1973

IDEAS AND INSIGHTS

The O'Jays - Love Train

What Makes a Hit

60 Years of #1 Songs

When it comes to climbing the charts, research suggests that it pays to be different. From Brenda Lee to Beyoncé, here's how the top songs stood out from the crowd.

By **Colin Morris**

For a multi-billion dollar industry, popular music gets a bad rap.

Pop music is often derided as insipid and endlessly recycled, and critics of the Top 40 often suggest that the key to making a hit is to copy and paste an earlier success with nothing more than some superficial variation. But recent research suggests that the opposite may be true.

In their paper "What Makes Popular Culture Popular? Product Features and Optimal Differentiation in Music," professors Michael Mauskapf of Columbia Business School and Noah Askin of INSEAD analyzed 60 years worth of tracks from the Billboard Hot 100, and found that the songs that chart highest tend to be *less similar* to their predecessors. When it comes to getting to the top of the charts, it pays to be different — though not *too* different.

"Breakout songs — those that reach the very top of the charts — simultaneously conform to prevailing musical feature profiles while exhibiting some degree of individuality or novelty," Mauskapf and Askin explain. "They sound similar to whatever else is popular at the time, but also have enough of a unique sound to help them stand out as distinctive."
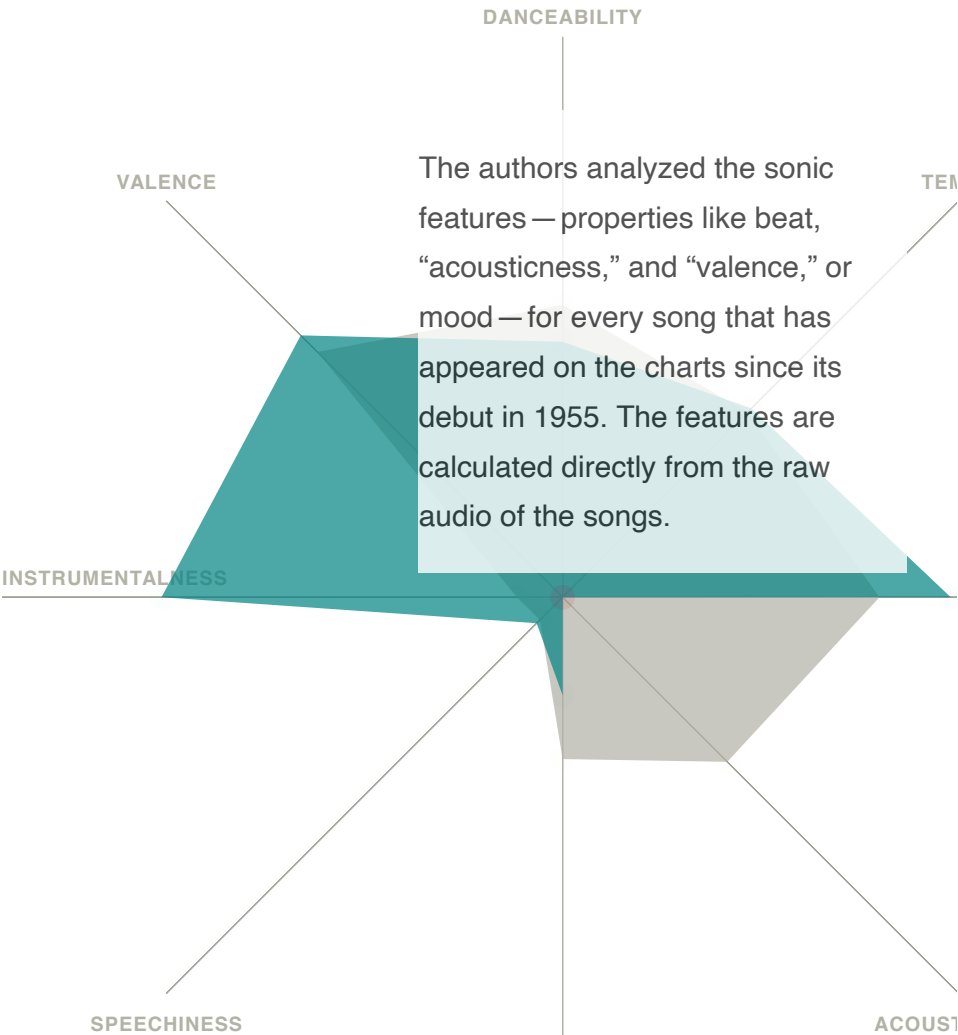
"What that suggests," the researchers conclude, "is that a hit song, or any other cultural product – like a film, or a novel — can't simply be reverse engineered from what's been
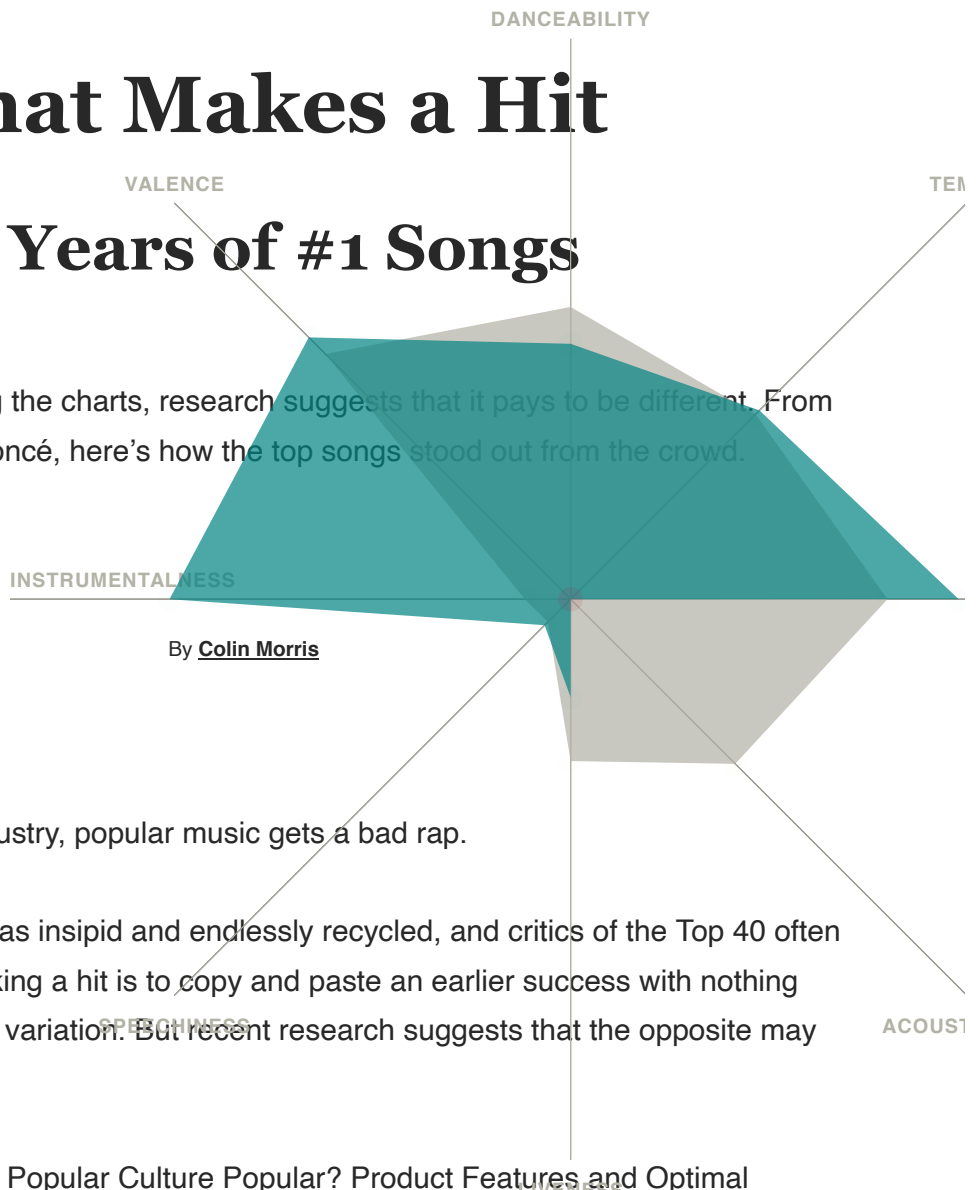
popular in the past. Popular success really is more art than science."

The O'Jays - Love Train

Jump to Explore all 60
years of #1 songs

DANCEABILITY

VALENCE   TEM

The authors analyzed the sonic
features—properties like beat,
"acousticness," and "valence," or
mood—for every song that has
appeared on the charts since its
debut in 1955. The features are
calculated directly from the raw
audio of the songs.

INSTRUMENTALNESS

SPEECHINESS   ACOUST

LIVENESS

Let's go over those features. As an
example, I'll be using "Believe" by
Cher, which held the #1 spot on the
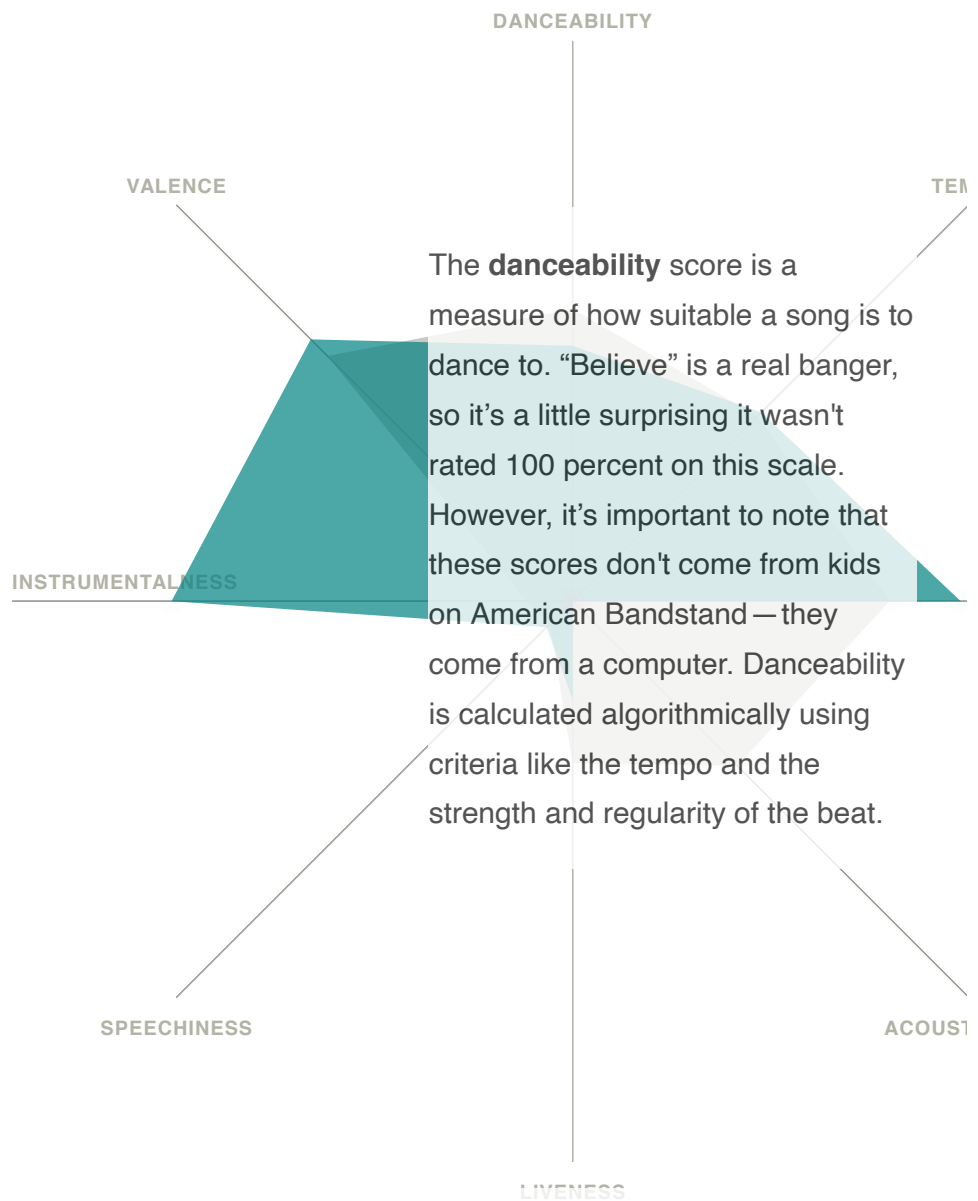Billboard Hot 100 for four weeks in
1999.

Believe
Cher

1973

It's got a good beat, and you can dance to it!

The O'Jays - Love Train

DANCEABILITY

VALENCE   TEM

The **danceability** score is a measure of how suitable a song is to dance to. "Believe" is a real banger, so it's a little surprising it wasn't rated 100 percent on this scale. However, it's important to note that these scores don't come from kids on American Bandstand — they come from a computer. Danceability is calculated algorithmically using criteria like the tempo and the strength and regularity of the beat.

