] Such systems have the known limitations that (1) not all singers are equally accurate; nor (2) can they avoid elisions (slides) that are pleasant in performance but blur the identity of pitches; and (3) low-pitched voices are more accurately decoded than high-pitched ones.[200] From a legal perspective, the fact that query-by-humming systems deliver *probabilities* of a match rather than *certainties* also limits their value. If one match-candidate is rated ninety-two percent probability of a match, another eighty-six percent, and a third seventy-one percent, there is no proof of infringement. Close examination of complete pieces is still necessary. Are the matching factors important or insignificant? This is the point at which cognitive factors can become worthy of assessment. In their absence, we are left with a ranked list—a series of probabilities without a touchstone in reality. Query-by-humming systems rely on pitch sequences to the exclusion of rhythmic and harmonic aspects of music.

E. The Boundary Paradox in Judgments of Similarity

Efforts to pose questions of musical similarity as if black-and-white answers existed are often miscast. Psychologists have long studied the difficulties that adhere to defining boundaries between

195. *See* D. Müllensiefen & M. Pendzich, *Court Decisions On Music Plagiarism and The Predictive Value of Similarity Algorithms*, MUSICAE SCIENTIAE DISCUSSION FORUM 4B 257–95 (2009). *See also* Y. Liebesman, *Using Innovative Technologies To Analyze For Similarity Between Musical Works in Copyright Infringement Disputes*, 35 AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION 331, 62 (2007).

196. *Id*.

197. Christopher Mims, *Query-by-Humming Musical Search Engine Launched*, MIT TECH. REV. (July 23, 2010), https://www.technologyreview.com/s/419949/query-by-humming-musical-search-engine-launched/ [https://perma.cc/FE66-82U7].

198. *The Tunebot Dataset*, NORTHWESTERN UNIV., http://tunebot.cs.northwestern.edu (last visited Mar. 1, 2018) [https://perma.cc/9Q73-7W7W].

199. The *Tunebot* database (assembled between 2007 and 2010) contains newly sung versions of previously recorded repertory. To a degree, the singers were careful to use consistent volume and timbral quality in order to facilitate matching. *See* Mark Cartwright et al., *Making Searchable Melodies: Human Versus Machine,* HUMAN COMPUTATION: PAPERS FROM THE 2011 AAAI WORKSHOP (WS-11-11 86–87).

200. For other query-by-humming projects, *See* WALTER B. HEWLETT & ELEANOR SELFRIDGE-FIELD, MUSIC QUERY: METHODS, MODELS, AND USER STUDIES (COMPUTING IN MUSICOLOGY 13) (2004).

classes of objects with porous outlines.[201] Subjects can easily agree on center-cases, but near the edges, answers are more tentative. Similarity is not so much suited to yes/no answers as to assessment of degrees. Classification systems may depend on clear boundaries where only fuzzy ones exist. Outside music, similarity studies have shown the difficulty of arriving at social agreement when the material at issue is a product of human creativity.[202] Truly creative work may not subscribe to an existing category. The work of Barbara Tversky and others has shown repeatedly that the rate of inter-subject agreement is higher for instances in the center of a bell curve than near a tail.[203] She has pointed out that parts can belong to multiple objects,[204] as they often do in popular music. She has shown unlikely correlations and contradictions in grouping.[205] As one example, dynamics are different for objects *named* than for objects *indicated by icons*.[206] Clusters of similar objects are identifiable by their cores but not by their boundaries. The *boundary paradox* merits close attention in our efforts to clarify the conundrums of music copyright and to map a way forward. At what point is "somewhat similar" not similar enough to warrant the label?

The fuzzy boundaries of musical categories are a perennial problem because music has no innate boundaries, but it has an extremely broad range of styles, means of expression, timbres, performing media, and so forth. Genre competition in recent decades has brought the problem of defining boundaries to wider recognition. A study of genre preferences by Chicago teenagers who were scanning the radio dial to "locate their style" showed that they could recognize it from the first note or chord through timbral perception.[207] The audio samples were as short as twenty-five milliseconds.[208] The genre samples included Western, country Western, blues, rhythm n' blues, et al.[209] The study is notable for what it excludes—subsequent notes, melodic contour, rhythmic patterns, et al. A twenty-five millisecond sample is like a bug preserved in amber: it is completely frozen.[210] This result accords with Levitin's studies.[211] In the dial-scan study, Robert Gjerdingen and David Perrott noticed incidentally that over the course

201. Michèle Lamont & Virág Molnár, *The Study of Boundaries in the Social Sciences*, 28 Ann. Rev. of Soc. 167 (2002).

202. Amos Tversky's *Features of Similarity*, 84 PSYCHOLOGICAL REVIEW 327–52 (1997) was seminal.

203. Barbara Tversky & Kathleen Hemenway, *Objects, Parts, and Categories*, 113 J. of Experimental Psychol.: Gen. 169 (1984).

