Sound Logos: Investigating the Saliency of Melody and Timbre

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Abstract

There is limited research on sound logos: short sounds used to accentuate a brand in a similar way that a visual logo works. In an attempt to contribute knowledge to this field, an experiment was designed to test the difference in the saliency of melody and timbre. After researching the complexity of these terms, the experiment's focus shifted to melodic contour and instrumentation. Out of 100 attempts, 30 participants completed a match-to-sample task involving a model sound logo and variations in melodic contour or instrument. The results show that there is a strong preference (average = 96.42%) for the options with the same melodic contour (different instrument) as opposed to the options with the same instrument (different melodic contour).

1. Introduction: Sound Branding

From a marketing and advertising perspective, it is important that customers know your brand and what it stands for. This is known as brand awareness, and is a crucial consideration in consumer behaviour. The ability to recognize or recall a brand can influence purchasing decision-making, especially when differentiating between competing companies. If a brand is familiar and perceived in a favourable way, then this can lead to repeat purchases, and brand loyalty, ultimately leading to an increased market share. [1]

Throughout the history of marketing, different strategies have been used to try and enhance brand awareness and ease of recognition. Thus, nowadays almost every company has its own visual logo so that we can quickly identify which brand it is. Furthermore, brands use strategies like signature colour schemes and product packaging to enhance familiarity of the brand and influence our perception of it.

More recently, there is increased attention in multi-sensory marketing, as logos and colour schemes only appeal to our sense of vision. Companies are trying to create brand awareness through other senses, such as auditory strategies.

Using sound for branding purposes, known as sonic branding, is becoming increasingly popular because it has been shown that sound and music are powerful tools that can affect consumers instantly, whether it is their mood, purchasing behaviour [2], or even physiological effects [3].

Some examples of where we can find sonic branding:

- The famous Mac startup sound or the iconic ringtone of a Nokia phone
- Mastercard's payment approval sound
- The background music played in a store or lobby
- Sound logos, such as for Intel, Hornbach, and McDonald's
- Product noises, such as for Grolsch or car doors closing
- Music in advertisements or campaigns, such as for Heineken or Trump

The term sonic branding is an umbrella term referring to all the examples mentioned above, but not all of these strategies use sound in the same way. Some use existing music, and some companies use their own sonic logos or sounds to add an extra dimension to their brand.

There are various sound branding analyses where these strategies are split into different categories [4]. One of these categories are the *extrinsic non-verbal sounds*, i.e. sound (sonic) logos. These sounds can be thought of as the auditory equivalent of a visual logo: short and concise sound fragments or melodies, (sometimes accompanying a visual logo) to accentuate a brand.

2. Sound Logos

There are several analyses and papers written about sound logos; what their aim is, why some of them are catchy, and experiments on how these sounds can affect us and change our behaviour. One analysis of sound logos divided 22 existing sound logos into three categories: melodious, noisy, and vocal/texted [5]. Some examples of each category are illustrated in Table 1.

Melodious	Noisy	Vocal/Texted
Intel	Audi	Hornbach
T-Mobile/Telekom	BMW	McDonald's

Table 1: Examples of existing sound logos categorised according to Anzenbacher (2012)[5]. The links can be followed to listen to the sounds.

It must be noted that the author mentions that these categories have been developed by simplifying many of the sound logos. Many of these sound logos “show numerous tracks with voice-overs, diffuse synth-and noisy parts”, however, they are analysed as “one single track and melody”. The reason for this simplification is because there are several qualities that the author wants to compare, and to take every musical factor into account would make it very complex. For example, the sound quality of the human voice in the ***vocal*** category was neglected, as the topic of speaking voice vs. singing voice is a complex topic in itself. As another example, the Intel sound logo is a complex sound (actually made up of 20 layers of sound[1] with various inharmonious and harmonious sounds), however, in the analysis by Anzenbacher it is regarded as just one main monophonic melody.

Aside from this analysis, there is still limited research on sound logos, as quoted by Nicolai Graakjær, a professor of communication and psychology, and a leading research figure in the field of sonic branding:

> “Generally, within studies on musical discourses in commercials, the sonic logo represents an understudied phenomenon” [6]

and

> “As regards non-verbal extrinsic sound-brand connections, contributions are very few.” [7]

To quote Krishnan et al. (2012), although sound logos are important branding devices, their creation often “depends on intuition rather than objective parameters”. In an attempt to contribute and expand our knowledge on sound logos, the project’s focus will be on melodious sound logos, such as the examples in the melodious category mentioned previously (further examples include the McDonald’s sound logo (excluding the vocals) and for Hyundai). Since these seemingly simple melodies can be strongly associated with brands, the question this paper addresses is which musical qualities of a sound logo are the most salient? Or, when a sound logo is changed in various ways, which musical qualities remain familiar? As an example, if the Intel logo is played using a different instrument, will we still recognize it as Intel? Or perhaps if the Intel sound logo's distinct timbre is used, but playing a different melodic structure, how familiar will it be?

In order to try to answer this question, various sub topics of timbre and melody are explored.

[1] https://www.creativebloq.com/features/audio-logos

3. Timbre

If, for example, the Intel sound logo were played using different instrumentation, this can be seen as a change in timbre. However, defining timbre, let alone measuring perceptual differences in timbre, is quite the challenge, as can be read in the quotes below. For example:

As written by music psychologist Stephen McAdams:

> Timbre is a misleadingly simple and exceedingly vague word encompassing a very complex set of auditory attributes, as well as a plethora of intricate psychological and musical issues. It covers many parameters of perception that are not accounted for by pitch, loudness, spatial position, duration, or even by various environmental characteristics such as room reverberation. This leaves myriad possibilities, some of which have been explored during the past 40 years or so. [8]

Or written in *Psychology of Music: From Sound to Significance*:

> Timbre is the intrinsic and distinctive quality of a sound produced by a musical source such as a certain instrument or particular human voice. The brilliant sound of the trumpet contrasts in timbre with the mellow, reedy sound of the clarinet. Timbre perception is a very complex topic that poses many methodological challenges to researchers [9]

The Acoustical Society of America (ASA) Acoustical Terminology defines timbre as:

> that attribute of auditory sensation which enables a listener to judge that two nonidentical sounds, similarly presented and having the same loudness and pitch, are dissimilar [10]

However, as there are various definitions of timbre, it is important to realise that:

> as a multidimensional attribute of perceived sound comprising everything that is not pitch or loudness, timbre is notoriously difficult to define [11]

Thus, attempting to measure perceptual differences in timbre will have its limitations because of the complexity of the topic. A change in instrument is a change in timbre, yet we can have changes in timbre without changing instruments. So changing instrumentation is only a categorical change in timbre. Though the question remains, how important is timbre for a sound logo? Firstly, a brief description of how we can try to measure perceptual differences between instruments.