INSTRUMENTALNESS

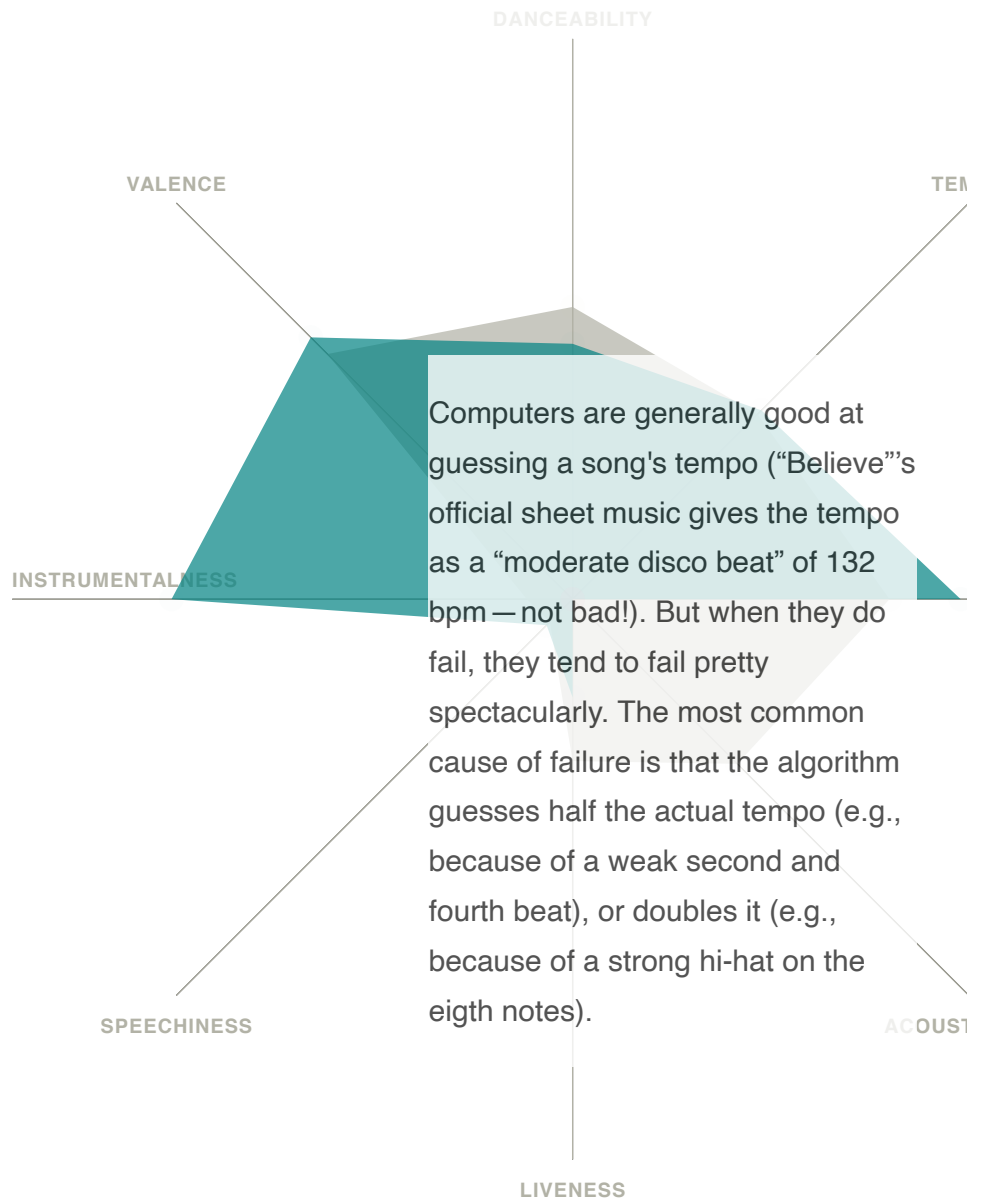SPEECHINESS   ACOUST

LIVENESS

The latter might explain why this song didn't reach the top of the danceability scale. The song features two sections dominated by synth pads, with no percussion: the intro, and a breakdown following the bridge. Our algorithm is very likely to "lose the beat" during these sections, and therefore ding the danceability score.

1973

The O'Jays - Love Train

Tempo is the simplest, most primitive sonic feature in our toolbox. It's just the speed of the song. "Believe" clocks in at a moderately fast 133 beats per minute.

DANCEABILITY

VALENCE

TEM

Computers are generally good at guessing a song's tempo ("Believe"'s official sheet music gives the tempo as a "moderate disco beat" of 132 bpm—not bad!). But when they do fail, they tend to fail pretty spectacularly. The most common cause of failure is that the algorithm guesses half the actual tempo (e.g., because of a weak second and fourth beat), or doubles it (e.g., because of a strong hi-hat on the eigth notes).
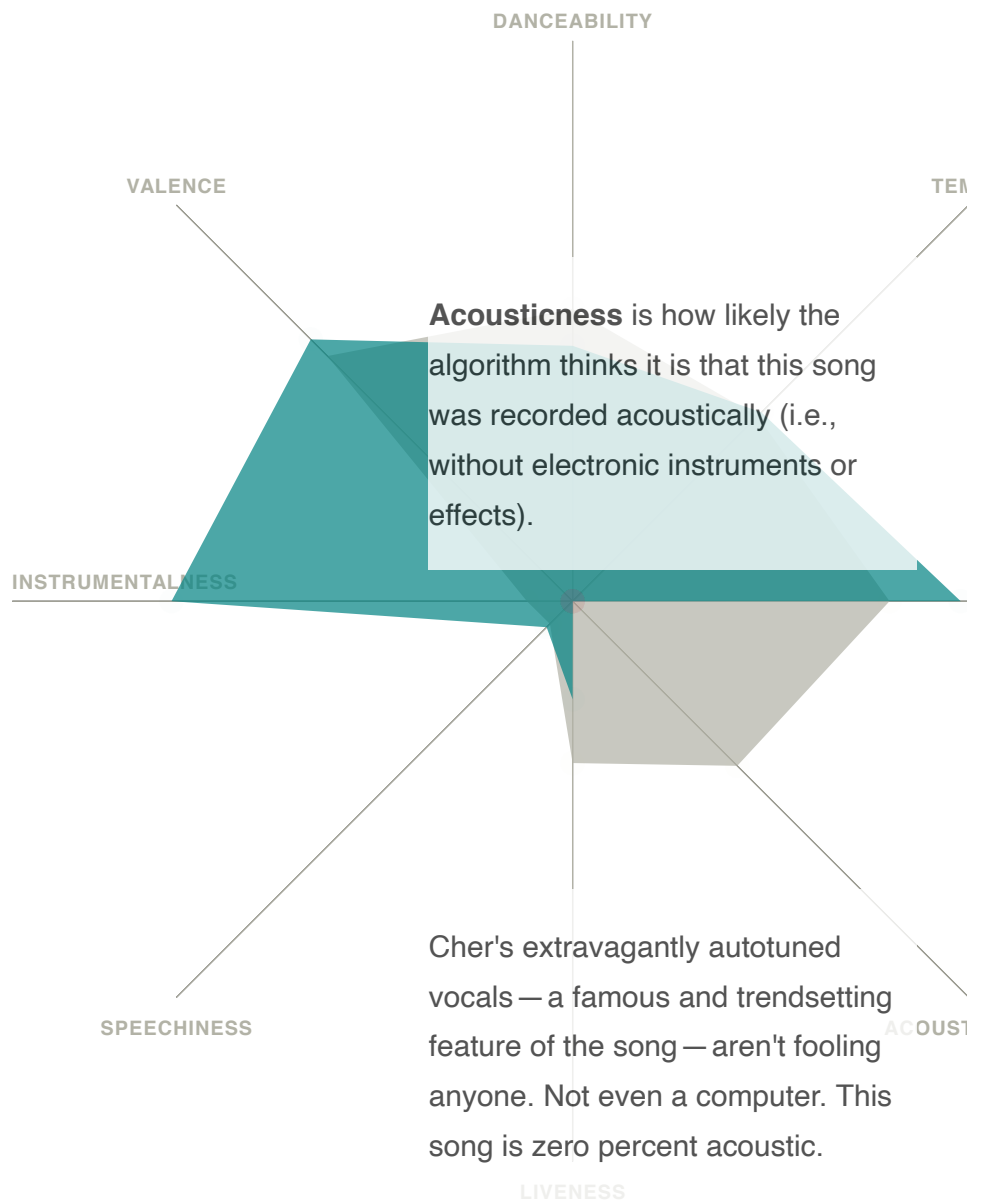
INSTRUMENTALNESS

SPEECHINESS

ACOUST

LIVENESS

Energy is a measure of a track's "intensity." This might seem similar to danceability, but a song can be energetic (fast, loud, noisy), but undanceable because of a disjointed or weak beat.

1973

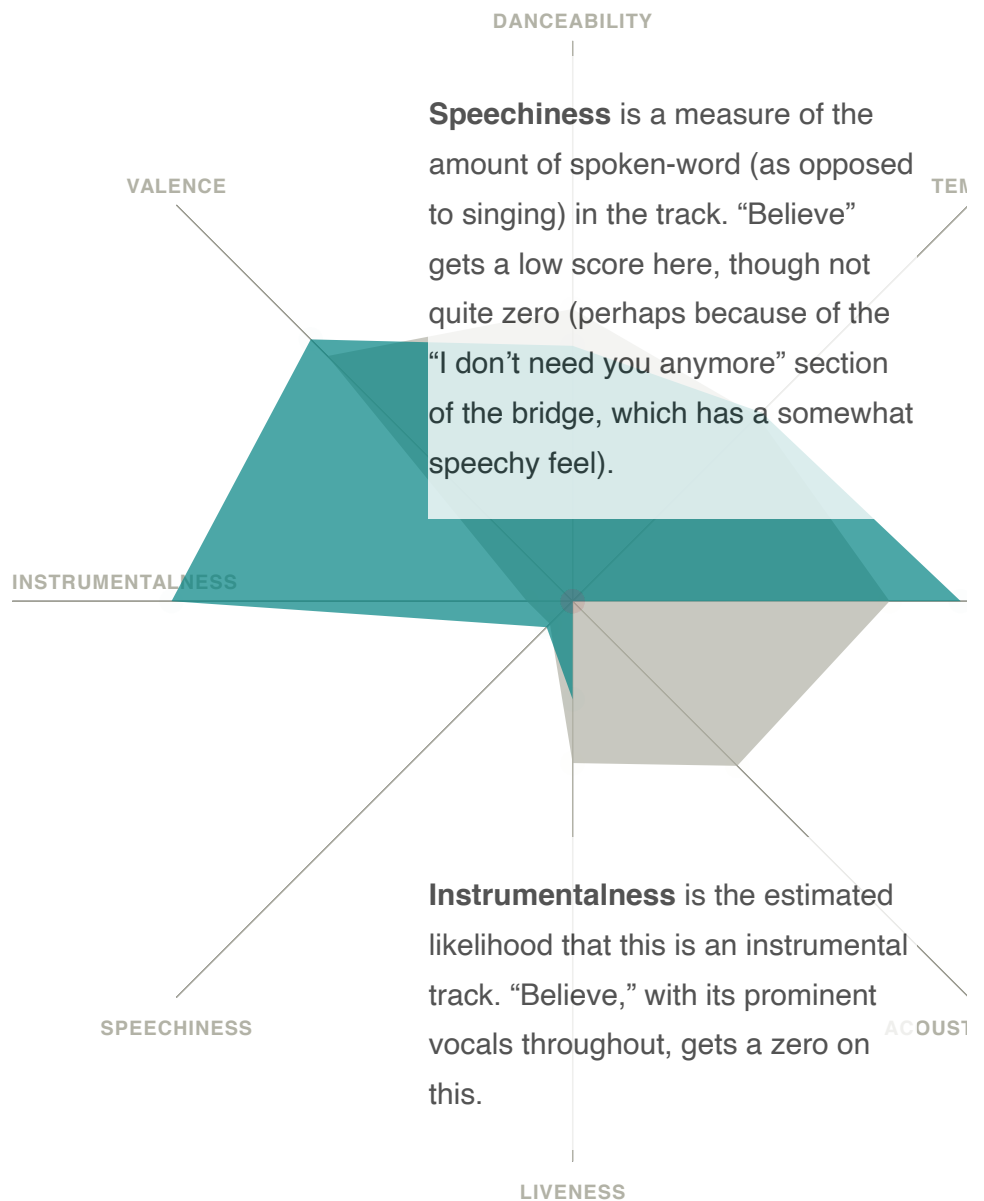## The O'Jays - Love Train

"Believe", with its "boots and pants" techno beat and throbbing synths gets a very high energy score.

DANCEABILITY

VALENCE

TEM

Acousticness is how likely the algorithm thinks it is that this song was recorded acoustically (i.e., without electronic instruments or effects).

INSTRUMENTALNESS

SPEECHINESS

ACOUST

Cher's extravagantly autotuned vocals — a famous and trendsetting feature of the song — aren't fooling anyone. Not even a computer. This song is zero percent acoustic.