204. *Id.*

205. *Id.*

206. Barbara Tversky, *Development of Taxonomic Organization of Named and Pictured Categories*, 21 DEVELOPMENTAL PSYCHOL. 1111 (1985) (exploring problems of categorization and classification in diverse domains of human endeavor).

207. *Id.*

208. *Id.*

209. *Id.*

210. *Id.*

211. Levitin, *supra* note 101.

of the study some titles were tacitly shifted from one genre to another—by *Billboard*, the industry news source for studios and artists.[212] The company's "sales expertise" inadvertently exposed the arbitrariness of category boundaries assigned by the recording industry.

It should be obvious that the wobbliness of genre definitions and the lack of human consensus on musical similarity in Flexer and Grill's work allow no ground for claiming (as in the "Blurred Lines" decision) that similarity of musical style can be considered a copyrightable feature.[213] Style is arbitrary. Whether a user considers an instinctive impression of one piece to conform to his or her preferred style, that judgment will depend partly on the user's subjective assessment. As we have seen, the work of Jacques Aucouturier and François Pachet further refutes the notion of distinctly different, immediately recognizable "styles" as a predominant criterion for judgments of musical similarity.[214] In the case of their work, timbre and mood eclipse genre and style.[215]

V. BRAVE NEW WORLDS OF SOUND

Because sound registrations for music are steadily assuming a greater proportion of all copyright registrations in the U.S., the copyright community must address the limitations of sound filings (in relation to legacy case law based on fully notated works) with all due speed.[216] Sound files are as fluid in the studio as textual content is in a word processor. A simple remedy to this fluidity would be to adopt a registration requirement for an indelible time-, date-, and length-stamp in sound-recording submissions. Registrants would also designate a primary version of each work when submitting a registration application. A registered score would remain preferable to a sound recording. A sound recording can contain incidental accretions that represent a particular style of performance that may obscure central features of the composition. As we have seen in experimental work, listeners are hard-pressed to distinguish between

212. Robert O. Gjerdingen & David Perrott, *Scanning The Dial: The Rapid Recognition of Music Genres*, 37 J. OF NEW MUSIC RES. 93 (2008). *Billboard* had discerned that one way to stimulate sales in lagging categories was to reposition popular hits from adjacent categories.

213. This reservation notwithstanding, *Billboard*'s statistics make interesting reading for those trying to map the landscape of digital music. Consider, for example, this statement: "A growing trend in the early first decade of the 21st century was to issue a song as a "remix" that was so drastically different in structure and lyrical content from its original version that it was essentially a whole new song." The article goes on to cite instances in which the remix eclipsed the underlying work in popularity. *Billboard Hot 100,* WIKIPEDIA, https://en.wikipedia.org/wiki/Billboard_Hot_100 (last visited Mar. 1, 2018) [https://perma.cc/W3QR-L8KD].

214. Aucouturier & Pachet, *supra* note 129.

215. *Id.*

216. Brauneis, *supra* note 98, at 7–31 (carefully parses provisions, cases, and partial contradictions in the implications of the 1970 and 1976 revisions).

durable features and ephemeral ones produced in performance. Notated submissions remain unambiguous.

The audio-engineering community espouses the hallowed principle of ground-truth.[217] Strictly, ground-truth refers to empirical evidence, but, by substitution, human responses to a set of questions referring to the object may adequately serve.[218] In music studies, this usually means that each subject listens to prepared examples and selects an answer from a limited set of choices.[219] The approach may have good potential for assessing similarity claims outside the context of pending cases. If we accept the goal of pursuing ground-truth principles for music comparison in general, we may be able to avoid some courtroom contention. Why should courts in the twenty-first century depend on rhetorical battles to decide whether two short examples of music are sufficiently similar to sustain a judgment of infringement? Who is the court's ideal listener if not the respondent to a musical-similarity survey?

