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The Sound of Om: Exploring the Harmonic Content of the Sacred Mantra

The Sanskrit "Om" is one of the most iconic sounds a person can verbalize. Beyond its prominence in Asian religion, it has, through globalization, gained worldwide recognition as a symbol of Eastern spirituality. A natural question to ask is: "why Om?"

In this research paper, I will be exploring the sound of Om itself, seeking to understand whether the vocalization of this particular syllable has some unique psychoacoustic quality that makes it naturally appealing to the human ear and body. In order to do this, I will be analyzing the sounded Om of an experienced meditator with a spectrogram. A spectrogram is a two-dimensional graph that shows the harmonic content of a sound, conveying the relative power (volume) of different component frequencies within a composite waveform. For an in-depth explanation of how spectrograms are constructed, consult David Jaffe's journal entry "Spectrum Analysis Tutorial, Part 1: The Discrete Fourier Transform" in the *Computer Music Journal* (Jaffe 9-24). To test the inherent attractiveness of an Om's waveform, I will modify a recording of a musical instrument (bass guitar) to match the spectrogram of a sounded Om. I will present a convenience sample of listeners with the same recording, untreated, treated to sound like the Om, and treated for application in a rock music context, and proceed to ask each listener which sample they prefer.

There is already much academic literature on aspects of the Om that may contribute to its power in meditation, as well as how mantra meditation itself is linked to measurable altered states of consciousness. Danish researchers Bent Stigby, Jennifer Rodenberg and Hanne Moth published a notable paper in 1980 which first established the practice of mining biodata from practicing meditators, also first confirming that the practice of Transcendental Meditation created changes in physiology that were measurable (Stigsby et al. 434-42). In 2018, Robin Carhart-Harris collaborated with a plethora of researchers to publish a paper documenting how changes in brain function observed in meditators practicing a variety of techniques, including Mantra Recitation, could also be observed in the brains of non-meditators under the influence of psychedelic drugs (Carhart-Harris et al). This research highlights how experienced meditators can induce mental states as dramatically removed from normal waking consciousness as a drug-induced psychedelic experience.

When dealing with the specifics of Om and the practice of Mantra Recitation in general, it is important to consider the sound being created and/or ruminated upon. The vocalization of Om, or any Mantra, is inherently musical in that it has a sense of rhythmic regularity and a measurable pitch and timbre. As Gurjar and Ladhake have observed, those who practice Mantra Recitation develop a sense of rhythmic regularity naturally over the course of practice (Gurjar and Ladhake 173). Below is a visual display of this excerpted from their research, using waveform graphs. The horizontal dimension represents time and the vertical dimension represents amplitude (loudness).

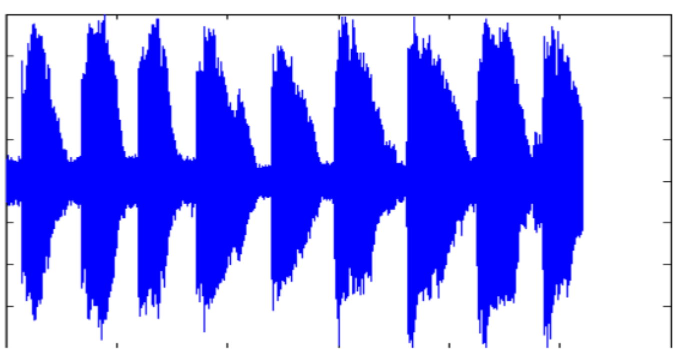
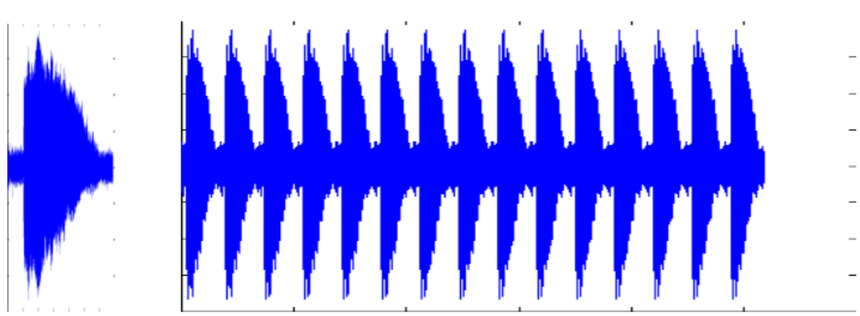


Fig. 1 Initial Chanting of single OM

Figure 2 depicts the chanting of OM by normal person after some days of chanting.



In terms of harmonic content, pitch and timbre, pitch refers to the fundamental frequency of a sound, the slowest audible oscillation. All natural sounds are composites of many sine waves sounding simultaneously at different volumes. A sound's fundamental is typically the loudest sine wave in its composition and determines the "note" or its pitch. Low and slow fundamentals, those closer to 0 oscillations per second (Hertz or Hz), are perceived as lower pitches, and high fundamentals, closer to infinity, are perceived as higher pitches. The range of normal human hearing is roughly 20Hz to 20kHz.