LIVENESS

Liveness is how likely the algorithm thinks it is that this song was recorded live. Again, the song's heavy-handed production leads to a very low score on this metric.
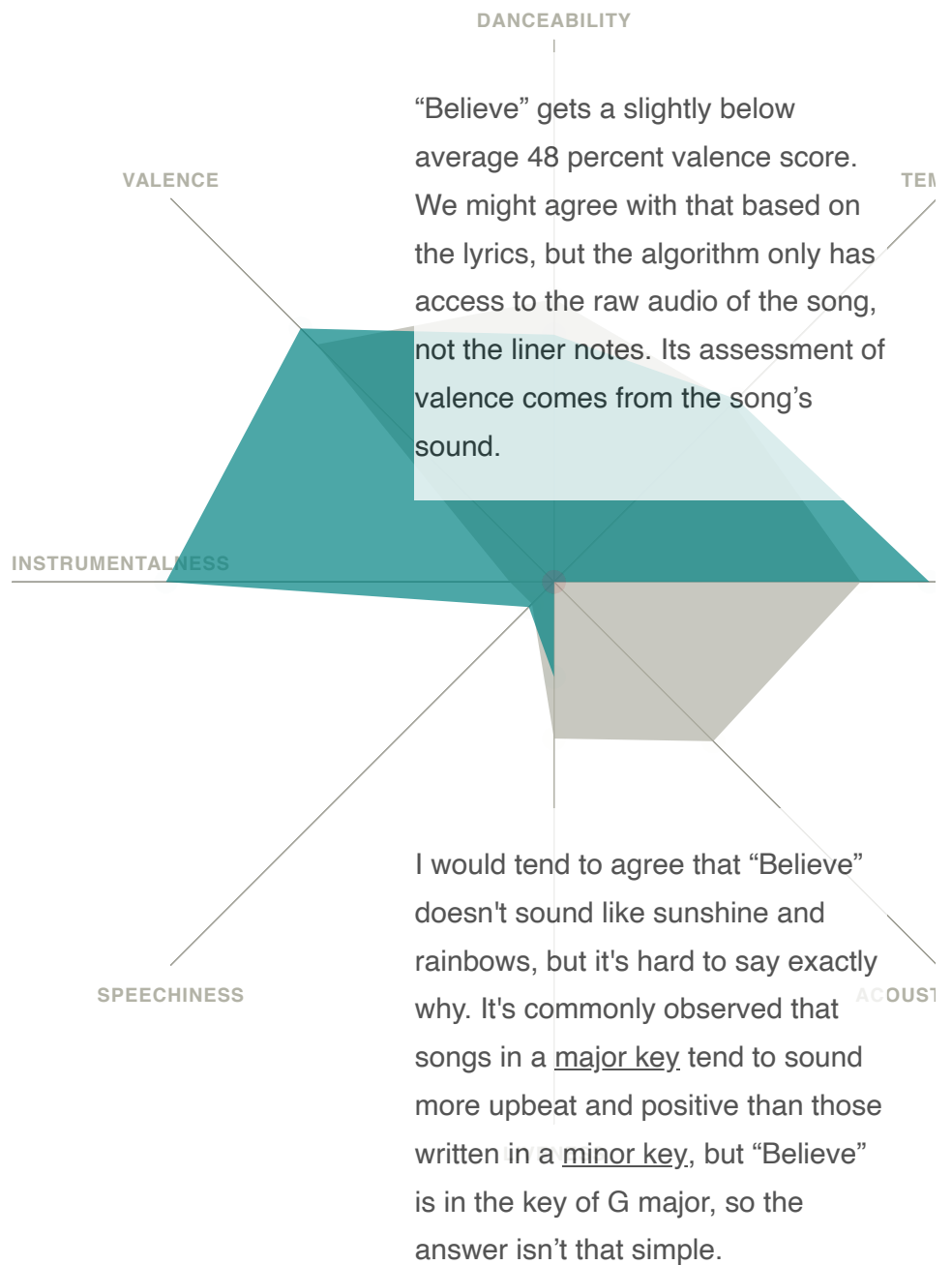
1973

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

Speechiness is a measure of the amount of spoken-word (as opposed to singing) in the track. "Believe" gets a low score here, though not quite zero (perhaps because of the "I don't need you anymore" section of the bridge, which has a somewhat speechy feel).

INSTRUMENTALNESS

SPEECHINESS

Instrumentalness is the estimated likelihood that this is an instrumental track. "Believe," with its prominent vocals throughout, gets a zero on this.

ACOUST

LIVENESS

Finally, **valence** is one of the most high-level, abstract features used. It represents the "positiveness" of the track. That is, is listening to it likely to make you happy? Or does it have more of a sad, dark vibe?

1973

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

"Believe" gets a slightly below average 48 percent valence score. We might agree with that based on the lyrics, but the algorithm only has access to the raw audio of the song, not the liner notes. Its assessment of valence comes from the song's sound.

INSTRUMENTALNESS

I would tend to agree that "Believe" doesn't sound like sunshine and rainbows, but it's hard to say exactly why. It's commonly observed that songs in a major key tend to sound more upbeat and positive than those written in a minor key, but "Believe" is in the key of G major, so the answer isn't that simple.

SPEECHINESS

ACOUST

Maybe there's just something unsettling about the alien, artificial

1973

The O'Jays - Love Train

sound of those synth pads? Or maybe it's something in the harmonies. The arpeggiated chord played after the first line of the chorus sounds a bit wonky: it's a major seventh, inverted such that the first two notes are separated by a semitone-an extremely dissonant interval. Or maybe it's just Cher's eerily robotic voice.

VALENCE

DANCEABILITY

TEM

INSTRUMENTALNESS

SPEECHINESS

ACOUST

LIVENESS
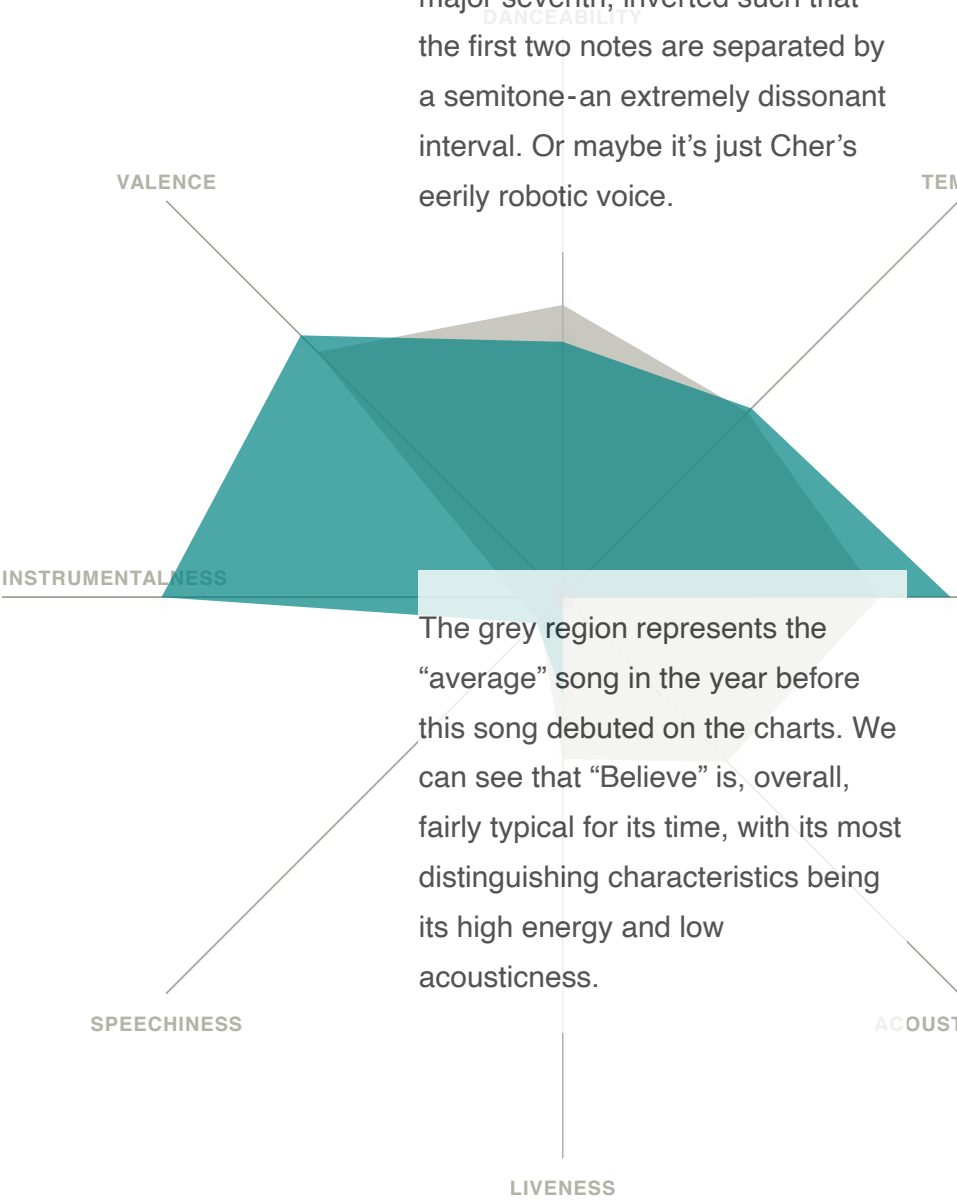
The grey region represents the "average" song in the year before this song debuted on the charts. We can see that "Believe" is, overall, fairly typical for its time, with its most distinguishing characteristics being its high energy and low acousticness.
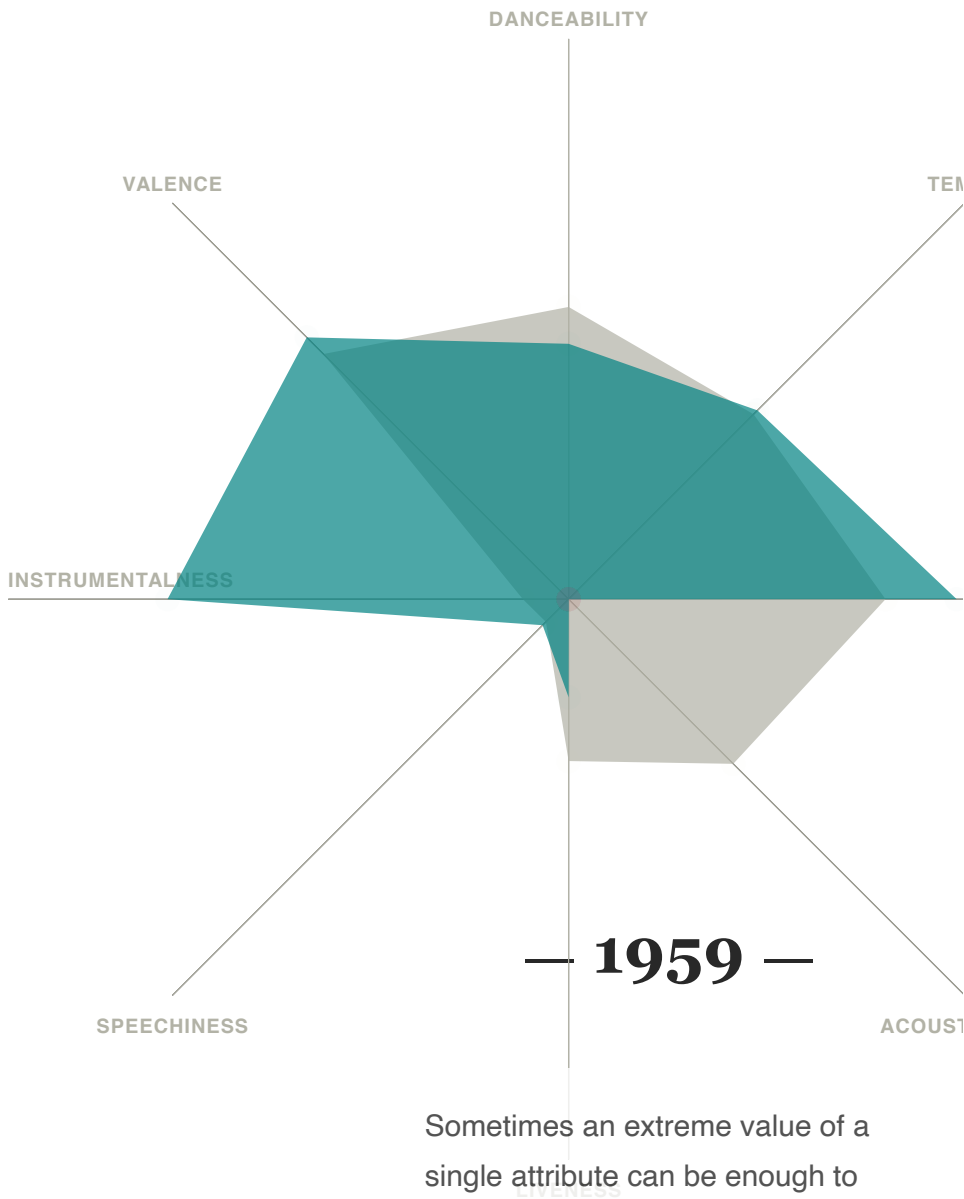
Let's take a note from Cher's book and "Turn Back Time" to the early years of the charts, as we explore some *atypical* hits through the years.

1973

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(Notice how the attributes of the average song have changed over time.)

DANCEABILITY

VALENCE

TEM

INSTRUMENTALNESS

— **1959** —

SPEECHINESS

ACOUST

LIVENESS

Sometimes an extreme value of a single attribute can be enough to make a song notably atypical, as with "The Happy Organ," which topped the charts in 1959.
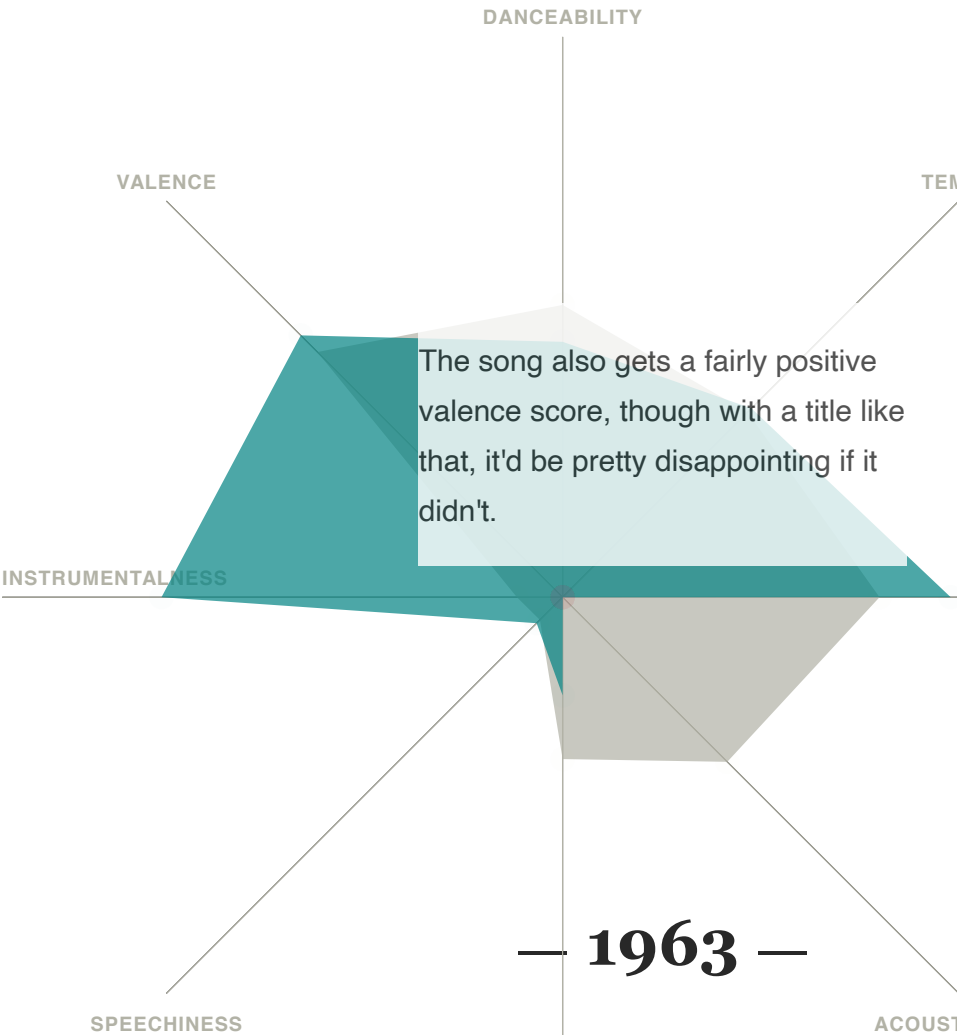
The Happy Organ
Dave "Baby" Cortez

1973

The O'Jays - Love Train

"The Happy Organ" was a fully instrumental track, which was fairly uncommon at the time, and became even rarer in later decades.