In a close examination of the contradictions between sound-based and notation-based opinions, Brauneis has delineated varieties of confusion in the wake of pertinent modifications to copyright law in the 1970s. Before reviewing the difficulties encountered in attempts to separate qualities of performance from qualities of recordings when recordings are taken as the *defining* instance of a musical work,[220] he crystalizes "the move away from musical notation" with these observations:

If there were one clear way of isolating a subset of features within a musical sound recording that constituted the musical composition and separating them from performance features, then it might be tempting to adopt the conservative interpretation of the 1976 Act as best fitting the language of the Act's provisions, whether or not it expresses the best policy approach. However, this Part will argue that in trying to isolate musical works within sound recordings, courts and commentators have adopted a varying and unstable combination of four approaches, and that all of these approaches are difficult to apply to sound recordings.[221]

Sound-only registrations could delineate creative contributions if copyright registration required that some account of pre-existing interpolations be identified. Audio files can include random elements

217. Dan P.W. Ellis et al., *The Quest for Ground Truth in Musical Artist Similarity*, LAB ROSA TECHNICAL REP. COLUM. U. (2002). The best metric the authors could reach in 2002 was 50% for inter-subject agreements on "artist similarity," which is only slightly lower than Flexer and Grills' recent (2016) correlations of "musical similarity." Flexer & Grill, *supra* note 165.

218. Adam Berenzweig et al., *A Large-Scale Evaluation of Acoustic and Subjective Music-Similarity Measures*, 28 COMPUTER MUSIC JOURNAL 63 (2004).

219. John Ashley Burgoyne et al., *An Expert Ground-Truth Set for Audio Chord Recognition and Music Analysis*, INT'L SOC'Y FOR MUSIC INFO. RETRIEVAL (2011).

220. Brauneis, *supra* note 98, at 8. The four approaches to similarity he describes bear (for convenience) the labels "notation, etiology, macro/micro, and music analysis."

221. *Id.*

from synthesizer firmware, samples from other audio sources, and clichés from works previously composed and registered by anyone. The same introductions, drum-tracks, and patterned accompaniments are found repeatedly in the works of one person, one group, and one community. Available tools make reservoirs of such materials easily available, but an enmeshed applicant's claim to a newly composed original can be dubious. Familiar procedures become invisible but not inaudible. Submissions of works that can be categorized as "grey" for their mixture of new and pre-existing materials do not fulfill the intent of U.S. copyright law to stimulate creativity, unless one accepts the intermixing itself (as in mash-ups) as equal in creativity to a piece newly composed.

Other capabilities offered by digital tools raise difficult questions. Artificial timbres, for example, may merit *patent* consideration: they depend on real-time processes, not settled templates. Sound morphing (transitioning from a synthesized trumpet to a virtual saxophone, for example) poses another spectrum of legal conundrums. Music videos can magnify the disparities between priorities in sound-based and score-based copyrights. YouTube offers no end of intellectual-property puzzles including three-way synchronizations of score, sound, and moving image. What status should be accorded to a video that leafs through a score created by the user while synchronizing a music track that obviously comes from a commercially available recording? The prospect of adequacy in a one-size-fits-all understanding of musical similarity in the world of digital media diminishes by the day.

Electronically composed music, which is "created" by prescriptive computer code, seems naturally suited to patent law. The focus is on the process of creation. Results can vary widely. Yet enthusiasm for the rigor of patent filings on behalf of short musical works may be slight. The most ambitious program to date, David Cope's Experiments in Musical Intelligence (nicknamed Emmy), developed between 1980 and 2010,[222] produced hundreds of new pieces.[223] Emmy software was optimized to simulate the musical style of genre of specific composers of the past (Bach, Beethoven, Mozart, Palestrina, Rachmaninoff, and many others). Apart from the musical discussion Emmy provoked, it also elicited *new kinds of questions* about musical similarity.

In addition to similarity questions, Emmy also stimulated numerous conversations about listener reactions to artificially

222. DAVID COPE, VIRTUAL MUSIC: THE COMPUTER SYNTHESIS OF MUSICAL STYLE (2001). In addition to numerous books and articles by Cope, Virtual Music gives comprehensive coverage of the phenomenon and responses to it. Those interested in listening to works produced by Emmy in performance will find many recordings available on the Amazon website.