Previous studies have tried to measure perceptual timbre differences using multidimensional scaling (MDS). This entails playing identical melodies with different instruments and asking participants to rate pairs of given sounds on a scale of *very similar* to *very dissimilar*, where these ratings are then fit to a distance model.

As timbre is hard to precisely define due to the many physical aspects that can differ (attack time/sharpness, nasality, richness, spectral centroid, brightness- to name a few), the strength of multidimensional scaling is the assumption that all listeners use the same perceptual dimensions to compare timbres. The outcome is that we can make graphic representations of timbre space, where similar perceived timbres are grouped closer together. For example, see figures 1 & 2.

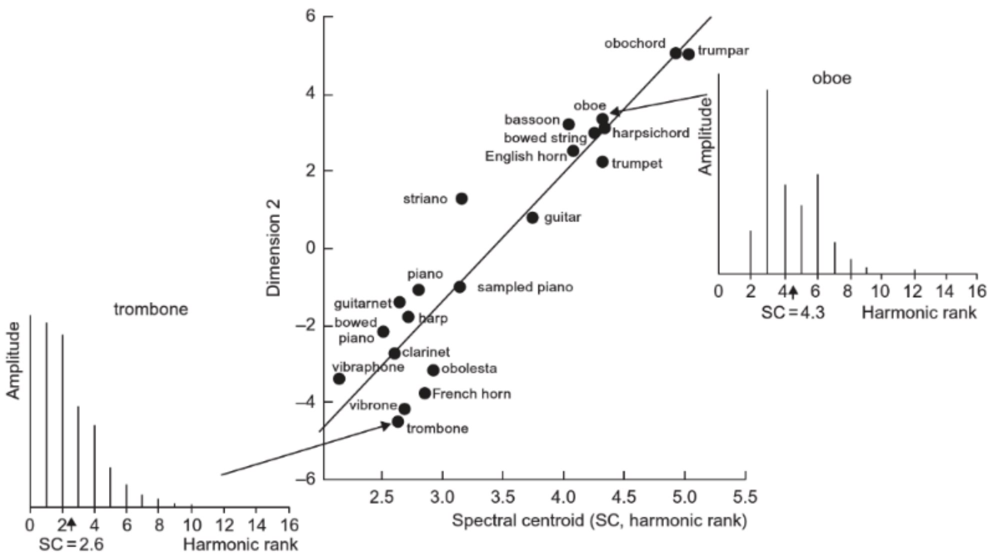

Figure 1: Excerpt taken from: McAdams, S. (2013). Musical timbre perception. The psychology of music, page 41.

"The graphs at the left and right represent the frequency spectra of two of the sounds (trombone and oboe, respectively). [...] The graph in the middle shows the regression of spectral centroid (x axis) onto the position along the perceptual dimension (y axis). Note that all the points are very close to the regression line, indicating a close association between the physical and perceptual parameters."

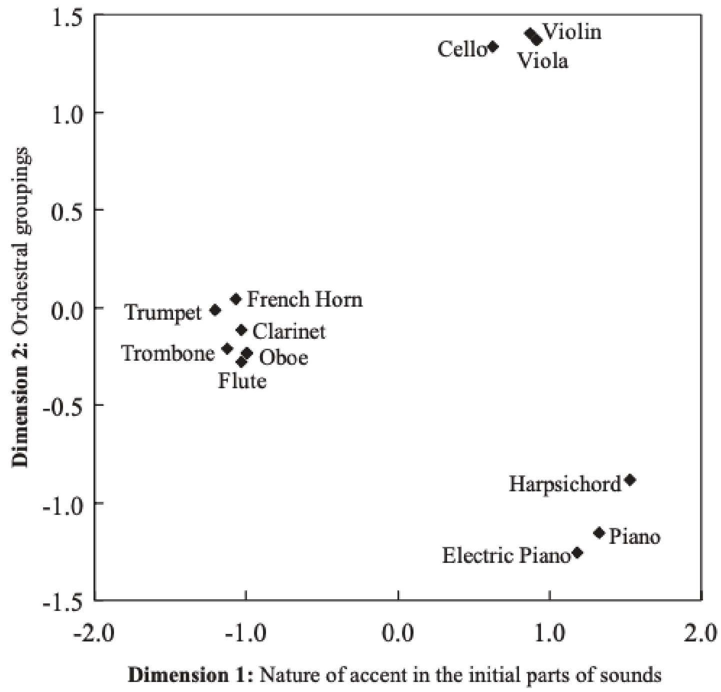

Figure 2: Two dimensional MDS solution for 12 instruments. "Dimension 1 might be influenced by the presence or absence of accent in the initial part of the sound. Dimension 2 might relate to traditional orchestral families." Excerpt taken from: Lim, S. W. H., & Goh, W. D. (2012). Variability and recognition memory: Are there analogous indexical effects in music and speech?. Journal of Cognitive Psychology, 24(5), 602-616. [12]

So from this information we have some idea of what instruments sound similar (i.e. have a similar perceived timbre). However, if we compare the two MDS solutions for timbre perception we still see inconsistencies, and the similarity depends on what dimensions we use. Note the distances between the trombone, oboe, and piano in the two graphs.

Previous research has looked at the importance of timbre for memorising melodies. In a 2015 study by Glenn Schellenberg and Peter Habashi, the duration of memory for melodies was examined, and whether such memory is affected by changes in key, tempo, or timbre [13]. Participants heard several unfamiliar melodies, and then heard them again after a delay (10 minutes, 1 day, 1 week), including some new melodies, and asked to provide recognition ratings.