DANCEABILITY

VALENCE

TEM

The song also gets a fairly positive valence score, though with a title like that, it'd be pretty disappointing if it didn't.

INSTRUMENTALNESS

— **1963** —

SPEECHINESS

ACOUST

LIVENESS

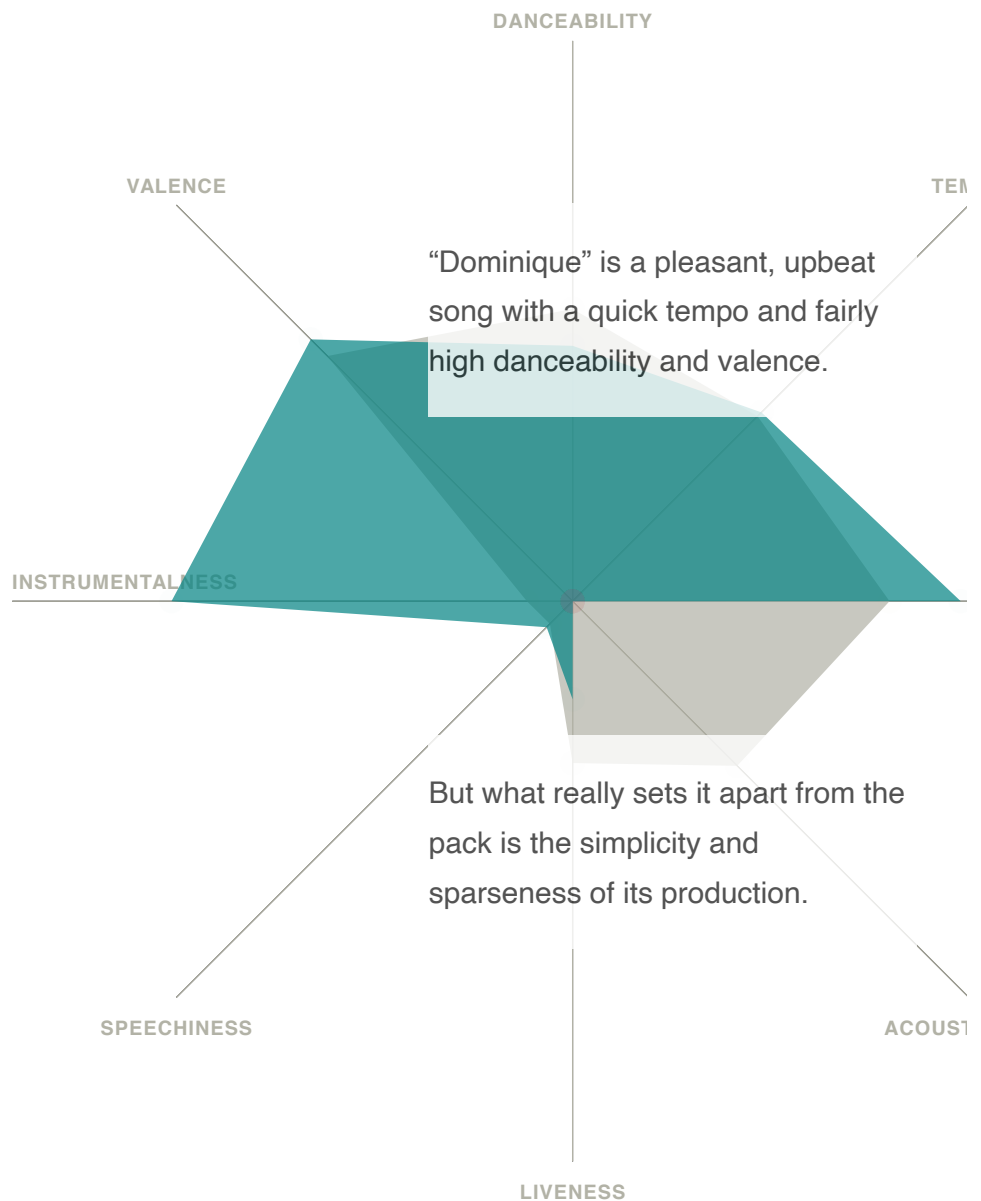"Dominique," sung by Jeannine Deckers, the so-called "Singing Nun" is a bit of an oddity. First, there's the performer. At the time, the charts skewed toward attractive, young, all-American singers and groups — Lesley Gore, Bobby Vinton, the Four Seasons, the Chiffons. Deckers, an actual Belgian nun, singing in French, was hardly the typical American Bandstand fodder.

1973

Dominique
Soeur Sourire

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

"Dominique" is a pleasant, upbeat song with a quick tempo and fairly high danceability and valence.

INSTRUMENTALNESS

But what really sets it apart from the pack is the simplicity and sparseness of its production.
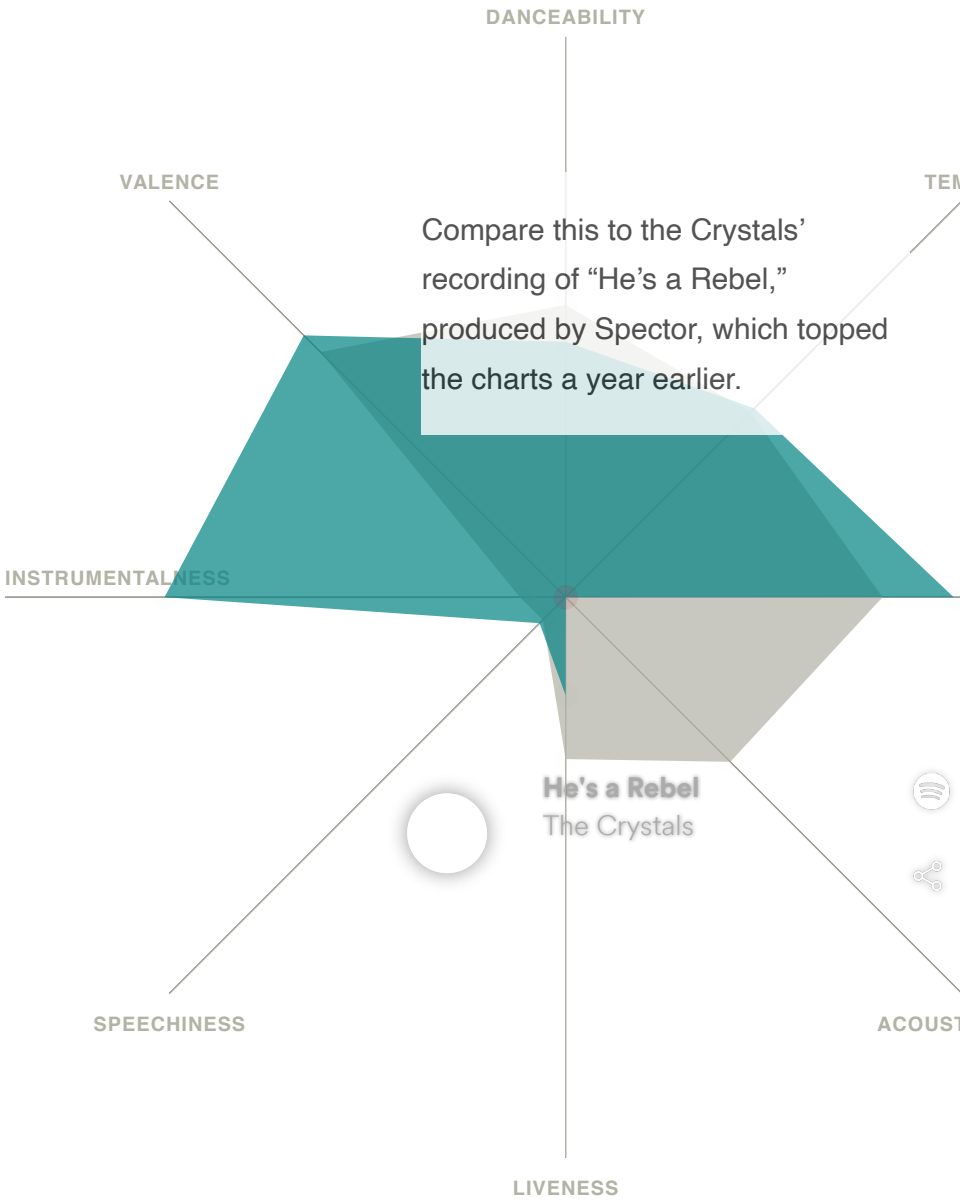
SPEECHINESS

ACOUST

LIVENESS

Deckers' vocals are overdubbed in the chorus, but otherwise, it sounds as if she might have recorded it in one take in her bedroom with a tape recorder and a guitar. This is not a "Wall of Sound," the production formula developed by Phil Spector that dominated the charts in the 1960s, by any means. And this is

1973

reflected in the song's unusually low energy and high acousticness.

The O'Jays - Love Train

DANCEABILITY

VALENCE   TEM

Compare this to the Crystals' recording of "He's a Rebel," produced by Spector, which topped the charts a year earlier.

INSTRUMENTALNESS

He's a Rebel
The Crystals

SPEECHINESS   ACOUST
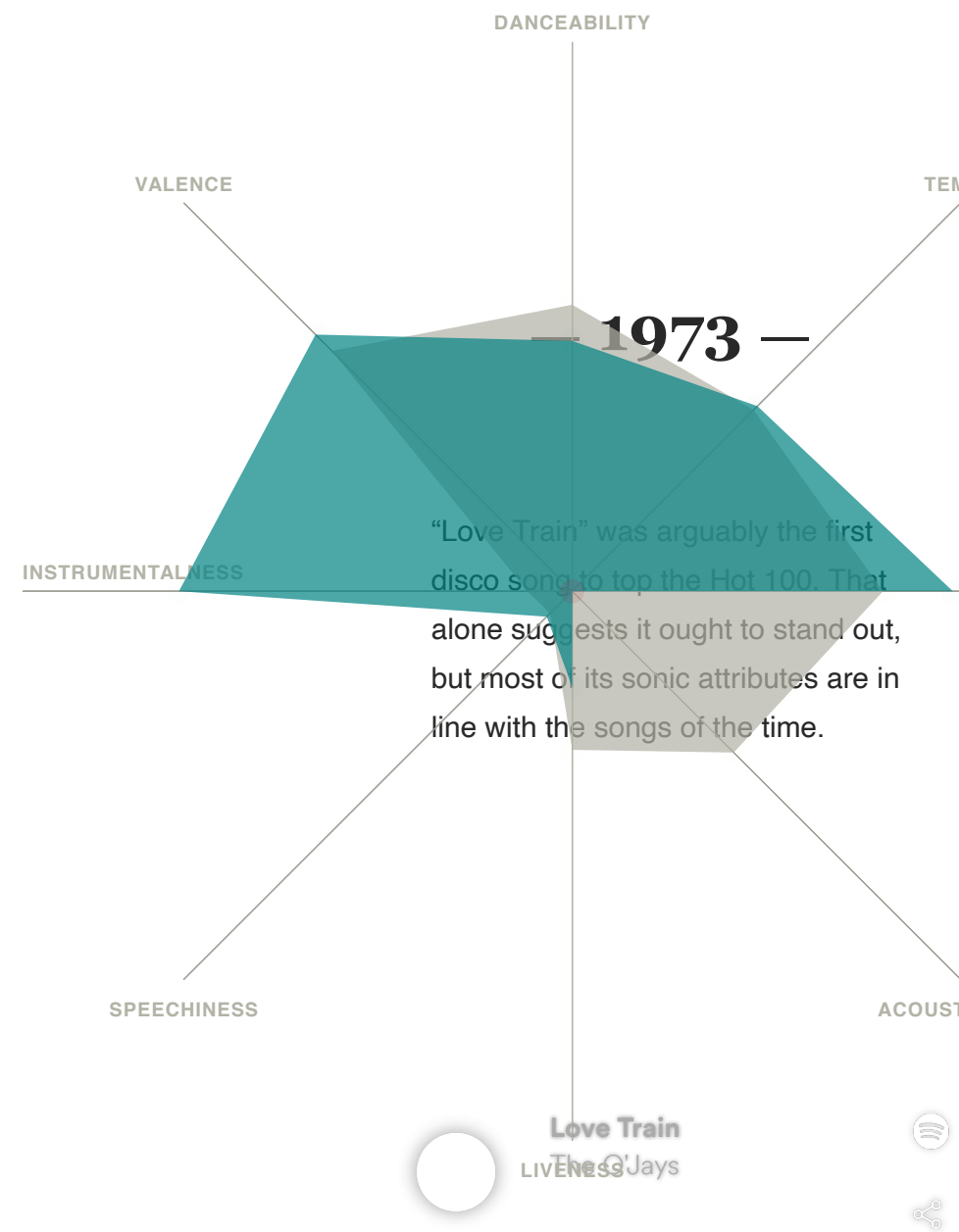
LIVENESS

The song has a much higher typicality score, and sonically, it feels much "bigger." There are a lot of instruments in the mix, compared to the lone guitar in "Dominique," and, importantly, we have drums articulating a clear beat, aided by the handclaps that start about halfway through. Over all the instrumentation, the vocals come through powerfully with rich

1973

The O'Jays - Love Train

harmonies, overdubbing and reverb. It's a classic Spector production, that's well deserving of its high energy score.

