Decreasing Pickleball Noise

Abstract

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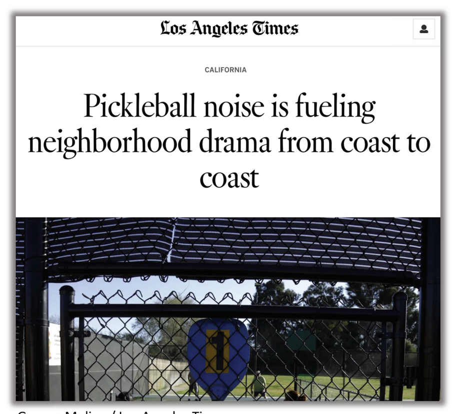
Pickleball is a rapidly growing sport, but there have been many complaints about games being too loud. The average noise level from a pickleball game is **70 decibels** when measured at 100 feet away from the court.[1] While this is not damaging, it adds noise to the environment, which annoys nearby communities.[2, 3, 4, 5, 6] One community member said that **"Because the noise is so bad, it ruins the quality of our life."**[7]

The goal of this project was to change the ball so it was not as loud, while still keeping the gameplay the same. I made 19 prototypes (not counting the control ball) using reasoning from different hypotheses and different materials. I found 15 designs that were quieter than the original ball, and one of them also bounced as well as the original ball. **This new ball design could be a peaceful compromise between pickleball players and their communities.**

Introduction

I chose to research this topic because I like playing pickleball, and I was surprised to learn that a lot of people don't like the sport because of how loud it is. I decided that I wanted to try and make the game quieter, and wanted to do something that hadn't been done before. I noticed that while there were a lot of commercially available "quiet" rackets, I only found foam pickleballs, which don't behave the same as traditional, plastic, pickleballs in use. This made me want to find a new ball design that makes the game quiet while still keeping the game the same. I started this project in Fall 2022.



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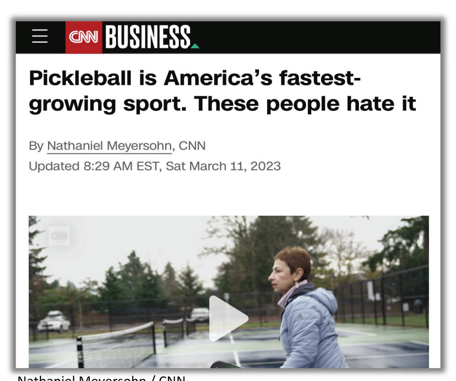


Nathaniel Meyersohn / CNN

I had 3 hypotheses coming into this project.

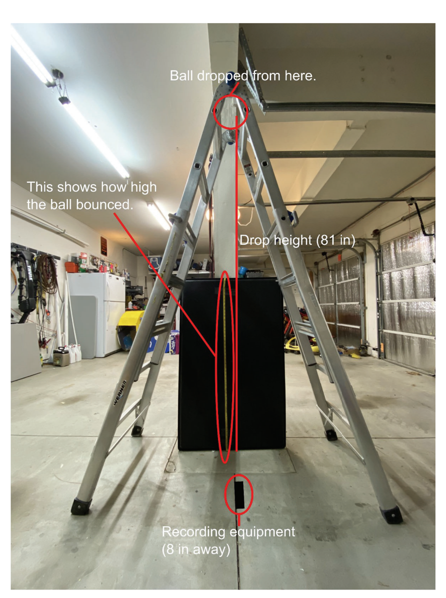
1) The sound is bouncing around the inside of the ball like a drum, therefore there needs to be one of the following:
   - Something covering the holes of the ball so no sound can escape
   - A sound-dampening material inside of the ball so sound cannot echo
2) The sound reflects off of the ball and paddle, therefore there needs to be a sound-dampening material on the outside of the ball
3) The hard surfaces on both the paddle and the ball are causing a loud noise, therefore there needs to be a compliant yet rigid surface on the outside of the ball

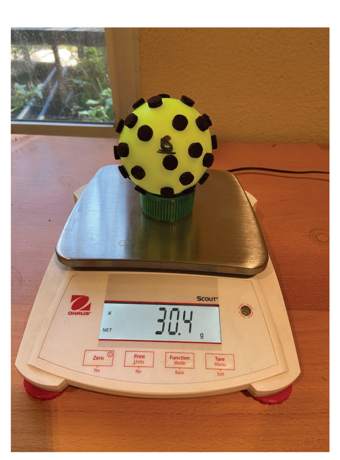
Methods

I modified pickleballs using materials I bought off of Amazon and McMaster-Carr. I chose a range of materials (ex: softer/harder/springier) to test out the different hypotheses. Materials included:

Echo-stopping modifications:	Reflective sound dampening materials:	Compliant materials:
-packing peanuts	-noise canceling foam	-felt dots
-spray foam	-velvet tape	-rubber dots
-pull-apart foam		
-tape to cover holes		

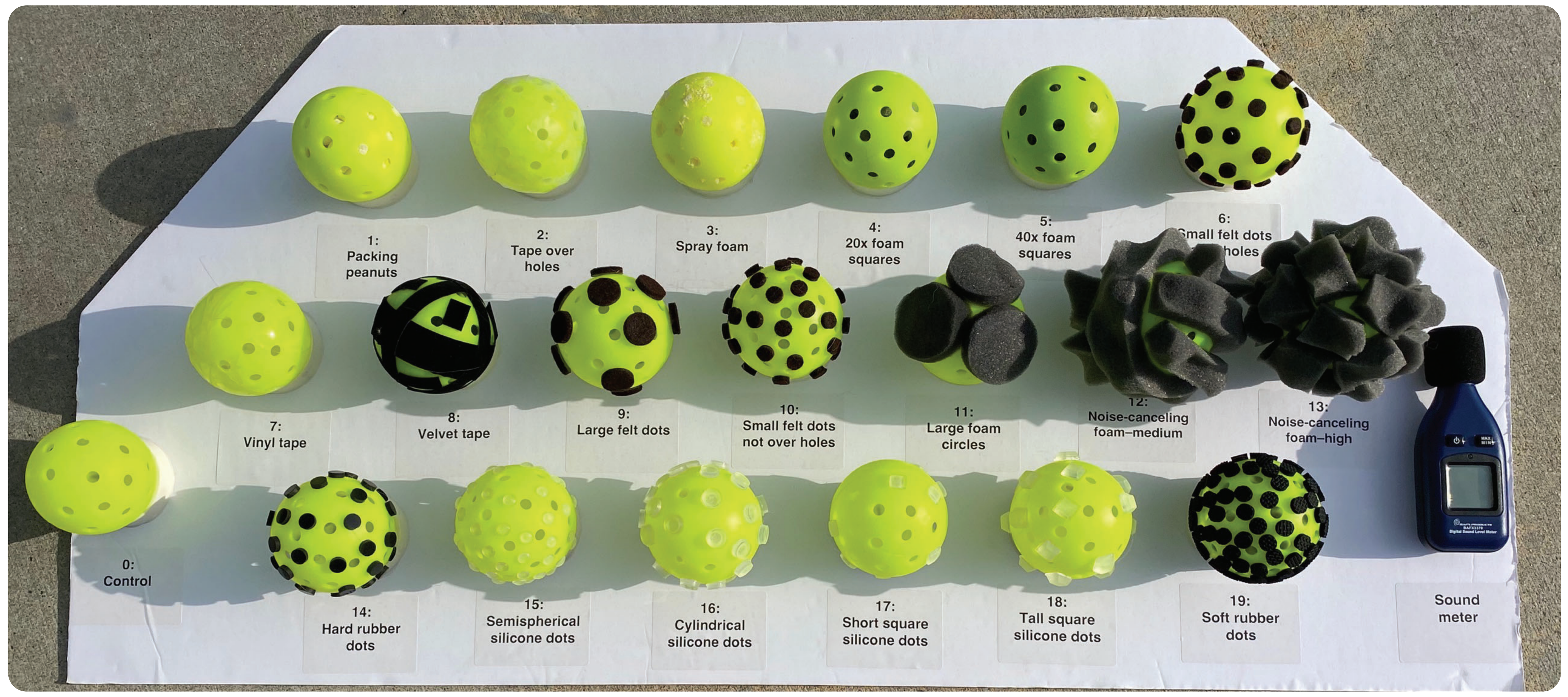
To find which ball was the quietest, I used a sound meter capable of displaying the loudest noise in a period of time. This number was measured in decibels, or dB. Decibels are a logarithmic measure of how loud something is, meaning that if something is 10 dB louder is has 10 times the sound pressure. I then made a rig which allowed me to drop a pickleball from a consistent height of 81 inches and measure how high it bounced (shown to the right). A sound meter was placed 8 inches away from the impact location. I then dropped each ball 3 times from my rig and recorded the bounce height and noise level. I averaged these numbers to get my final numbers. I also took one recording of each ball so I could get its dominant frequency, which is the most hearable frequency in a certain recording. The greater the dominant frequency is, the higher the noise is in terms of pitch. I also measured the mass of each ball so I could find any trends.