The researchers concluded that changing the timbre from exposure to test had a negative impact on recognition for all three delays. However, it is important to note that in this case a change in timbre was a change in instrument, from piano to saxophone. It is further mentioned:

> Halpern and Müllensiefen (2008) found that memory for previously unfamiliar melodies was impacted negatively when the timbre changed from exposure to test, either from piano to organ (or vice versa) or from recorder to banjo (or vice versa).
>
> Peretz, Gaudreau, and Bonnel (1998, Exp. 3) found a similar detrimental effect of a surface change on recognition when melodies were changed from flute to piano (or vice versa) at test.
>
> When Lim and Goh (2012) changed melodies to a *similar* timbre at test (e.g., from violin to cello or vice versa), however, recognition was as good as when the melody was represented in the original timbre. This result implies either that memory for timbre is approximate or that a similar timbre provides a match between the test melody and the mental representation that is strong enough to confer the same recognition benefit as the original timbre.
>
> Other studies have provided converging evidence of memory for timbre (Wolpert, 1990), and also have shown that memory for melodies presented in some timbres (i.e., the human voice) is better than memory for melodies presented in other timbres (instruments; Weiss, Schellenberg, Trehub, & Dawber, 2015a; Weiss, Trehub, & Schellenberg, 2012; Weiss, Vanzella, Schellenberg, & Trehub, 2015b).
>
> Timbre may be a particularly salient surface feature because it provides information about the source of the melody, and because source cues tend to be encoded in mental representations of auditory objects (Johnson, Hashtroudi, & Lindsay, 1993).
>
> In one instance, nonmusicians judged two **different melodies** presented in the **same timbre** as being more similar than the **same melody** presented in two **different timbres**.

This last sentence refers to an experiment done by Wolpert in 1990 [14]. This study examined **the salience of instrumentation over melody in identifying music excerpts**. In this paper it is stated:

> Musicians and nonmusicians were tested on match-to-sample recognition tasks. In the first task, subjects were asked to choose which resembled the model more: (a) identical melodies played with instrumentation different from the model, or (b) different melodies played with the same instrumentation as the model. …
>
> Ninety-five percent of the nonmusicians chose instrumentation over melody and harmonic accompaniment as the salient cue for recognition. Musicians always chose melody and harmonic accompaniment over instrumentation. These findings indicate that untrained listeners do not share or perhaps use the same cognitive schemata as trained listeners do. Further, the assumptions held by musicians that melody and harmonic accompaniment define the essential structure of much Western music, while instrumentation is cosmetic, may not be shared by nonmusicians. (Wolpert, 1990)

In this experiment, participants were presented a model (e.g. *Twinkle Twinkle Little Star (Twinkle)* played on celesta) and then given two other sounds, one with a change in instrumentation and one a change in melody (i.e. *Twinkle* played on oboe, or Hot Cross Buns played on celesta), and asked which of these two sounds was "most like the model". The experiment used famous nursery rhymes, such as *Twinkle* and *Hot Cross Buns*, but also used unfamiliar melodies composed by the researcher in the same "genre".

Model: Twinkle (Celesta)

Option A: Twinkle (Oboe) *

Option B: Hot cross buns (Celesta)

Thus, option A was the same melody but a change in instrumentation, and option B was a change in melody but the same instrumentation. The dependent variable was the choice A or B in this task. Correct (*) meant the melody was chosen and incorrect meant the instrumentation option was chosen (arbitrarily allocated, no attachment to the meaning of the word 'correct'). The results (shown in figure 3) show that 52% of the nonmusicians chose option A, the same melody but different instrumentation, for both unfamiliar and familiar melodies. However, there is a notable difference between the familiar and unfamiliar melodies, as for the unfamiliar melodies it seems the instrumentation is a much more salient factor when comparing sounds.

TABLE 2
Number of Nonmusicians Completing Trials Correctly

Task	Tune			
	Familiar	Unfamiliar	Both	Neither
1. Melody vs. instrumentation	14	2	22	4
2. Accompanied melody vs. instrumentation	10	2	25	5
3. Instrumentation vs. harmony	3	3	2	34

NOTE. The values represent the number of subjects out of 42 who gave correct answers in all trials in a category.

Figure 3: Excerpt from Wolpert 1990. Looking at row (1), about half the nonmusicians chose the melody (i.e option A) for both unfamiliar and familiar tunes.

So, not only is timbre hard to define, it seems the importance of timbre (on musical memory) even differs between levels of musicianship. For nonmusicians, it is not entirely clear whether melody or instrumentation is more important for recognizing or matching sound excerpts, and seems to depend on how familiar we are with the melody. Information about both timbre and melody are more memorable than key and tempo, as concluded in Schellenberg and Habashi's 2015 study, titled appropriately: "Remembering the melody and timbre, forgetting the key and tempo".

However, to say that timbre is a more salient feature or more important than melody as the cue for recognition, or vice versa, is problematic because of how we define these two terms. What is exactly meant by a melody? And what style of melodies are tested, since there are still plenty of individual differences.

4. Melody

The term melody also has various definitions:

> Melody is the organization of successive musical sounds in respect of pitch

Tovey, 1956, p. 91[15]

> We define a melody as a sequence of pitches that sound like they belong together

Tan, S. L., Pfordresher, P., & Harré, R. (2017) [9]

> Music is an abstract domain, in the sense that a melody is recognized on the basis of relations in pitch and time between consecutive notes. As such, almost everyone can identify “Happy Birthday” or “Hey Jude” when the tune is played on a novel instrument (e.g., xylophone), in a novel key (pitch level), or at a novel tempo (speed).

Schellenberg, E. G., & Habashi, P. (2015) [13]

Research on melodies is similarly methodologically challenging as timbre research, as captured well in the following excerpt from *Psychology of Music: From Sound to Significance* (Tan, Pfordresher, & Harré, 2017)

> A lot of research we have discussed so far has involved melodies created by experimenters to manipulate certain features of melodies (e.g. melodic contour) while holding other features constant (e.g. tonality). Although it makes sense to do this from the perspective of the scientific method, there are limitations to such artificial melodies. A particularly salient limitation is that these melodies tend not to be very ‘catchy’. As a result, they may not provide a good basis for understanding long-term memory for melodies. Listener recognition for such artificial melodies is surprisingly poor, and much poorer than our ability to recognize familiar melodies (Halpern & Bartlett, 2010)

Thus, to manipulate a melody by, for example, rearranging the order of the notes, can lose the whole essence of what we define as a melody, and can influence our memory of it.

> … musical features that facilitate memory can also be found when comparing the structure of a given melody to other melodies one might know. Müllensiefen and Halpern (2014) demonstrated this by analyzing features of melodies in comparison to a larger corpus of melodies, which included popular songs. For instance, the authors found that melodies with large interval jumps (they use ‘Under the Boardwalk by the Drifters as an example) facilitated the feeling of recognition, even if a listener hadn’t heard it before. Large jumps like those used in this tune constituted a distinctive feature of the melodies in the corpus because most melodic intervals are small.