Timbre is a musical term used to refer to the quality of a sound. A trumpet and guitar sound very different, even if they are sounding the same note (the same fundamental frequency). This is because the production of a given fundamental vibrates different physical materials in different ways, generating higher frequencies that are multiples of the fundamental (Gann 20-24). The generation of these higher *partials*, as they are known, always follows a mathematical pattern called the Harmonic Series. It is the relative volume of these upper partials in relation to each other and the fundamental that produce the timbre of any sound. To produce a sample of my bass guitar that sounds like an Om, I will play the fundamental frequency of the Om and digitally adjust the volume of upper partials to match the timbre of the Om.

Experimental Design

The Om I will be basing my research on is one analyzed by Indian researchers Gurjar and Ladhake, who have already gone through the trouble of arranging a professional recording of an Om sounded by an experienced meditator. Below is an excerpted spectrogram of a male meditator's Om with a fundamental frequency of ~108 Hz (Gurjar and Ladhake 784).

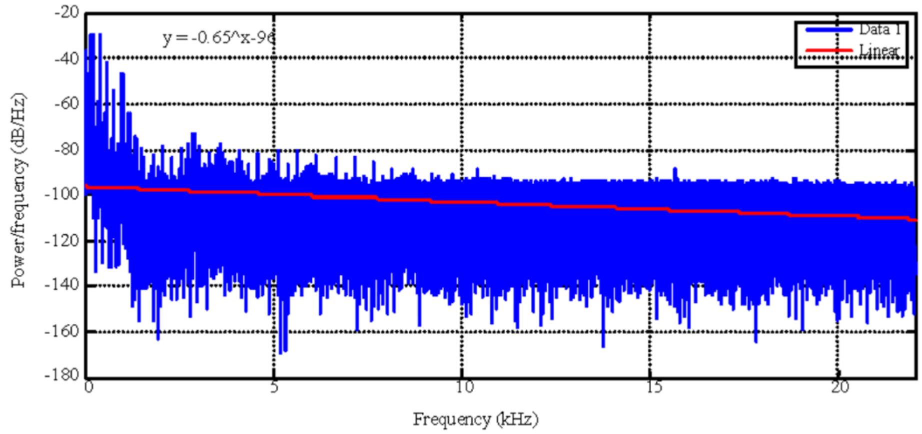


Fig. 5: PSD of sound OM of male speaker with slope of -0.65 for linear fitting

The fundamental frequency of this Om (~108Hz) is conveniently close to the octave of a bass guitar's "A" string, 110Hz. This being so, I have recorded the sounding of this note on bass using the same digital conversion factors as were used to capture the Om, a 44.1kHz sample rate rendered into a .wav file (Gurjar and Ladhake 782). To record my bass, I plugged it into a Focusrite Scarlett 2i4 interface using a quarter inch cable and tracked directly into Logic with no signal processing.

Using the Equalization (EQ) software built into Logic, I had the bass recording modified to match the spectrogram of the Om. I reached out to producer Jake Morenc (Happy Medium, Nosie Complaint, DUENDE, Closeout, The Framers, and more) to aid in the equalization process. Logic's EQ interface includes a real-time analyzer option for displaying a spectrogram of tracked audio. Below is a screen capture of the frequency response exhibited by the bass sample once filtered to match the spectrogram of the Om.

I designed a Google Forms survey to administer to a convenience sample of college-aged individuals. The survey presented individuals with the three samples and asks which sample they found to be most pleasing, also requesting a brief description of their rationale for choosing a specific sample over the others. I marketed the survey as part of a "sound design study." The survey was distributed via Instagram and Snapchat, where my I posted a link to the survey on my stories (24-hour temporary posts).

After collecting the data from respondents, I determined the favored sample by a measure of which sample was chosen to be "most pleasing" the highest number of times. To ensure that the favored response is enough of an outlier to not have won by chance, I will perform a single-tailed hypothesis test at a significance level of $\alpha=0.05$.

Hypothesis (H_1)