DANCEABILITY

VALENCE

TEM

— 1973 —

INSTRUMENTALNESS

"Love Train" was arguably the first disco song to top the Hot 100. That alone suggests it ought to stand out, but most of its sonic attributes are in line with the songs of the time.
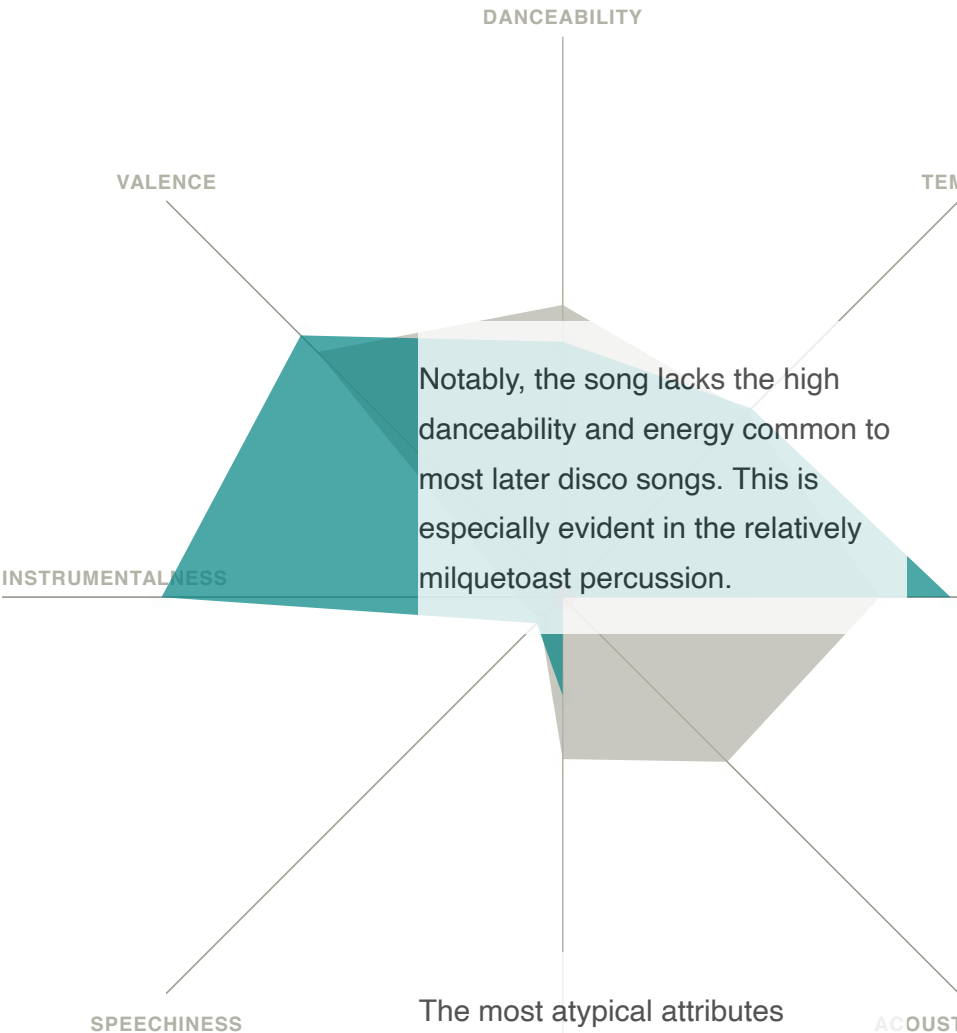
SPEECHINESS

ACOUST

Love Train
The O'Jays
LIVENESS

New genres rarely emerge out of a vacuum — they evolve out of other genres, and "Love Train" probably

has more in common with the Philadelphia Soul tracks that came before it — themselves an evolution of the Motown sound — than with the disco tracks of a few years later.

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

Notably, the song lacks the high danceability and energy common to most later disco songs. This is especially evident in the relatively milquetoast percussion.

INSTRUMENTALNESS

SPEECHINESS

ACOUST

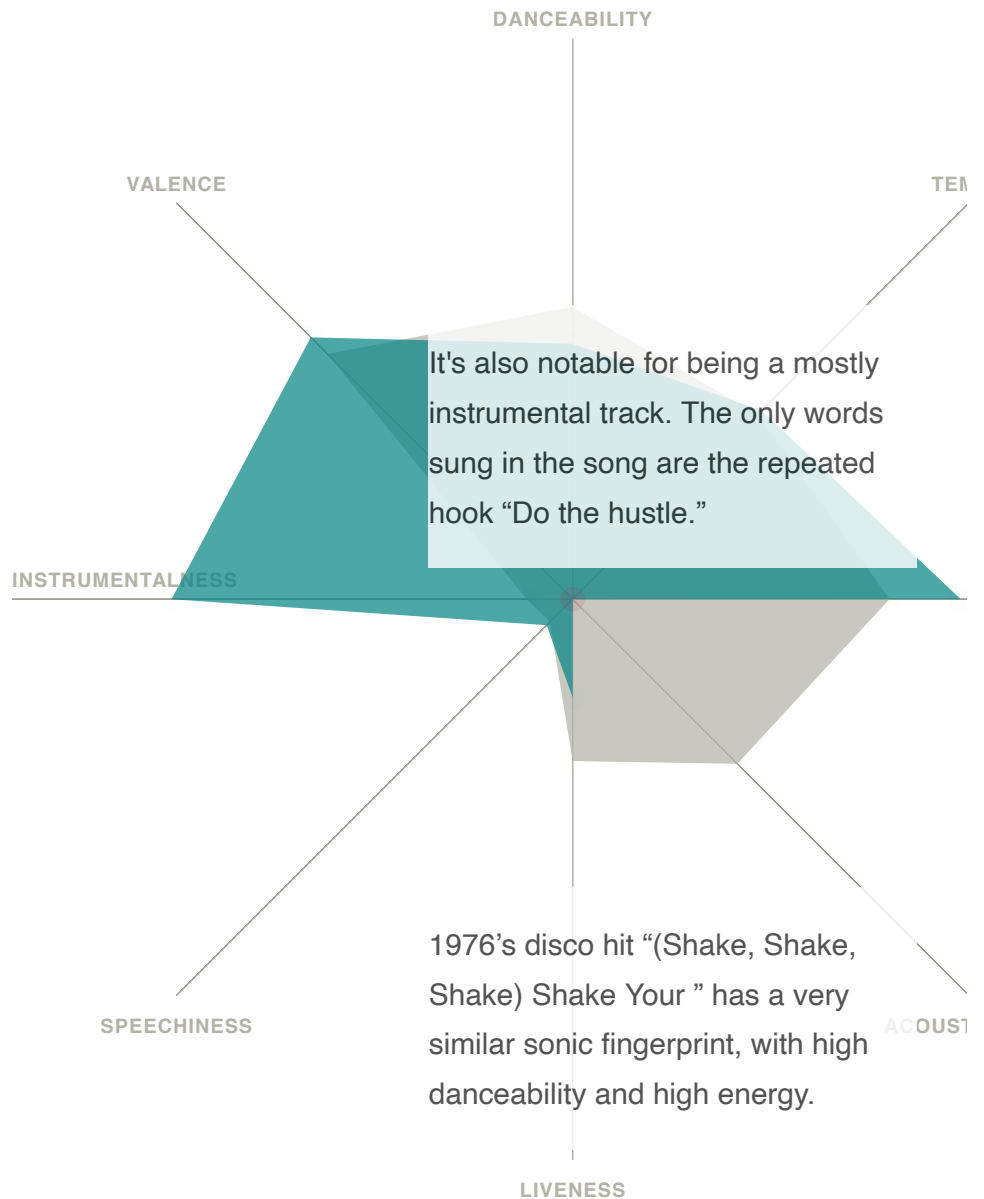LIVENESS

The most atypical attributes identified by the algorithm — high instrumentalness and no acousticness — are questionable. This isn't an instrumental track (and doesn't even feature any signficant instrumental sections), and while there are clearly some electric guitars involved, it otherwise sounds pretty acoustic, with no traces of the drum machines or synthesizers that were soon to come.

1973

The O'Jays - Love Train

By 1975, disco as we know it today had more firmly taken shape. That year's '"The Hustle" amped up the danceability and the energy.

DANCEABILITY

VALENCE

TEM

It's also notable for being a mostly instrumental track. The only words sung in the song are the repeated hook "Do the hustle."

INSTRUMENTALNESS

SPEECHINESS

ACOUST

1976's disco hit "(Shake, Shake, Shake) Shake Your " has a very similar sonic fingerprint, with high danceability and high energy.

LIVENESS

Gloria Gaynor's iconic "I Will Survive" reached number 1 in early 1979, just before the disco bubble popped.

1973

I Will Survive - Single V...
Gloria Gaynor

The O'Jays - Love Train

DANCEABILITY

VALENCE   TEM

The song features an interesting juxtaposition of low valence with high energy and danceability. It's a classic "dancing through the tears" track that stood out from its peers in part by dint of a much sparser production than was typical of disco songs at the time.

INSTRUMENTALNESS

SPEECHINESS   ACOUST

By 1983, emotional ballads like "I Will Survive," with their roots in Soul music, had mixed with the ascendent pop rock genre to produce the power ballads of the 1980s. Though not as danceable as "I Will Survive," Bonnie Tyler's power-ballad "Total Eclipse Of The Heart," which went to #1 in 1983, similarly electrified a low-valence song with an energetic production.

Total Eclipse of the Heart
Bonnie Tyler

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

— 1986 —

INSTRUMENTALNESS

1986 was a big year for mainstream popularity of hair metal. Bon Jovi had previously released two albums, with their most successful single peaking at #39 on the Hot 100. But "You Give Love a Bad Name," the debut single from their third album, rocketed to #1. The song is pretty atypical compared to the average Hot 100 song of the time, but it demonstrates some of the hallmarks of a genre that would achieve a significant presence on the charts in the coming years.

SPEECHINESS
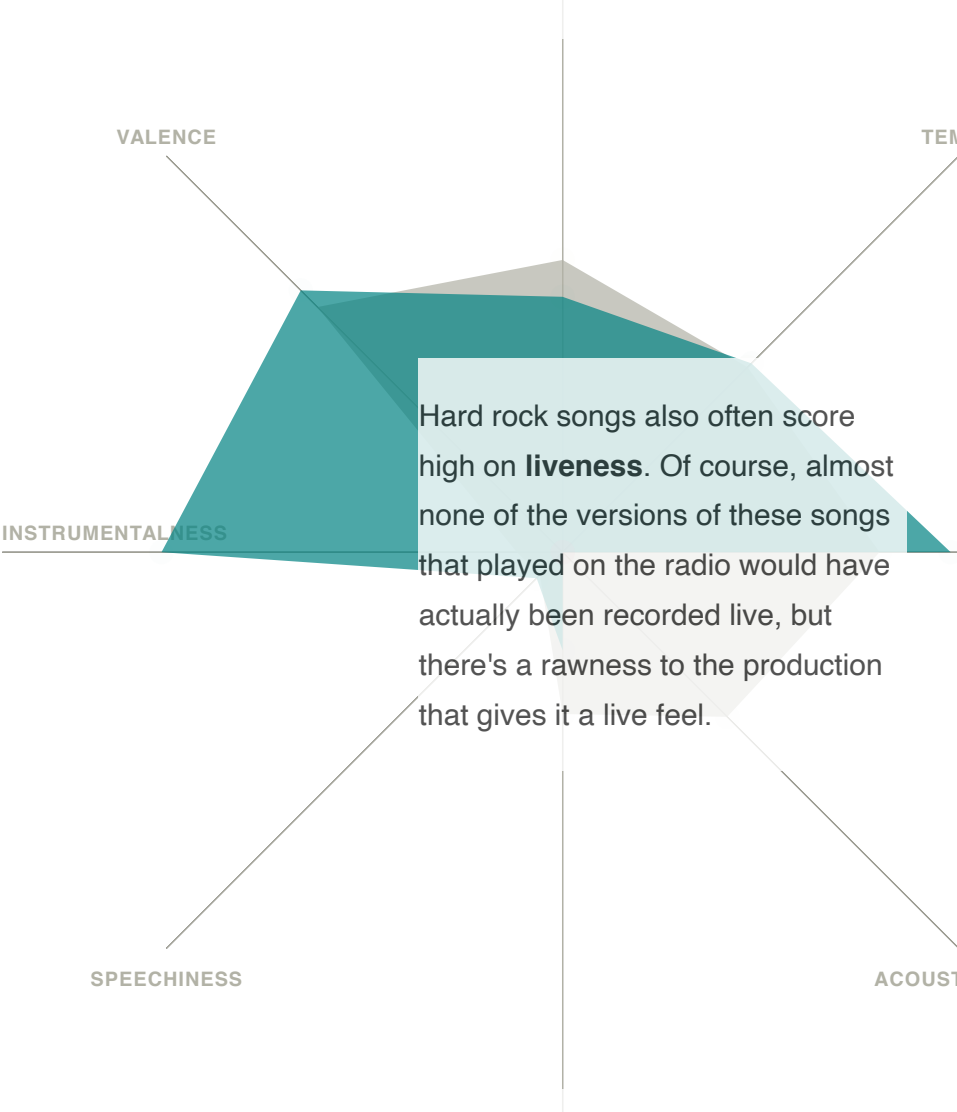
ACOUST

LIVENESS

You Give Love A Bad Na...
Bon Jovi

1973

The O'Jays - Love Train

Hard rock is a perfect example of a genre whose songs are defined by their energy - *noisy* and strident, and filled with colossal guitar solos and hard percussion - without necessarily being danceable.

DANCEABILITY

VALENCE

TEM

Hard rock songs also often score high on **liveness**. Of course, almost none of the versions of these songs that played on the radio would have actually been recorded live, but there's a rawness to the production that gives it a live feel.

INSTRUMENTALNESS

SPEECHINESS

ACOUST

Bon Jovi's follow-up single, "Livin' On A Prayer," also went to #1, and features a similar profile of high energy and liveness, contrasted with low valence and danceability.