Essentially, this means that some melodies could be inherently more recognizable than others, due to for example, the interval range.

Thus, if we want to address the question, what is more important for recognition: the order of the notes or the timbre, then from the information presented above it will be difficult to control this test, because changing the order of notes could turn the melody into some random, incoherent sequence of notes, an "artificial" melody, where we know that "listener recognition for such artificial melodies is surprisingly poor, and much poorer than our ability to recognize familiar melodies" [16]

In another study, famous audio logos were reduced in form to test which musical qualities lead to brand recognition. For example, taking the McDonald's or Intel logo but only playing the pitches in order (without the distinct rhythm), or only playing the rhythm but not the pitches. The conclusion was that "pitch is a far more significant parameter than rhythm for recognising audio logos and corresponding brands", and a proposed reason for this could be "that rhythmic perception generally requires auditory stimuli with durations longer than a few seconds" [17]. However, there is still plenty of variation due to individual differences between sound logos. In this experiment there is also an interesting discovery about the recognition of the famous Intel sound logo:

> As for the individual differences, it is perhaps surprising that only very few students were able to identify correctly the Intel brand, while about half (averaging the two test condition results) wrote alternative, but nearly equivalent nouns or brand names such as 'computer', 'Dell', 'Microsoft' and 'Windows'. It is, for that matter, interesting and rather paradoxical, then, that the 'Intel Inside' sound is widely renowned as a model example of effective audio branding (cf. Jackson, 2003, pp. 2-3; Bronner, 2004, pp. 51-52; Lindstrom, 2005, p. 22; Roth, 2005, p. 25; Straka, 2007, p. 67; Kusatz, 2007, p. 3). Thus, even though the Intel logo was recognised after version IV by all students (in both tests), it appears that Intel's partnership with Dell and other computer companies has resulted in brand confusion. [17]

This study also concludes that "the most recognised logos after RAF [reduced articulation form] are the McDonald's, Nokia and JYSK logos, and they are also the ones with the largest pitch ranges (ambitus)" which is in line with the previously mentioned notion that large interval ranges create a sense of recognition. However, with all these conclusions made the authors also mention that:

> It is worth noting that the results on the basis of the individual logos might very well be due to factors not considered in the experiment, such as the subjects' previous experience and acquaintance with the logos and brands. For that matter, it appears that the three well-recognised logos are derived from pre-composed or pre-existing music material, while the two remaining logos are specifically made for the brand, and that, of course, might have an important influence on the results, but we cannot know for sure.

To summarise, there is disputable evidence as to what element of a music excerpt is most salient for memorization and recognition: the instrumentation or the melody. This depends on factors such as how perceptually close the instruments are when compared (i.e. violin to cello - similar, banjo to recorder - dissimilar), how familiar the original melody was (famous nursery rhyme, or previous experience with a sound logo or not), whether there was harmonic accompaniment, and whether the participants were musicians or not. Also, previous studies have looked into folk songs and nursery rhymes, yet testing short melodic musical pieces in the style of sound logos is yet to be explored.

In the context of sound branding and sound logos, it is favourable for a sound logo to be able to adapt, yet still retain the associations with the brand, similar to how visual logos can be reduced such as shown in figure 4 (more information about sound logo adaptation can be found in the appendix, section 10.1). Further, for new companies it is valuable what the focus should be on when designing such a figure: a particularly memorable melody or highly distinct instrumentation, there is still no conclusive consensus of what is a more salient feature in the context of sound logos. Thus, the following experiment design will be proposed to test the question: which sound quality is more salient in a sound logo, the instrumentation or the melody?

Figure 4: “Responsive” logos. Being able to reduce a logo yet keep associations is a key quality of a good visual logo.

5. Research Statement

The problem at hand is that there is conflicting evidence and a lack of consensus as to what musical qualities are most salient when listening to short musical fragments, such as for sound logos. This depends on what kind of sound/music is in question, e.g. if the melody is familiar, or to what extent a person is considered to have musical abilities.

For this experiment, two variables are addressed, the melodic contour and the instrumentation. In a within-subjects experiment design, participants will hear a sound logo, along with a variation in melodic contour or instrumentation, to see which variation participants will perceive as *most similar* to the original sound, akin to Wolpert's match-to-sample experiment. This will be repeated for several combinations.

E.g.:

Model Sound Logo

Option A: variation in melodic contour
Option B: variation in instrumentation

6. Experiment Design

In order to examine which musical quality is more salient for sound logos, the melodic structure or the instrumentation, the experiment design was similar to Wolpert's 1990 match-to-sample choice task, however, instead of the melodies being familiar, original sounds were composed in the style of melodious sound logos, which should be unfamiliar to the participants. Each sound logo had its own distinct melodic structure and distinct instrument used. Then, in an online experiment, a sound logo was presented along with two other sounds: a variation in instrumentation, or a variation in melodic structure; where participants will be asked to choose which sound is more similar to the original sound logo. From these results we can extract information for which cases the instrumentation is chosen more often than the melody and for which cases the melodic structure is a more salient feature.

Having mentioned in the previous sections about the arguably infinite approach for creating melodies and choosing timbres, several design choices were made intended to reduce the complexity of the task and narrow the scope of the original question that is being addressed: what is more salient in a sound logo, the timbre or the melody? For this experiment, five sound logos were composed each with a distinct melodic contour and a distinct instrument, according to existing literature on melodies and perceptual timbre differences.

In table 2, the combinations of timbre and melody can be seen. A1, B2, C3, D4 & E5 are all original melodic sound logos composed in their own distinct instrument, produced in Ableton Live Suite 11 using MIDI. Then, the instruments can be swapped between melodies.

Melody	Instrument				
	1	2	3	4	5
A	A1	A2	A3	A4	A5
B	B1	B2	B3	B4	B5
C	C1	C2	C3	C4	C5
D	D1	D2	D3	D4	D5
E	E1	E2	E3	E4	E5

Table 2: Structure used in the experiment. 1-5 are the five instruments, A-E are the five melodies. A1, B2, C3, D4, E5 are the model sound logos, each with a distinct melodic structure and instrument.

Thus, sound logo A1 is: melody A, played in instrument 1. Sound logo A2 is: melody A, played in instrument 2. Sound logo E4 is: melody E, played in instrument 4.