223. *Id*. When Cope turned his back, Emmy produced many thousands of pieces, but he discarded the less admirable ones.

composed music. After the University of California, Santa Cruz (where Cope taught) began to present concerts by live performers of Emmy's repertory, listeners had far more positive reactions than those who had heard the first MIDI files.[224] The question that live performances of Emmy's compositions put into high relief is this: What is protectable in such a performance? Is the music created by Emmy (being synthesized from traits automatically extracted from the works of long-dead composers) copyrightable? Why? These questions are pertinent to Emmy's successor, a virtual composer named Emily Howell (also Cope's creation). She is evolving her own musical style (without reference to pre-existing works) over time.[225] In a series of lectures and live events at Stanford University (1997), listeners were asked in one concert to judge which of ten pieces in a live program were composed by a past composer and which by Emmy.[226] They found the task difficult. Titles of individual pieces were generic. When answers were tabulated, few respondents were correct more than half the time.[227] Are we able to distinguish between traits of *composition* and traits of *performance*? It appears that compositional traits are harder to detect in live performance.[228] The subtlety of such distinctions, when combined with variations in perception from one listener to another, pose further pitfalls for sound-based work registrations. They can be further complicated when occurring in combination with vocal and timbral synthesis, the use of artificial instruments, machine-choreographed robots, and other phenomena gestated in research labs. All can fall within the spectrum of musical authorship.

Apart from these puzzles, questions of music copyright are unnecessarily confined to the world of commercial entertainment. That world seems not to acknowledge that most of the world's music is created for immediate, non-commercial use. Music as understood in studios is merely a small subset of the world's music, most of which is unrecorded and unnotated. The music-copyright community could develop sharper perspectives on its immediate tasks by exploring the challenges that may eventually come from both indigenous and overseas cultures. The online world offers extensive tools (courses,

224. *Id.*

225. Jacqui Cheng, *Virtual Composer Makes Beautiful Music—And Stirs Controversy*, ARS TECHNICA (Aug. 29, 2009, 8:40 PM), https://arstechnica.com/science/2009/09/virtual-composer-makes-beautiful-musicand-stirs-controversy/ [https://perma.cc/7J4F-ZYQ3].

226. *See* Cope, *supra* note 222 (selectively represented in the essays and sample pieces in Cope's book).

227. Mary Jane Cope & Karen Bentley, Concert at Stanford University Musical Composition Symposium: Are Computers Approaching Human-Level Creativity? (Nov. 8, 1997) (film available from Cardinal Cable). Programs were distributed after the quiz was conducted.

228. Although controlled studies by psychologists have not produced systematic evidence of the relative discrimination of musical content from timbre, a start on the evaluation of artificial composition has been considered. *See* Marcus Pearce & Geraint Wiggins, *Towards a Framework for the Evaluation of Machine Compositions*, PROCEEDINGS OF THE AISB'01 SYMPOSIUM ON ARTIFICIAL INTELLIGENCE 22–32 (2001).

videos, and multimedia websites) to enable a broader understanding of music in the non-commercial world. The importance of the music debated in the "Blurred Lines" case seems limited in relation to the prospect of dozens of potential matches for short, random passages in either work. The multiple aspects of musical similarity reviewed above in retail environments come into sharper focus at the wholesale level.

All up, *sound in the absence of notation* is a much less secure foundation for establishing a definitive version of a creative work than *notation in the absence of sound*. In musicology, both digital and analog, the lack of tangible substance in sound has been a topic of discussion since the time of Plato. "Music exists only in sound," observed the noted scholar Margaret Bent, "but, paradoxically, sound is its *least stable* element."[229] Sound, she argues, has no obvious analogies to text, numbers, or pictures.[230] The *instability* of sound is a primary obstacle to defining "substantial musical similarity" for the purposes of copyright. Whose sound? Yours or mine? Yesterday's or today's? The prospect of establishing a firm, fair, easy-to-implement solution to music copyright problems with one versatile, durable set of principles seems remote. Music and its methods of delivery will continue to change. While we cannot foresee the details of these changes, we can be confident that neither retrospective understandings nor one-size-fits-all solutions will lead to better rubrics for evaluating musical similarity.

229. Margaret Bent, *Editing Early Music: The Dilemma of Translation*, 22 EARLY MUSIC 373 (1994).

230. *Id*.