1973

The O'Jays - Love Train

Whitesnake's "Here I Go Again" has one of the most exaggerated versions of the prototypical metal song graph, making it extremely atypical, relative to its peers on the chart.

DANCEABILITY

VALENCE

TEM

INSTRUMENTALNESS

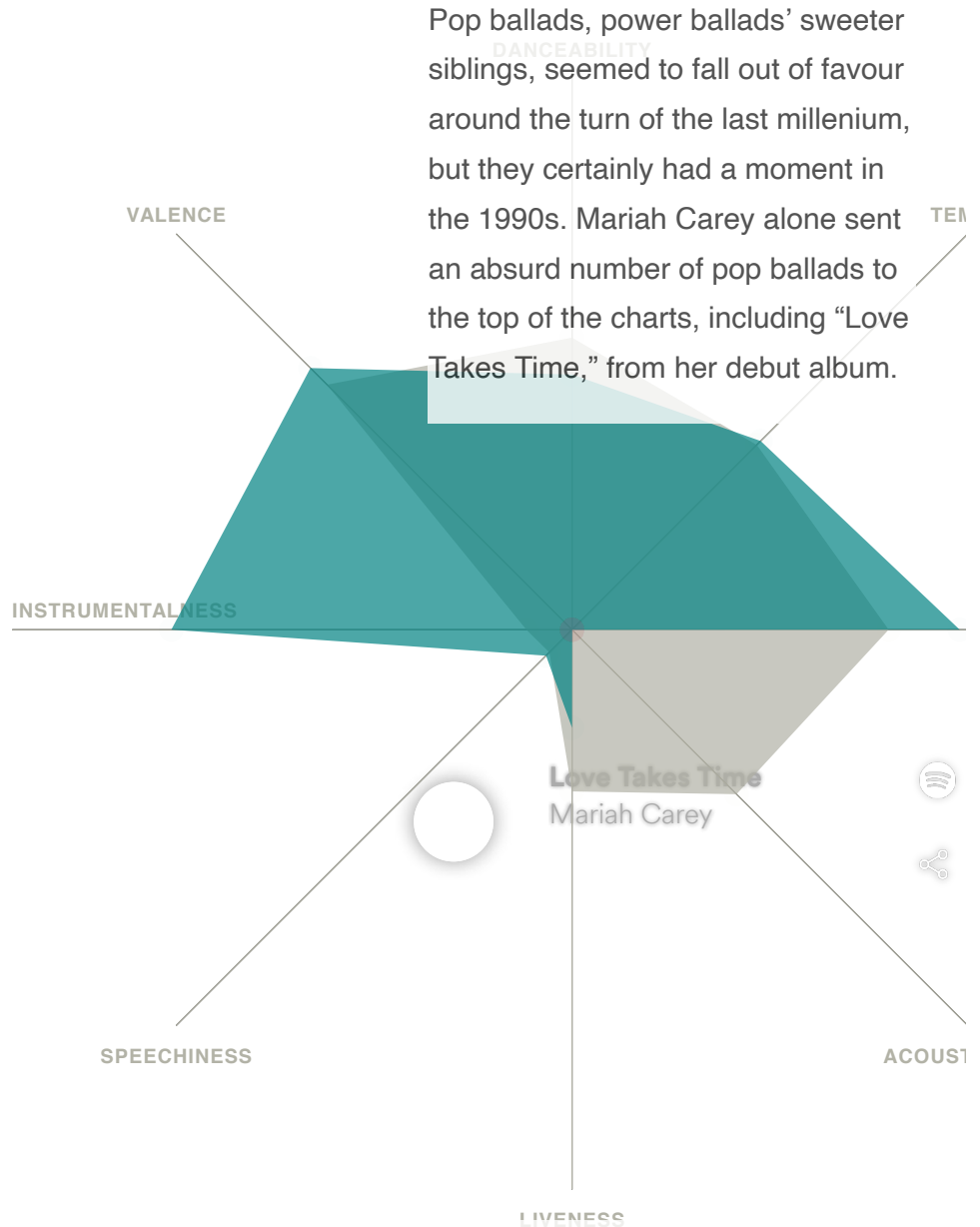Here I Go Again
Whitesnake

SPEECHINESS

ACOUST
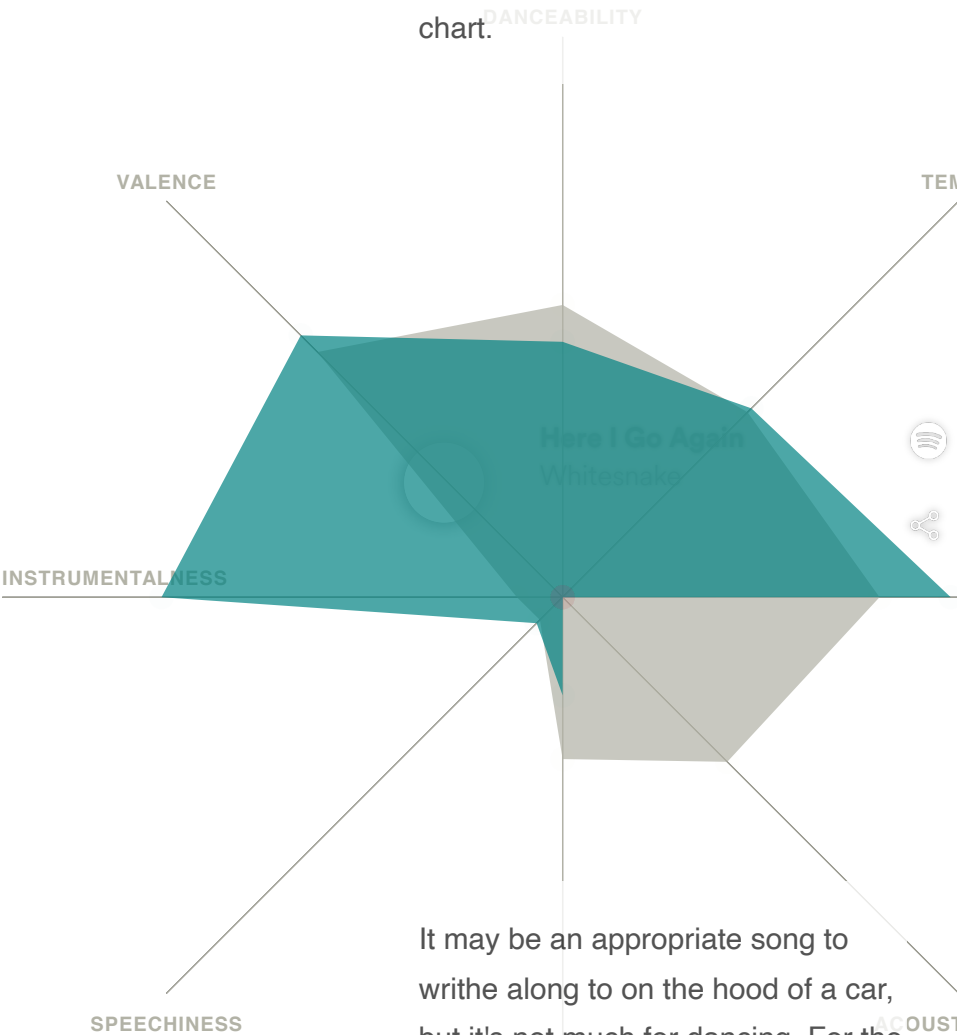
It may be an appropriate song to writhe along to on the hood of a car, but it's not much for dancing. For the first minute of the song, until the first chorus, there's no percussion, just some mellow synths and contemplative piano chords. From that point, the energy of the instrumentals and vocals explodes, but the overall mood remains pretty low, and the low tempo and subdued verses render it virtually undanceable.

— **1990** —

The O'Jays - Love Train

Pop ballads, power ballads' sweeter siblings, seemed to fall out of favour around the turn of the last millenium, but they certainly had a moment in the 1990s. Mariah Carey alone sent an absurd number of pop ballads to the top of the charts, including "Love Takes Time," from her debut album.

VALENCE

DANCEABILITY

TEM

INSTRUMENTALNESS

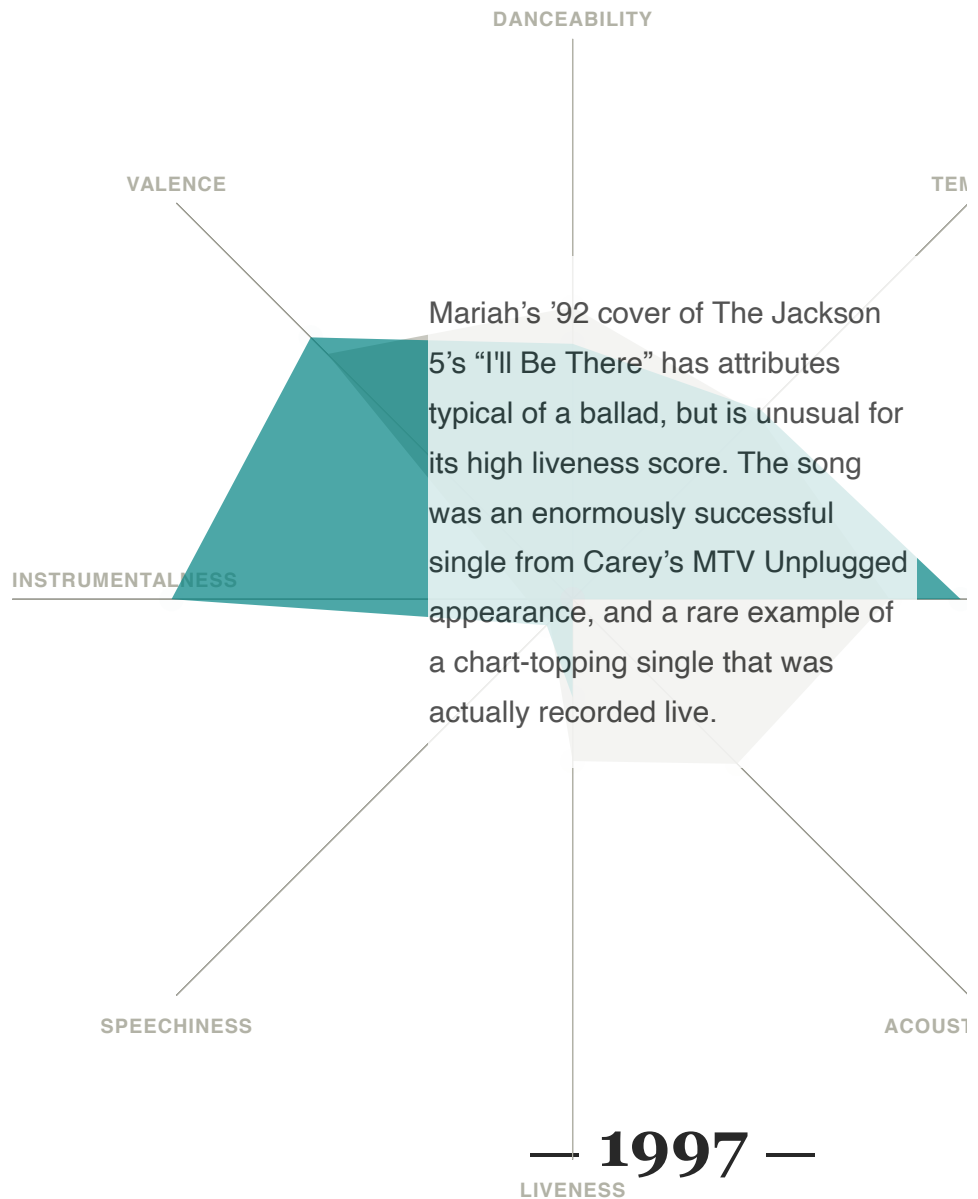Love Takes Time
Mariah Carey

SPEECHINESS

ACOUST

LIVENESS

A signature characteristic of ballads is low valence. Ballads don't need to be about a sad topic, but even when they're written around a happy theme, their sound is serious and reflective.

1973

The O'Jays - Love Train

Ballads also tend to be acoustic, and have relatively low danceability, tempo, and energy.

DANCEABILITY

VALENCE

TE[M]

Mariah's '92 cover of The Jackson 5's "I'll Be There" has attributes typical of a ballad, but is unusual for its high liveness score. The song was an enormously successful single from Carey's MTV Unplugged appearance, and a rare example of a chart-topping single that was actually recorded live.