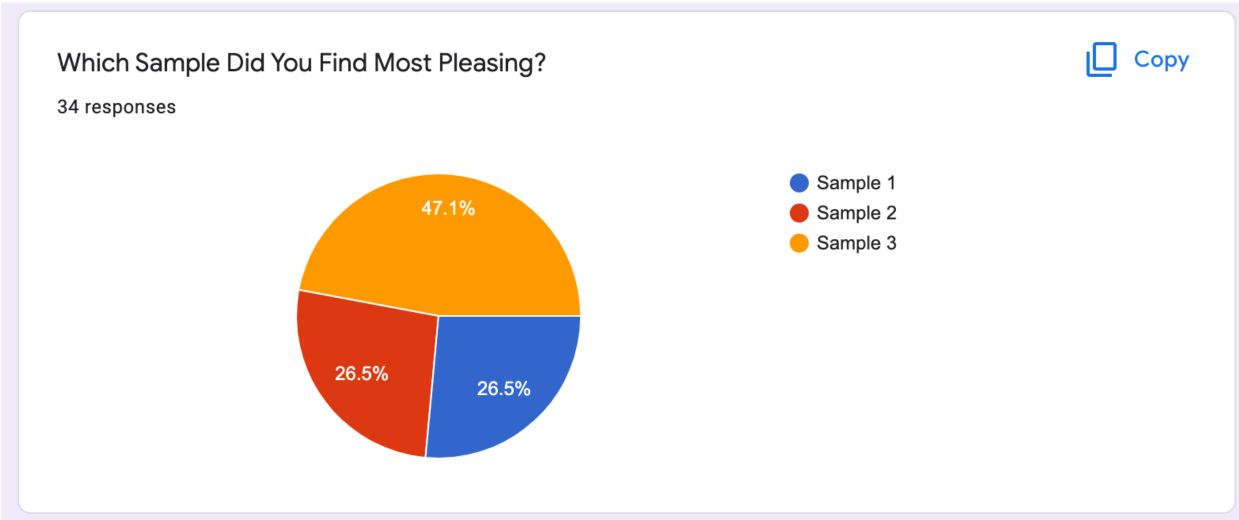
I predict that a plurality or majority of surveyed individuals will prefer the bass sample treated to imitate an Om at a significance level of $\alpha=0.05$.

Null Hypothesis (H_0)

No statistically significant plurality or majority of surveyed individuals will prefer the bass sample treated to imitate an Om at a significance level of $\alpha=0.05$.

Results

Below is a screen capture of the survey results.



Out of 34 responses, 47.1% (16 people) preferred Sample 3. An equal proportion of respondents, 26.5% (9 people each) preferred Samples 1 and 2. You can listen to the samples as they were presented in the survey by visiting the link below.

https://youtu.be/KRMG-jdhYys

Sample 1 is the untreated bass, Sample 2 the bass treated for use in a rock music context, and Sample 3 the bass treated to match the spectrogram of an Om. Beyond the question regarding preference, the survey also requested that respondents briefly describe their choice. On the following page I've embedded some of my favorite responses from respondents who preferred Sample 3.

Which Sample Did You Find Most Pleasing? *

- ( ) Sample 1
- ( ) Sample 2
- (•) Sample 3

Briefly Explain Your Choice *

Sounded the most full, if that makes sense. It sounded purposeful and more complex then the other samples.

Which Sample Did You Find Most Pleasing? *

- ( ) Sample 1
- ( ) Sample 2
- (•) Sample 3

Briefly Explain Your Choice *

Feels like Buddhist temple

Which Sample Did You Find Most Pleasing? *

- ( ) Sample 1
- ( ) Sample 2
- (•) Sample 3

Briefly Explain Your Choice *

it felt like a warm hug from my mother no kizzy no cap😤✨

Statistical Analysis

To test the proposed hypotheses, I performed a single-tailed hypothesis test for proportions using the standard formula:

$$z = \frac{p^{\wedge} - p_0}{\sqrt{\frac{p_0(1 - p_0)}{n}}}$$

$p^{\wedge}$ represents the observed proportion of individuals who preferred Smple 3 and p_0 represents the expected proportion of individuals to prefer Sample 3 in the null hypothesis. *n* represents the sample size of 34 respondents. Given that the null hypothesis predicts no preference for the Om treated sample, I will assume an equal distribution of preference for each response, represented as an expected proportion of 0.333. This gives us the following values:

$p^{\wedge}$= 0.471

p_0= 0.333

n= 34

The calculation of our *z*-score looks like this:

$$z = \frac{0.471 - 0.333}{\sqrt{\frac{0.333(1 - 0.333)}{34}}}$$

The above calculation provides a z-score of 1.71, situated comfortably above the critical value of 1.645 required to reject the null hypothesis at a confidence interval of 95%. With this in mind, we can reject the null hypothesis and assert that the preference for Sample 3 is statistically significant at a significance level of $\alpha=0.05$.

Conclusion

The Sanskrit Om has been part of human culture for millennia and shows no sign of expiration. While the mental benefits of Mantra Recitation have been proven to be significant, little research has been done in the field of studying the acoustics of certain mantras, the most famous being Om. In this research paper, I have found evidence that the timbre of a sounded Om from an experienced meditator has certain attractive qualities that translate to other sounds. This may have applications in the world of sound design, where the timbre of processed or synthesized sounds can be made more pleasing by being manipulated to match the timbral qualities of Om. In terms of insight on the nature of Om itself, this research indicates that the longevity and prevalence of Om as a mantra may lie not only in cultural preservation for the sake of tradition, but also in the sonic qualities of the sounded Om itself.

Works Cited

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