6.1 Participants

The experiment, made in Qualtrics (Qualtrics, Provo, UT), was sent via social media (Whatsapp, Email) to participants in the personal network of the author where the participants were encouraged to forward the experiment to others. The participants received no financial reward, their participation was entirely voluntary and they could end the experiment at any moment.

100 participants attempted the experiment, however, not all data could be used for the analysis. Many participants did not finish the experiment. Out of the 100 attempts, 30 participants completed the experiment successfully which is the data that is used for the analyses. The average age was 48.2 years, with a range of 23-79. In figure 5 a histogram can be seen of the distribution of age groups. Out of the 30 participants, 20 were male and 10 were female. 5 out of the 30 participants had mild hearing damage, examples include partial deafness (unilateral or low frequency) and tinnitus. 6 out of the 30 participants can be considered musicians. The average length of time it took to complete the experiment was 2447 seconds (40.78 minutes), with one outlier removed, who took 134.2 hours in total[2].

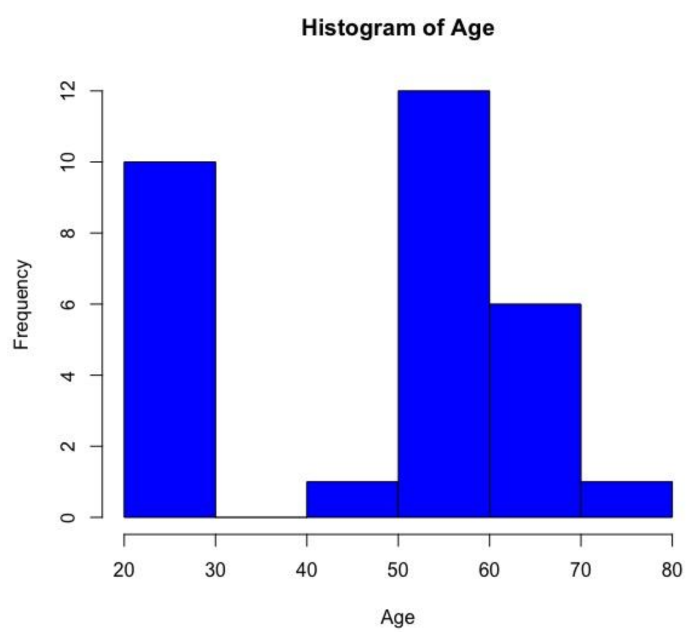

Figure 5: Histogram of the age of participants that completed the experiment, n=30.

[2] The participant most likely started the experiment, and finished it at a different time.

6.2 Procedure

Participants were first briefed about the experiment and the ethical procedures, followed by demographic questions about their age and gender. Next, participants were asked several questions in order to judge their level of musicianship. These questions included (a) whether or not the participant played an instrument, and if so what, and for how long; (b) whether the participant sang in a choir/chorus, and for how long, (c) whether or not the participant had private musical training/lessons. Furthermore, two questions were added: (d) whether the participant had any hearing damage, if so what, and (e) to what extent they considered themselves musicians.

After the introductory question phase, the participants were presented two example questions so that the participants would know what to expect, as well as be able to adjust their volume levels correctly. The participants were advised to wear head/earphones. After the example questions, the participants had to complete 80 questions, where a model sound was presented (e.g. A1), followed by two variations (a melodic variation e.g. B1, or an instrument variation, e.g. A2), where participants were asked to select the option that *is most similar to the model*. This vague phrasing of the question was done deliberately, akin to Wolpert's study, "because it was important that the instructions not direct the subject's attention to any one aspect of the music, nor in any way make clear the musical assumptions of the culture" so that we can get a true impression of what sounds are perceived as similar by the participants.

Each sound was designed to only be heard once, yet there were some problems with this, as will be discussed in the appropriate *Discussion* section.

The answer options were counterbalanced in two versions of the experiment, where the participant was randomly allocated in one of two experiments. This is because it could be possible that answer choices are influenced by which of the two answer options were heard first. Thus, version 0 of the experiment had, e.g.:

(Question 1)
Model: A1
Answer option 1: A2
Answer option 2: **B1**

(Question 2)
Model: A1
Answer option 1: B1
Answer option 2: **A3**

And version 1 of the experiment had the answer options swapped:

(Question 1)
Model: A1
Answer option 1: **B1**
Answer option 2: A2

(Question 2)
Model: A1
Answer option 1: **A3**
Answer option 2: B1

Then the order of all the 80 questions was randomised. The general process of the experiment was similar to the one carried out by Wolpert in 1990. An original sound logo was played, e.g. A1, and then two variations were played where the participant had to choose which of the two options was "most like" the model sound.

However, if every combination were to be tested in this way, then the experiment would be very complex, and participants would need to hear and evaluate 600+ combinations. Thus, in order to reduce the experiment in terms of complexity, A1 was only compared in the row containing A or column containing 1. Below is a visualisation of this procedure (in tables 3 & 4) and expected results in table 5.

Timbre(Melody)	1	2	3	4	5
A	A1	A2	A3	A4	A5
B	B1	B2	B3	B4	B5
C	C1	C2	C3	C4	C5
D	D1	D2	D3	D4	D5
E	E1	E2	E3	E4	E5

Table 3: Comparison options for sound logo A1.

Timbre(Melody)	1	2	3	4	5
A	A1	A2	A3	A4	A5
B	B1	B2	B3	B4	B5
C	C1	C2	C3	C4	C5
D	D1	D2	D3	D4	D5
E	E1	E2	E3	E4	E5

Table 4: Comparison options for sound logo B2.

This means, for each model sound logo XY, there will be 16 comparison questions, an example is shown below in table 5.

Question #	Model	Melody same (0)	Instrument same(1)	Example answers
1	A1	A2	B1	0
2	A1	A2	C1	1
3	A1	A2	D1	0
4	A1	A2	E1	0
5	A1	A3	B1	0
6	A1	A3	C1	1
7	A1	A3	D1	1
8	A1	A3	E1	1
9	A1	A4	B1	0
10	A1	A4	C1	0
11	A1	A4	D1	1
12	A1	A4	E1	0
13	A1	A5	B1	0
14	A1	A5	C1	1
15	A1	A5	D1	0
16	A1	A5	E1	0

Table 5: Dummy results for sound logo A1, with all 16 variations.

The results of this evaluation would show whether there is a difference in scores between the two columns, for example, using dummy values shown in table 6.

Sound Logo	Melody Preference	Instrumentation Preference
A1	10	6

Table 6: Example scores for sound logo A1 for 1 participant.