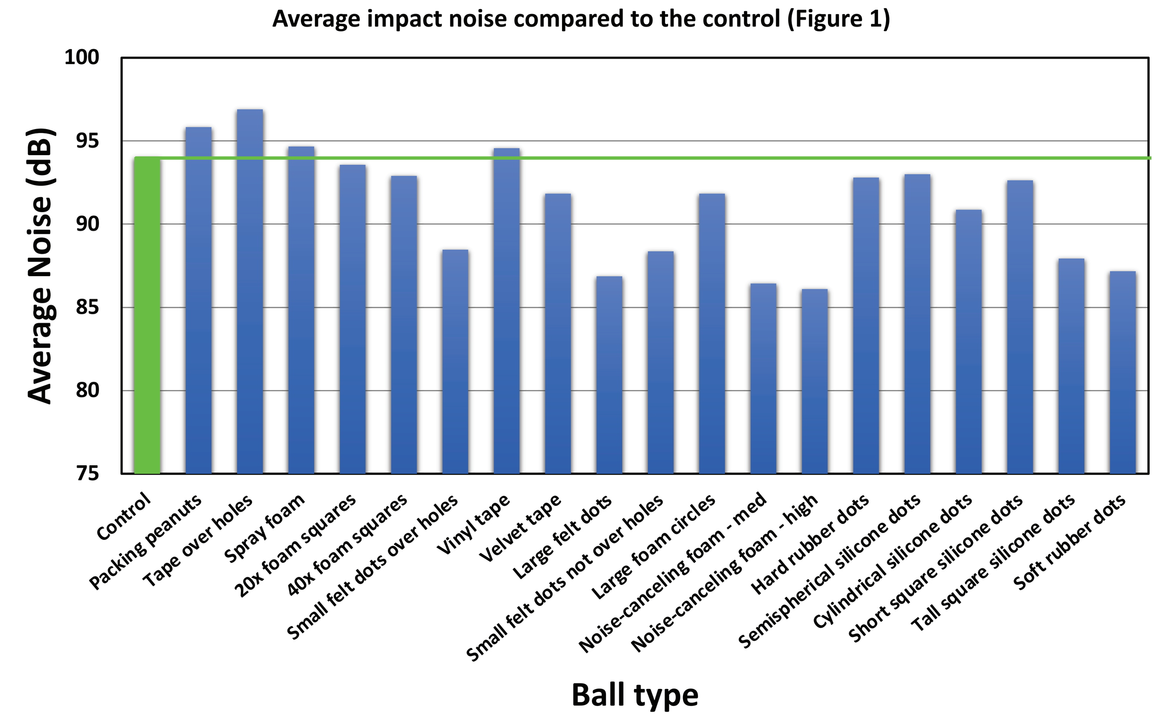


Measuring the masses of two different balls.