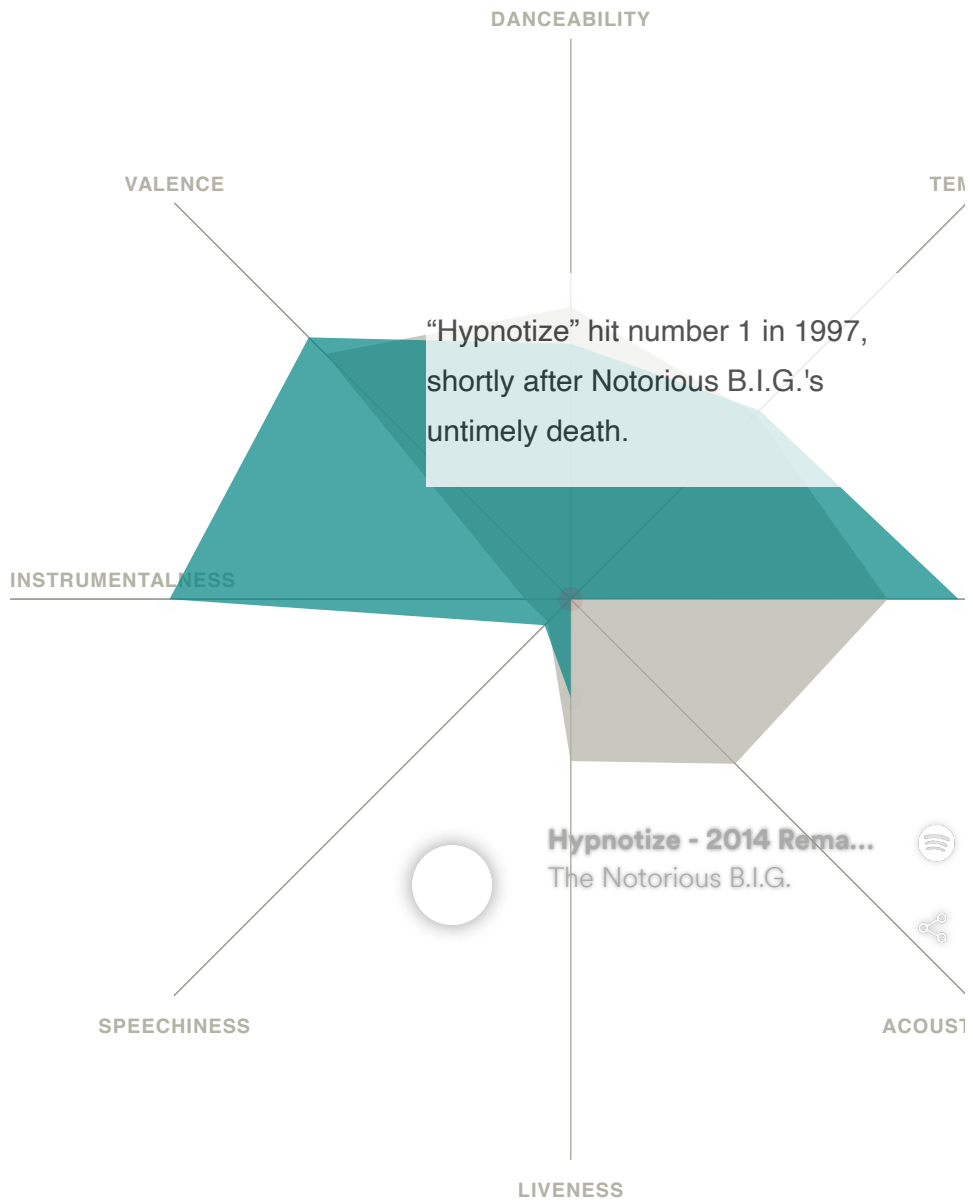INSTRUMENTALNESS

SPEECHINESS

ACOUST

1997

LIVENESS

The golden age of hip hop may have been during the late 80's and early 90's, but the Billboard Hot 100 was a bit slow to catch up. Before the mid-90's, #1 songs featuring rap were rare, and often novelties ("Baby Got Back," for example, and "Ice Ice Baby"), or pop songs with rap elements (e.g., Paula Abdul's

"Opposites Attract," or Blondie's 1981 song "Rapture," often cited as the first Billboard #1 song to include rap).

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

"Hypnotize" hit number 1 in 1997, shortly after Notorious B.I.G.'s untimely death.

INSTRUMENTALNESS

Hypnotize - 2014 Rema...
The Notorious B.I.G.

SPEECHINESS   ACOUST
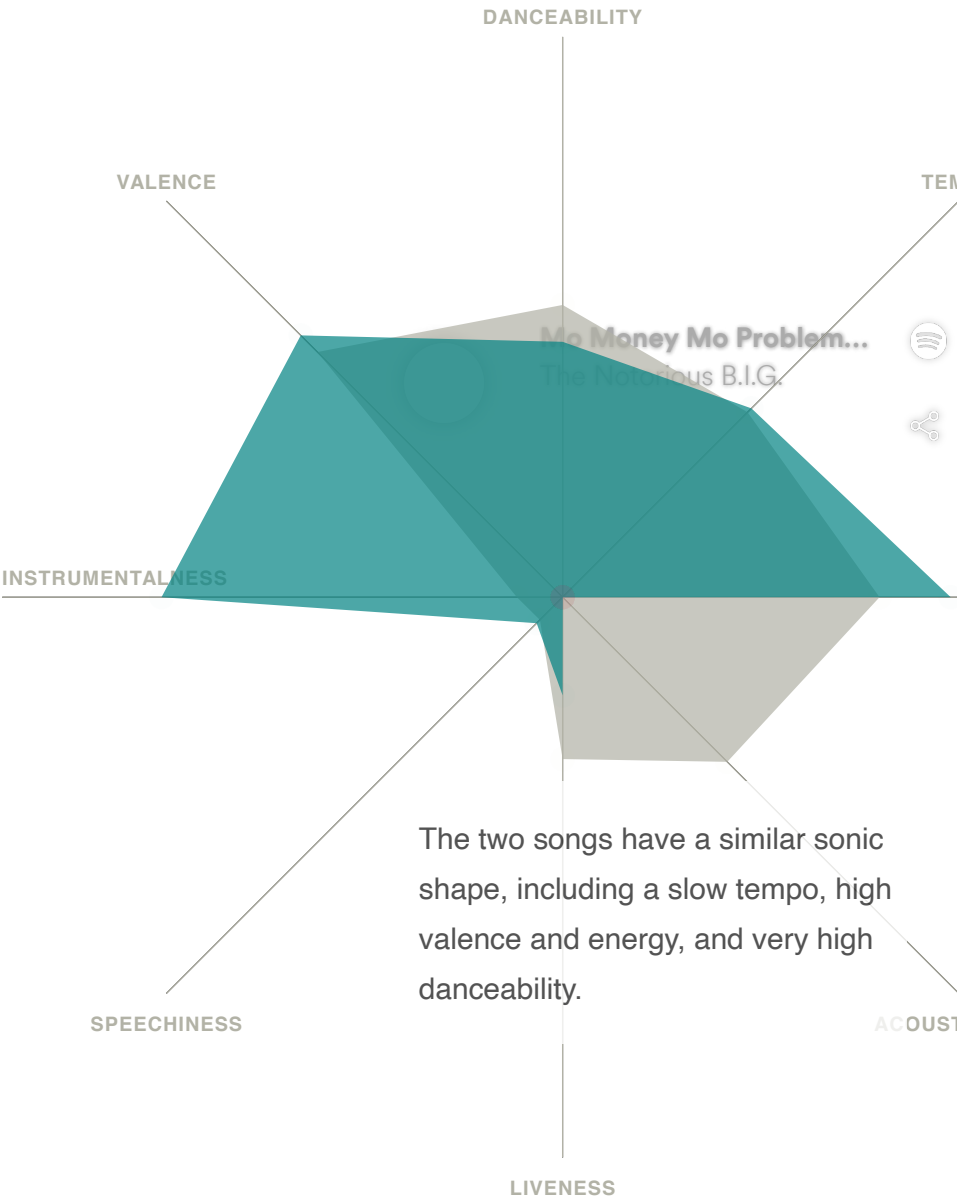
LIVENESS

Rapping often sounds a lot like spoken word, so rap songs tend to have a distinctively high speechiness score.

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"Mo Money, Mo Problems" was released later the same year, giving B.I.G. his second posthumous number 1.

DANCEABILITY

VALENCE

TEM

INSTRUMENTALNESS

Mo Money Mo Problem…
The Notorious B.I.G.

The two songs have a similar sonic shape, including a slow tempo, high valence and energy, and very high danceability.

SPEECHINESS

ACOUST

LIVENESS

Rap may not be conventionally thought of as a very danceable genre, but these songs have a strong beat and both use the trick of having a catchy chorus sung by a female vocalist.

1973

The O'Jays - Love Train

In 2001, OutKast reached number 1 following a similar sonic blueprint. "Ms. Jackson" is another track with rapped verses anchored by a simple, catchy sung chorus.

DANCEABILITY

VALENCE

TEM

INSTRUMENTALNESS

Ms. Jackson
OutKast
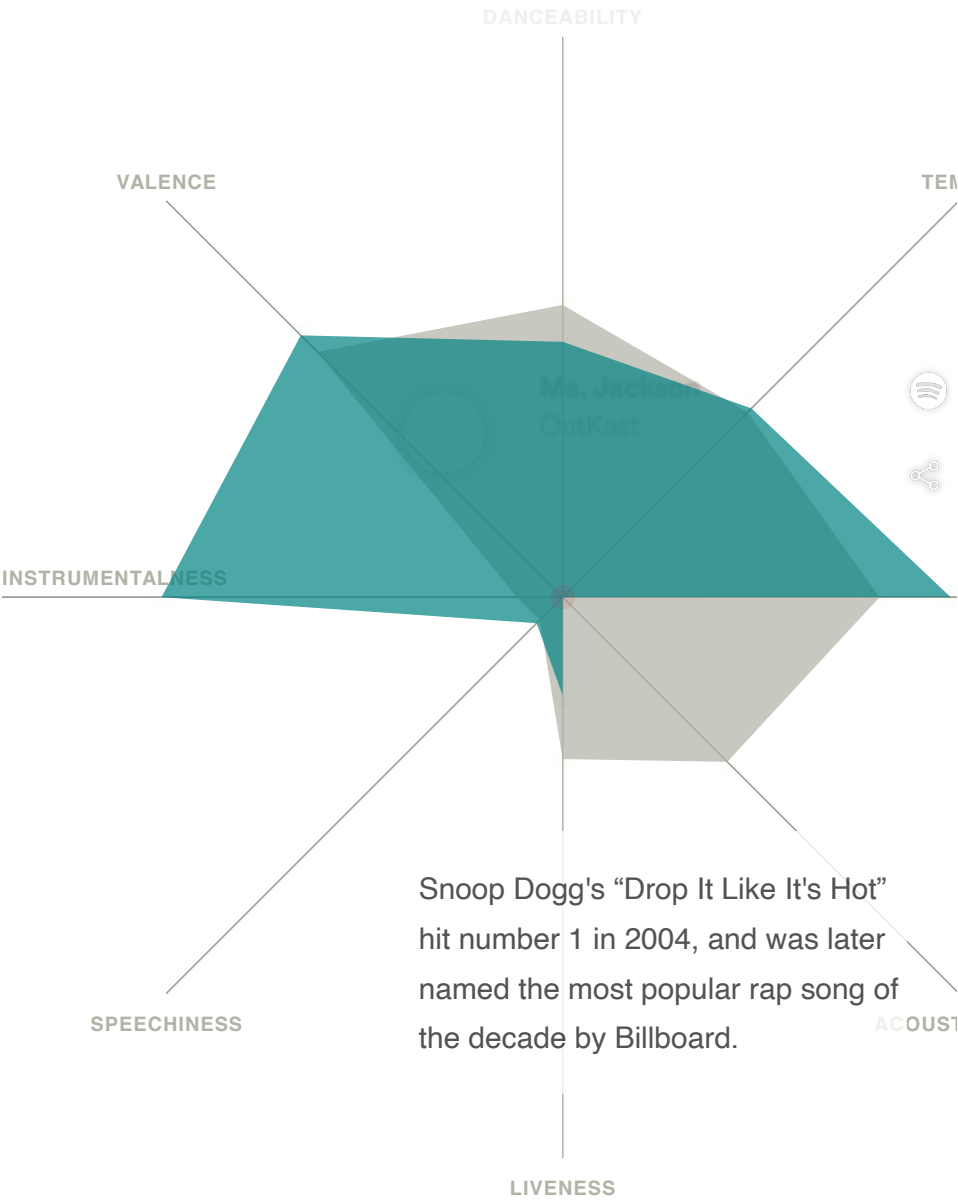
Snoop Dogg's "Drop It Like It's Hot" hit number 1 in 2004, and was later named the most popular rap song of the decade by Billboard.

SPEECHINESS

ACOUST

LIVENESS

Drop It Like It's Hot
Snoop Dogg

1973

The O'Jays - Love Train

"Drop It Like It's Hot" shares many characteristics with the previous hip-hop number ones we've seen: high speechiness and danceability and a slow tempo.

DANCEABILITY

VALENCE

TE[M]

But it stands out for having incredibly low energy. Listening to the song, this feels like an accurate assessment. The mood is laid-back, Snoop Dogg's delivery is casually cocky, and, above all, the production, courtesy of The Neptunes, is starkly minimalist. The song features some oddball percussion (notably including tongue clicks) some restrained, occasional synths, and beneath it all, what sounds like the persistent hiss of a white noise machine. And that's about all.

INSTRUMENTALNESS

SPEECHINESS

ACOUST[

LIVENESS

The mid 2000's also saw a few pop stars reach number 1 with songs featuring quasi-rap elements. For example, Gwen Stefani's 2005 hit "Hollaback Girl"–the shouty vocals of which probably owe more to Toni

Basil than N.W.A. This pop oddity is another Neptunes production.

The O'Jays - Love Train

DANCEABILITY

VALENCE

TEM

Hollaback Girl
Gwen Stefani

INSTRUMENTALNESS

Fergie's 2006 number one "London Bridge" is another example of a pop song with vocals lying somewhere between rapping, chanting and shouting. Despite being derided as a "Hollaback Girl" rip-off upon its release, its sonic attributes are strikingly different (being less danceable, much slower, and much less energetic).

SPEECHINESS

ACOUST

LIVENESS

London Bridge
Fergie

— 2013 —

The O'Jays - Love Train

Lorde burst on the scene in 2013 with her singular debut single, "Royals."