Thus, sound logo A1 will have a ‘melody preference’ score of (e.g.) 10, which is equal to 16 - (instrument preference), for each participant.

6.3 Stimuli

For this experiment, sounds in the style of sound logos had to be made. In the following sections it is explained how these sound logos were designed and chosen.

6.3.1 Guidelines for designing a sound logo

According to Anzenbacher's (2012) analysis of existing sound logos, there are various features that the sounds have in common. Several points include:

- Average length of sound is 2.68 seconds
- Average number of tones is 4 to 5, with no tone sequences containing more than 10 tones
- Average pitch range is 7 semitones, which equals perfect fifth
- Primarily consonant and small intervals
- Compact rhythmic structuring, very short inter-onset intervals

These guidelines are extracted from existing sound logos, so when creating/composing my own sound logos, they had to roughly adhere to these guidelines. The reason I propose 'roughly' is because the above guidelines are an analysis, showing for example 'average number of tones', so even between existing sound logos there is a difference in the amount of tones, and there should be some differences so that the melodies do stay distinct.

6.3.2 Composition of melodies

For this experiment, the sound logos should be distinct, yet within the domain of short melodic sequences. Thus, the question is what can be changed in terms of melody, and what must stay controlled in order to have distinct melodies. As this experiment is about melodic sound logos, they should follow the structure of existing sound logs, which means controlling several parameters based on the information mentioned previously. For this experiment, all the melodies should have:

- Similar length of sound
- Short inter-onset intervals, i.e. time between notes (according to Anzenbacher (2012))
- Same starting note
- Monophonic
- Same scale (C-major diatonic)
- Starting C3
- Upper bound C4, Lower bound C2

The things that are changed in terms of melody are:

- Melodic contour
- Interval size/range (within limit)
- Number of notes (within limit)

Melodic contour is the general shape of the melody line, where notes can rise and fall or stay the same pitch. The reason why this parameter is chosen to be changed (i.e. not kept controlled) is outlined in Chapter 5 of *Psychology of Music; From Sound to Significance*:

> "Changes in pitch direction are highly salient to listeners, more so than the degree of change in semitones (Jones, 1987). A performance error that results in a change to the melody's contour is far more noticeable (and far less common) than an error that does not cause such a change."
>
> "Even infants can discriminate between two melodies that differ only in one pitch if it alters the melodic contour (Trehub, Thorpe & Morrongiello, 1985)."
>
> "When you hear a melody for the first time and try to remember it, contour is one of the primary features you are likely to retain. Dowling (1978) reported a study in which people heard pairs of melodies and had to determine whether the second melody constituted a transposed version of the first melody or was a different melody. Listeners had a hard time ruling out altered melodies that were 'tonal answers' which were different melodies (i.e. made up of a different pattern of intervals), but preserved contour and also preserved the overall pitch context known as key."

Thus, the melodic contour is an important aspect of a melody and we can tell two pieces apart by their contour. The reason the key is kept the same for this experiment is because memory/information about the key fades, as shown in the study "Remembering the melody and timbre, forgetting the key and tempo" [13].

In other words, a melody can have many different qualities that make it distinct. The key, rhythm, melodic contour, interval range, etc. So to keep the melodies as controlled as possible, having one variable to focus on and change will help to reduce the complexity of the problem. Since melodic contour is perhaps the most salient variable that makes two melodies distinct, this variable was chosen to test.

6.3.3 Instrument selection

The instruments used should be distinct, which are based on the previous MDS solutions mentioned. However, the sounds will be made in Ableton 11 Live Suite, where these sounds are synthesised and emulated, and not accurately reflecting the true timbres tested in the MDS procedures. In table 7, the sound logos can be seen, including all their parameters, and in figure 5 the MIDI compositions are shown.

Melody	Instrument	Instrument used	Melodic Contour	Amount of tones	Interval	Pitch range	Contour notation
A	1	Grand Piano	Rising	6	C3 → C4	12 semitones	[+-+++]
B	2	Vibes Pure (vibraphone emulation)	Falling	7	C3 → C2	12 semitones	[- - - -]
C	3	Rubber Pluck (plucked guitar emulation)	Flat	6	C3	0	[ ]
D	4	Cruiser Strings (Violin emulation)	Rising-Falling (rainbow)	7	C3 → A3 → C3	9 semitones	[+++- - -]
E	5	Swell Brass (Trumpet emulation)	Falling-rising (bucket)	6	C3 → G2 → C3	8 semitones	[- - ++]

Table 7: Information about the sound logos used in the experiment

The instruments chosen represent the instruments piano, vibraphone, guitar, violin, and trumpet. These instruments were chosen on the basis of the MDS solution presented in figure 1. The instruments had to be perceptually distinct, however, there are of course some instruments which will sound more similar or different, because they share some key qualities, such as attack time. For example, it is expected that the piano sound is more similar to the vibraphone than to the trumpet sound because of, for example, the similar attack time. Similarly for the violin and trumpet sound, as they appear closer on the perceptual map. Moreover, the sounds do not reflect the MDS solution perfectly as the sound logos were made using stock emulations in Ableton 11 Live Suite. By having a range of different instruments in the experiment, any biases could be detected.

7. Results

Table 8 below shows the melody preference for each sound logo (maximum = 16), as well as the total melody preference (out of 80), per participant. Melody preference means a participant chose the variation with the same melody but played in a different instrument.

Participant	A1 Melody Preference	B2 Melody Preference	C3 Melody Preference	D4 Melody Preference	E5 Melody Preference	Total Melody Preference
1	16	16	15	15	16	78
2	15	16	16	16	14	77
3	16	16	16	16	16	80
4	16	16	16	16	16	80
5	15	16	16	16	15	78
6	16	15	16	15	14	76
7	16	16	16	16	14	78
8	15	16	16	16	15	78
9	15	16	16	15	16	78
10	16	16	15	15	16	78
11	15	16	15	16	13	75
12	13	13	11	13	14	64
13	14	15	16	16	15	76
14	16	16	16	16	16	80
15	13	11	14	16	16	70
16	16	13	16	16	15	76
17	15	13	15	16	15	74
18	16	16	16	16	16	80
19	16	15	16	15	14	76
20	15	16	15	16	16	78
21	16	16	16	16	15	79
22	16	15	16	15	15	77
23	16	16	16	16	14	78
24	15	15	16	16	16	78
25	16	16	16	16	16	80
26	16	16	16	16	15	79
27	15	16	16	16	16	79
28	16	16	15	16	15	78
29	16	15	15	16	15	77
30	15	16	16	16	16	79
Average	15.40	15.33	15.53	15.70	15.17	77.13
Percent (%)	96.25	95.83	97.08	98.13	94.79	96.42

Table 8: Melody Preference Score (MP) for each sound logo, for each of the 30 participants. Maximum Total MP score = 80

From this table, it is clear that there is a strong preference for the melody option (average total melody preference score = 77.13/80 = 96.42%). However, analyses were performed to check whether any factors influence these scores.