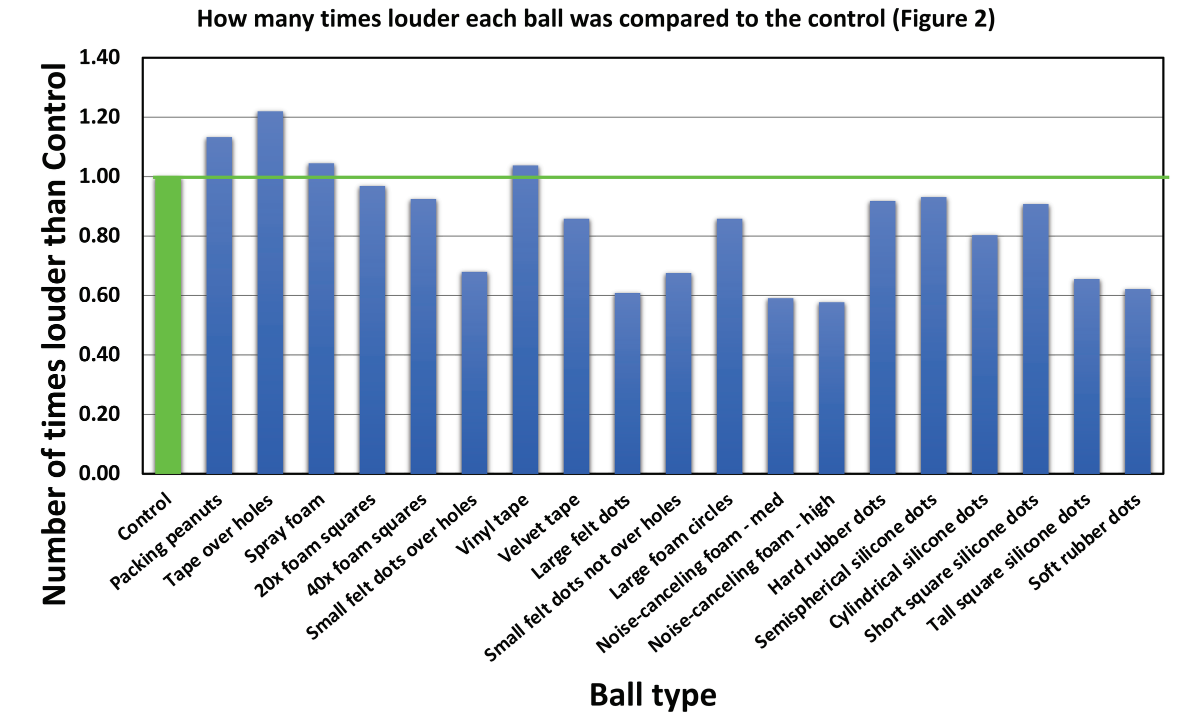
Results



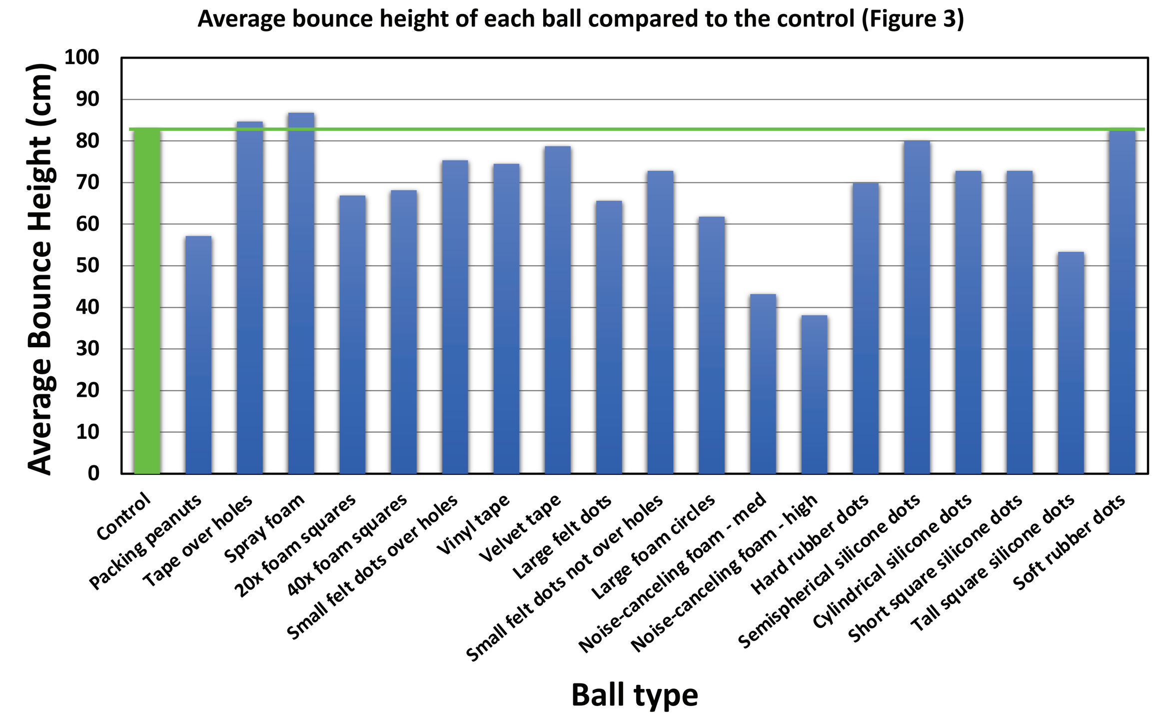
Average impact noise compared to the control (Figure 1)