DANCEABILITY

VALENCE   TEM

INSTRUMENTALNESS

SPEECHINESS   ACOUST

LIVENESS

"Royals" has been described as "minimalist pop," and its sonic attributes match that description well. With the exception of dancability, all are dramatically pared down compared to the previous year's average
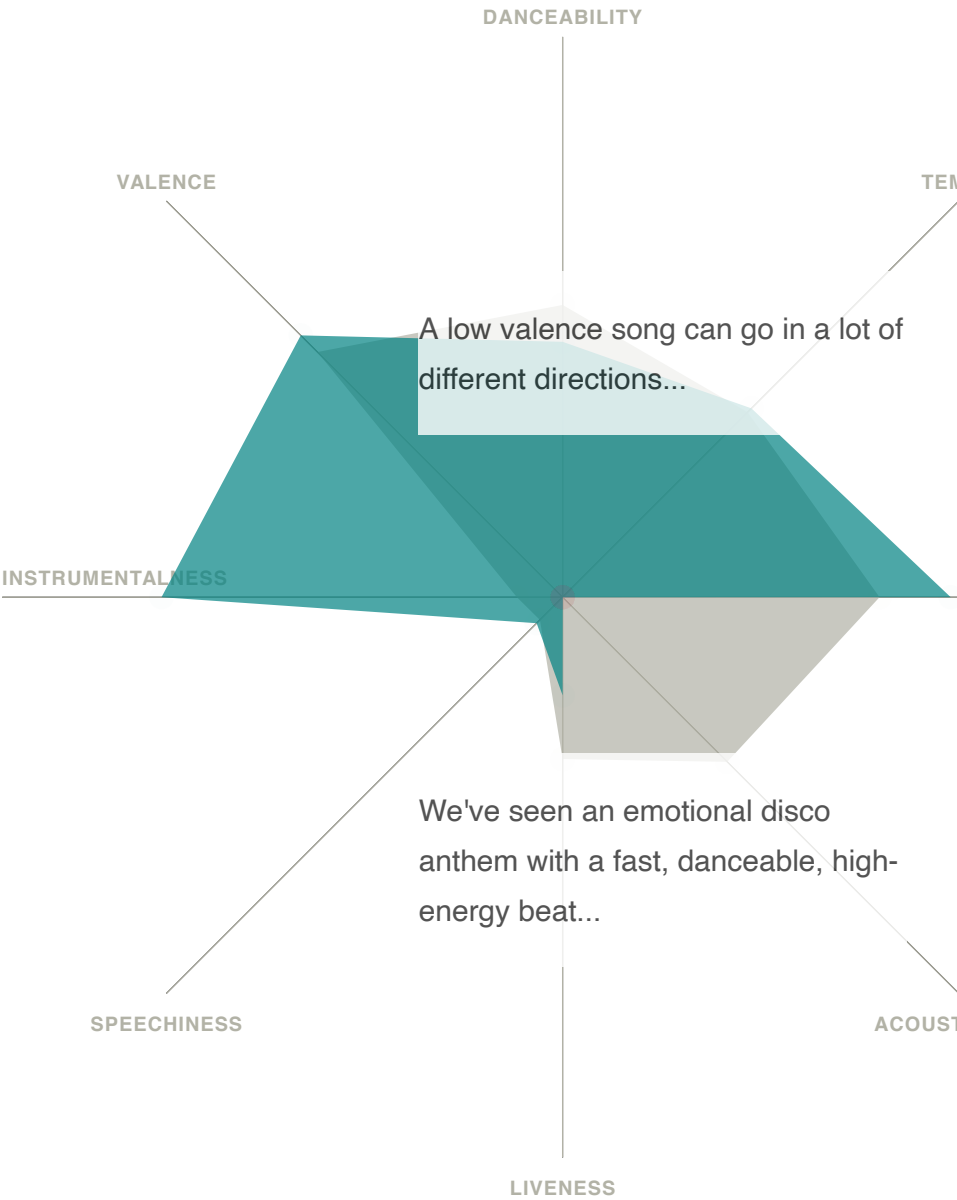
The song is notable both for its relatively high level of

1973

The O'Jays - Love Train

"speechiness," perhaps explaining in part its subsequent heavy rotation on hip-hop and R&B stations, and its particularly low valence.

DANCEABILITY

VALENCE

TEM

A low valence song can go in a lot of different directions...

INSTRUMENTALNESS

We've seen an emotional disco anthem with a fast, danceable, high-energy beat...

SPEECHINESS

ACOUST

LIVENESS

And an 80's power ballad: slow and undanceable, but with bombastic energy....

1973

The O'Jays - Love Train

And some serious diva ballads: slow, low-energy, and undanceable...

DANCEABILITY

VALENCE

TEM

But this is our first example of a low-valence song that is slow and unenergetic, but still danceable.

INSTRUMENTALNESS

The key here is the primacy of the beat. The crisp fingersnaps of the song's backbeat are our constant companion. Beyond Lorde's vocals, the percussion is the main attraction, and there's very little other instrumentation to draw our attention away.
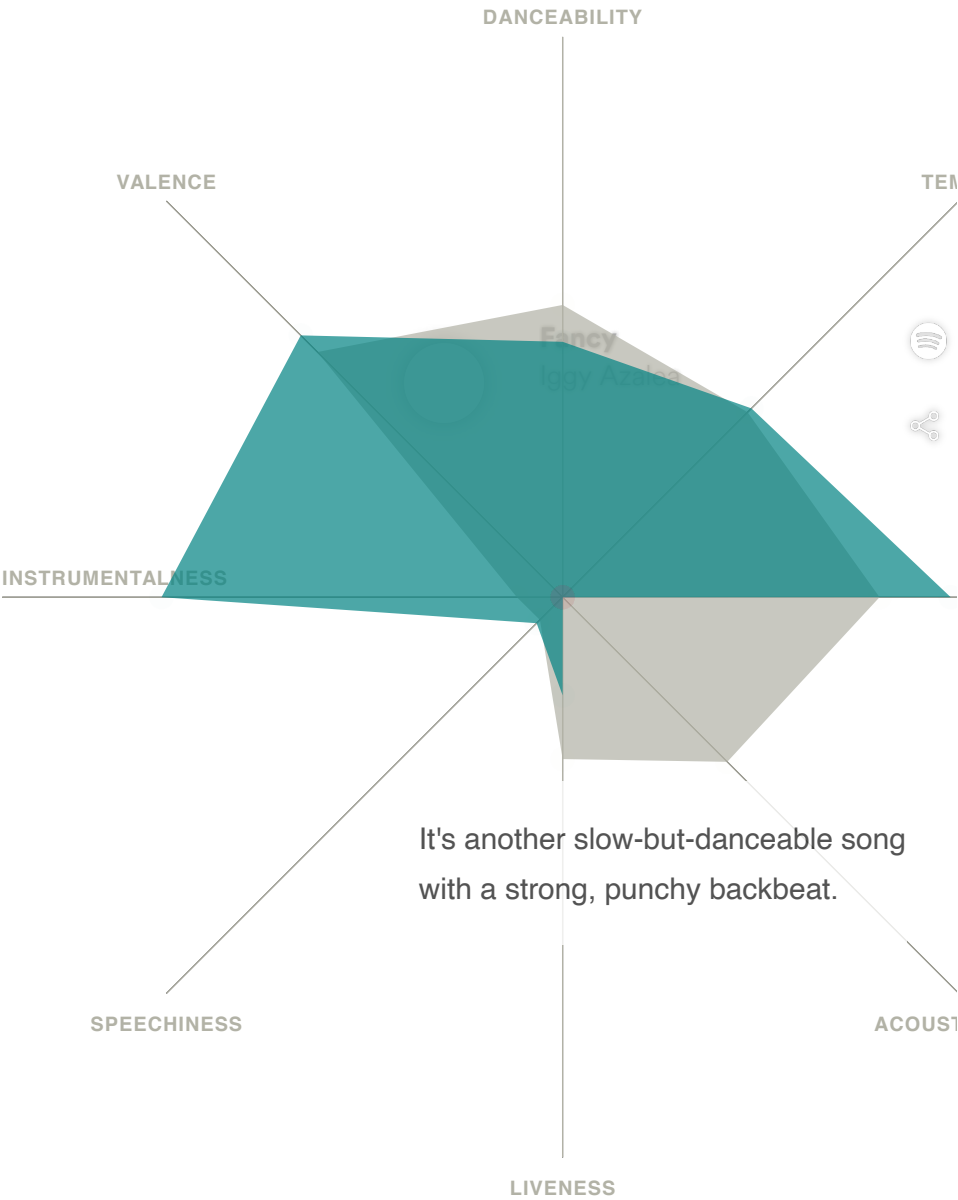
SPEECHINESS

ACOUST

LIVENESS

Its slow tempo may prevent it from being truly danceable, but it's certainly a toe-tapper.

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The O'Jays - Love Train

"Fancy," 2014's undisputed song of the summer, follows a somewhat similar template, with some extra danceability and energy.

DANCEABILITY

VALENCE

TEM
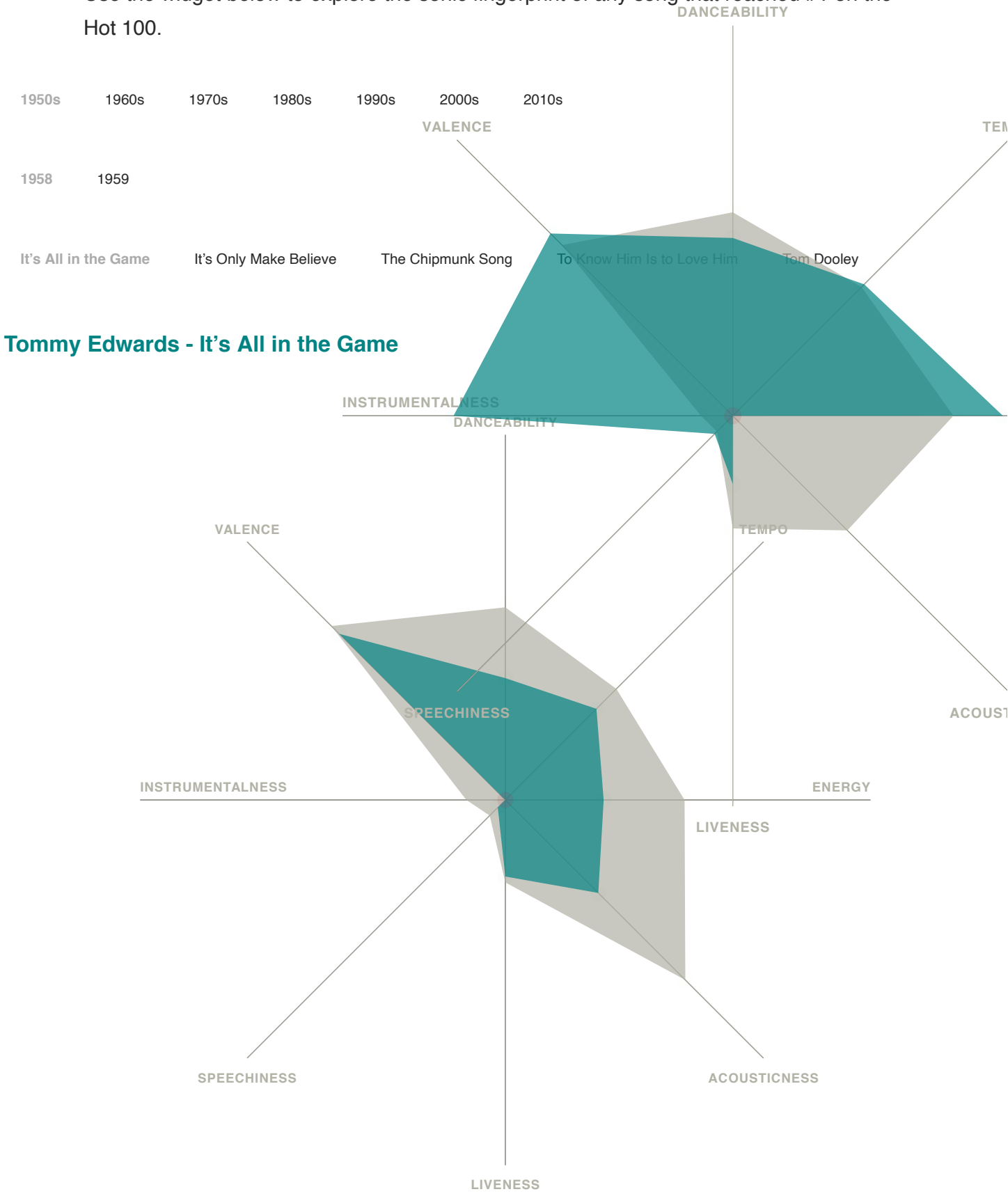
INSTRUMENTALNESS

SPEECHINESS

ACOUST

It's another slow-but-danceable song with a strong, punchy backbeat.

LIVENESS

It also adds a catchy, persistent synthesized bassline and dials up the energy with Charli XCX's shouty vocals on the chorus.

1973

Explore 60 Years of Top Hits

The O'Jays - Love Train

Use the widget below to explore the sonic fingerprint of any song that reached #1 on the Hot 100.

DANCEABILITY

1950s   1960s   1970s   1980s   1990s   2000s   2010s

VALENCE   TEM

1958   1959

It's All in the Game   It's Only Make Believe   The Chipmunk Song   To Know Him Is to Love Him   Tom Dooley

Tommy Edwards - It's All in the Game

INSTRUMENTALNESS

DANCEABILITY

VALENCE

TEMPO

SPEECHINESS

INSTRUMENTALNESS   ENERGY

LIVENESS

ACOUST

SPEECHINESS   ACOUSTICNESS

LIVENESS

SIMILAR SONGS

Cathy's Clown   Stagger Lee   I'm Leaving It Up to You   All You Need Is Love   The Tears of a Clown

A Horse with No Name   I'm Telling You Now   I Want to Hold Your Hand   Go Away Little Girl   Travelin' Man

The O'Jays - Love Train

DISSIMILAR SONGS

Wonderland by Night   Grazing in the Grass   Here I Go Again   Titles, Chariots of Fire   DANCEABILITY   The House of the Rising Sun

Black Or White   Love Theme From Romeo & Juliet   Stranger on the Shore   Call Me   With Or Without You

VALENCE   TEM

Appendix

INSTRUMENTALNESS

Data is courtesy of Michael Mauskapf and Noah Askin. Sonic attribute data ultimately originates from Spotify's Echo Nest API.

The paper on which this is based, "What Makes Popular Culture Popular? Product Features and Optimal Differentiation in Music," uses a few additional attributes from Echo Nest not shown here, namely the song's key, its mode (major or minor), and its time signature. (As categorical attributes, these would have been difficult to incorporate into the visualizations shown here.)

SPEECHINESS   ACOUST

For the sake of simplicity, I manually corrected the tempo of two of the example songs visualized above ("Total Eclipse Of The Heart," and "Love Takes Time") to 1/2 of the algorithmically inferred tempo. Exploring the full catalog of number ones, you may still notice a few examples of songs whose detected tempo is half or double what it should be (such as "Hey Jude").

LIVENESS

The code for this essay is available on GitHub here.