7.1 Analysis

From the table it is clear that the population in question has a strong preference for the melodic option. However, do the additional variables have any effect on the Total Melody Preference Score (TMP)?

Does musicality affect total melody preference score?

6 out of 30 participants can be considered musicians. This is a relatively weak comparison between the two groups because of the difference in size.
An independent T-test was used to compare the scores between musicians and nonmusicians.
TMP score (M= 76.60, SD = 3.24) and musicality; t(28) = 2.362, p = .025.
Although the p-value < 0.05, the sample sizes being compared are too different, violating the equal variance assumption.

Does gender have an effect on total melody preference score?

20 out of 30 participants were male. 10 were female.
An independent sample T-test was used to compare the scores between males and females.
There was not a significant difference in TMP score (M= 76.60, SD = 3.24) and gender; t(28) = -0.590, p = .560.

Does hearing damage affect total melody preference score?

5 out of 30 participants had hearing damage. Similar to the musicality variable, this is a big difference in group size to compare.
Nevertheless, an independent sample T-test was used to compare the scores between people with and without hearing damage..
Although there was a significant result affecting TMP score (M= 76.60, SD = 3.24) and gender; t(28) = 1.380, p = .0178, again the group size difference violates the equal variance assumption.

Does age affect total melody preference score?

A correlation analysis was performed on age and TMP score. Age does not have a significant effect on TMP score; r(28) = -.0.031, p = 0.869.

Does experiment type/order of sounds heard affect total melody preference score?
16 participants completed experiment 0, and 14 participants completed experiment 1.
An independent sample T-test was used to compare the difference in TMP scores and experiment type.
There was not a significant difference in TMP score (M= 76.60, SD = 3.24) and gender; t(28) = -0.40, p = .692.

7. Discussion

From the results it shows that in a match-to-sample task involving short melodic sounds, participants have a strong preference for choosing the option with the same melody as the model sound, played in a different instrument, as opposed to the option with a different melody played with the same instrument as the model sound. Variables such as age, gender, hearing damage, musicality, or which experiment the participants did do not have a significant effect on these preference scores. There are several discussion points about the experiment.

7.1 Problems with the experiment design

The experiment design was very complex and participants struggled with keeping their attention on task for all of the 80 questions. Hence the low rate of completion of the task (30/100 attempts). Although the task was substantially decreased in size (from 600+ comparisons to 80), the experiment was still considerably tedious for the participants, as roughly 40 minutes was needed to listen to and evaluate 240 sounds. Furthermore, other feedback mentioned that eventually all the sounds begin to sound similar because of the many repetitions with small variations.

Another problem with the design of the experiment was that the participants could choose at what tempo they heard the sounds, and how long the interval was between the sounds heard. A participant could click all 3 sounds rapidly in succession, or click the sound and wait a few seconds. For this experiment, controlling the time between the sounds heard was not controlled, although this could have been an important influencing factor. For future research it would be best to have the time between the sounds heard controlled.

A further interesting part of the experiment was that due to the vague instructions: "select the sound which is most like the model" (taken from Wolpert's study - to not direct attention to any specific aspect of the sounds), participants felt that there was such an idea of a correct or incorrect approach. Thus, participants adopted tactics during the experiment and stuck to them. For example, several participants mentioned that they did not clearly understand the instructions, so they would focus mainly on the variation with the same melody in the hope that this was the 'correct' answer. Thus, perhaps they would not change their answer even if in some cases the instrument variation was considered more similar.

Another point of discussion is that the sounds used for the experiment were not always optimal. By using Ableton 11 Live Suite and copying the MIDI notes to a different instrument track meant that not all sounds were of the same quality. The sound logo played with a vibraphone had short strikes, yet using this MIDI sequence for a trumpet emulation meant that the rhythm was not intended to be played on a trumpet, and so would not sound natural. Nevertheless, this was done to keep the melodies as controlled as possible. For future research it would be preferable to have musicians play the actual melodies.

Lastly, the task at hand, a match-to-sample task involving sound logos with melodic and instrument variations, is a limited method of approaching sound logo research. A match-to-sample task is focused on short-term memory and instant comparisons, so there is no way of knowing how well the memory of these sounds is retained. An interesting approach for future research would be to use a delayed match-to-sample task, where there is some delay between the model sound and the other options, to see if a delay affects retaining the melodic information. However, as described in the Melody section (section 4, page 9), doing research involving melodies where certain features are manipulated, such as the melodic contour, while keeping other features constant (e.g. tonality), makes sense from a scientific perspective, although the result is that these melodies tend not to be very ‘catchy’, and memory of such artificial melodies is much poorer than for familiar melodies. This means that these artificial melodies may not provide a good basis for understanding long-term memory of melodies of sound logos.

7.2 Problems with Qualtrics

The experiment was made using Qualtrics so that this could ease distribution, as a link could be sent to participants where they could perform the experiment at home or elsewhere. Though, using Qualtrics for this experiment proved challenging; many experiments would freeze, where the participant could not complete the experiment. Moreover, the experiment was programmed so that each sound could only be heard once, yet when the experiment was frozen, refreshing the page would lead to the situation where the participants could hear the sounds again. Furthermore, there was nothing stopping a participant from changing the order in which to hear the sounds. One could click option 2 before the model option, and so controlling the order of sounds heard could not be done.

Another problem with Qualtrics is that in the data it was not shown in what order the participants were shown each question. It would be interesting to see whether there is a difference in results for the first half of the experiment versus the second half, as participants undoubtedly grew tedious and frustrated with many sounds to evaluate.

8. Conclusion

In conclusion, this research shows that in a match-to-sample task involving sounds in the style of sound logos, participants choose the option for the same melody overwhelmingly more than the option with the same instrument. Despite the problems with the experiment mentioned previously, the fact that the results show a clear preference for melody is interesting for several reasons.

Firstly, these results do not necessarily align with Wolpert's results, and even differ from her earlier work done in 1987. In Wolpert's original paper, the researcher found that musicians consistently choose the option with the same melody (different instrument), while nonmusicians did not do so. Furthermore, in the earlier work by Wolpert, a recording of Bach's Variation 10 was played with 4 different instruments. "Many of the subjects thought they heard four entirely different excerpts "[14]. It seems that for the current experiment, information about the melody is retained for short melodic sequences. However, this could be due to the time between the sounds heard, and since this was a different task, not even testing the effect of instrumentation.

As the domain of sound perception is complex and the melodic structures used are limited, contributing knowledge in this form, and specifically for sound logos, gives us information about which form of sound logo adaptation is beneficial for recognizability. What we can extract from these results is that the melodic contour, representing a distinct melody, is a crucial feature for a sound logo, more important than instrumentation. This idea is exemplified in McDonalds' audio campaigns throughout the years [6]. McDonald's has kept their melody the same for their sound logo but have used different instruments for each specific marketing campaign. For example, using a vuvuzela during the World Cup, or a Mexican guitar sound to promote their new Mexican-influenced menu item. By using the same melody but changing the instruments each time, it could mean that the population could become familiar with the melody, regardless of the instrument, so that it is universally recognizable.

Lastly, experimenting with sounds, melodies and instruments has proved particularly difficult due to the complexity of sound research. Trying to control melodies and timbres scientifically is challenging due to the many perceptual differences of these variables. The same sound can be heard by two individuals differently, evoking different feelings and responses. This project started with trying to find out which sound quality is more important in a sound logo, the timbre or the melody. After extensive research it was clear that these two variables are highly complex and thus a large amount of reductions had to be made in order to compare the two qualities.

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10. Appendix

10.1 From: Nicolai Jørgensgaard Graakjær (2019) Sounding out i'm lovin' it – a multimodal discourse analysis of the sonic logo in commercials for McDonald's 2003–2018, Critical Discourse Studies, 16:5, 569-582, DOI: 10.1080/17405904.2019.1624184

Adaptations

Adaptations refer to short-term variations – restricted to only a small number of commercials – in the structure of the sonic logo. Most expressively, adaptations are shown through the principal motif y and are varied through various musical resources including its melodic structure and the instrument by which the motif is performed. In addition to the varieties of (the gradually reduced appearance of) human voices, the motif is performed by a wide assortment of musical instruments throughout the collection, including bass guitars, guitars, violins, flutes, bells, pianos, trumpets, saxophones, trombones, horns, xylophones, harps, banjos, harmonicas, and drums. Instrumentational variations also occur relating to whether the motif is performed by one instrument, by more than one instrument in unison, or by one instrument accompanied by other instruments. The variations in melodic structure include rhythm, range, intervals, tonality, and pitch.

The adaptations can be considered as an additional protection against 'constipation' and possible wear-out effects while still being able to produce brand recognition and recall. However, the adaptations also serve to produce promotional signification relating to the particular commercial's message. To give just a few examples illustrating the range of varieties (it is beyond the scope of the paper to go into further analytical detail at this point, and hopefully the following exemplifications will suffice for the present purpose): in a commercial from June 2004, motif y is sung brightly by a woman in a relatively high register in the key of G major. The relative 'lightness' of the musical resources here seems to adapt to the promotion of a salat menu apparently targeted for women (as shown throughout the prior parts of the commercial). In October 2004, a group of children shouts (with no fixed tonality) motif z, which seems to adapt to the commercial's promotion of a children's menu while copromoting Disneyland Paris. In April 2006, motif y is performed by a small group of recorders. The music sounds out of tune, as the recorders' pitches do not entirely match. In resembling the type of sounds a group of children might be able to perform in a primary school setting, the motif here seems to adapt to the childlike naivete displayed in the prior parts of the commercial: A bride is seen trying on a wedding dress in a shop and becomes furious when she realizes that she is not able to buy the dress by adopting McDonald's logic of a 'coinoffer' – the music thus also seems to add a sense of humor to the situation. In December 2009, motifs y and z are performed by Spanish guitar to adapt to the allegedly Mexican origin of the promoted product (El Maco). In a commercial from March 2012, motif y is performed by a number of air horn compressors in C minor and with no melodic syncopation. The motif here seems to adapt to the copromotion of the 2012 UEFA European Championship in men's football (sponsored by McDonald's) by including a traditionally widespread and rhythmically unsophisticated sound from the stands of football stadiums. In a commercial from May 2013, motif y is performed swiftly by an electronic piano in C major beginning at the fifth of the scale; the music here seems to adapt to the illustration of how McDonald's makes it 'easy not to grill by yourself' by expediently providing grilled barbeque burgers.

The examples illustrate that adaptations relate to specific aspects of promotional significance, including the characteristics of the promoted product and its target group, features of the offered service and production, connections with some specific external affair, and/or characteristics of the commercial's mode of address. The realization of the identified meaning potentials is of course dependent on viewers' interpretation and prior knowledge of musical conventions, symbols and stereotypes. The examples clearly indicate though, how musical resources can act (to certain viewers) as 'style flags' that identify a particular musical style and, by connotative extension, a cultural genre and context for that particular musical style (Tagg, 2013, p. 522).

The sonic logo is actually varied so extensively that no musical structure manifests the exact same way across the collection. A majority of the variants have in common an ascending, syncopated five-note melody, but significant exceptions occur throughout the collection, as exemplified above. By comparison, the visual presentation of the logo and slogan is much more stable, as all of the commercials include white lettering below a pair of golden colored arches. Of these elements, the golden arches seem to embody the core visual brand element (Oswald, 2012, p. 57). This highlights how a relatively stable setting is needed for adaptation to emerge: 'Adaptation consists of holding certain selected elements constant while varying others' (Sinclair & Wilken, 2009, p. 149).

One reason why this volatile and seemingly amorphous musical accompaniment can qualify as an identifiable sonic logo is that it unfailingly accompanies the relatively stable visual presentation of the logo and slogan at the end of each commercial. Moreover, each variation presents an allusion to previous appearances, and the regular distribution can arguably have inculcated viewers with an expectation and a sense of a musical prototype – assuming that, to most viewers, motif y has been 'emancipated' from its Timberlakian origin. From this perspective, the variations arguably refer to a prototype or 'fuzzy schema' that generates 'a set of objects which is roughly coextensive' and 'not capable of being formulated into explicit operational criteria' (Zadeh, 1982).