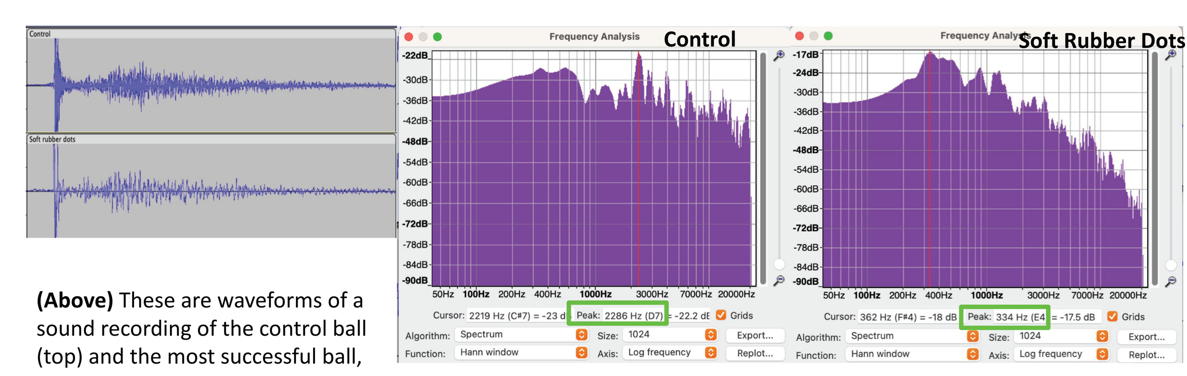
How many times louder each ball was compared to the control (Figure 2)



Average bounce height of each ball compared to the control (Figure 3)



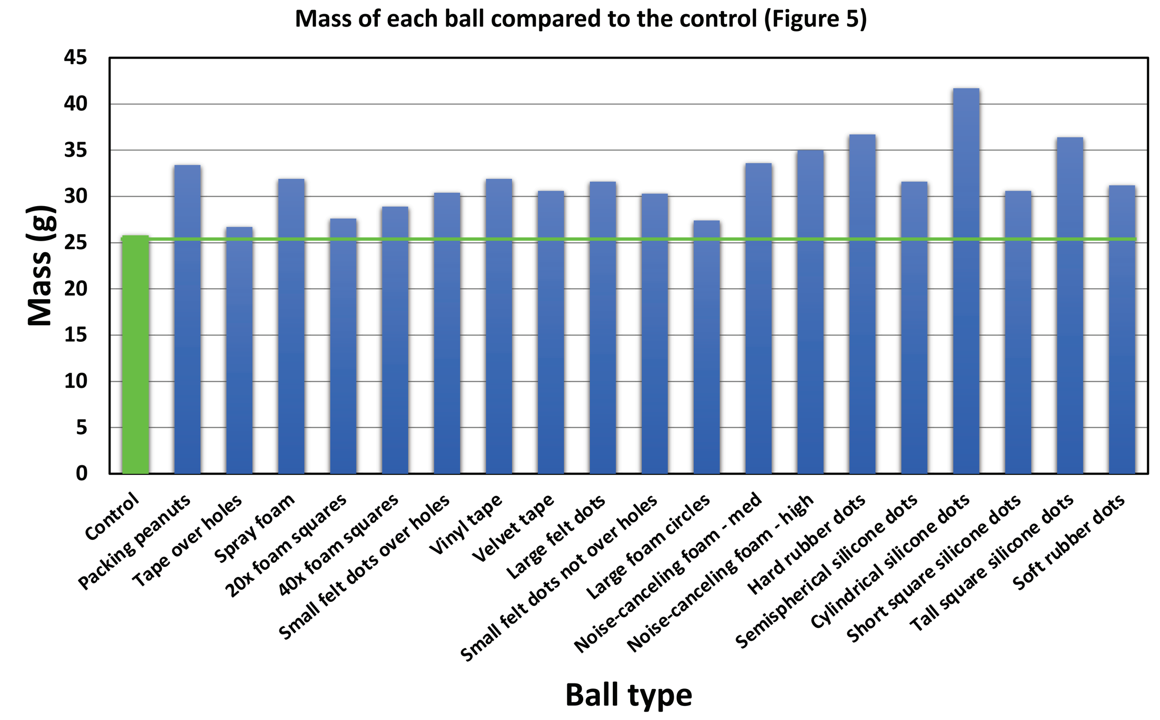
Analyzed recordings of the control ball and the most successful ball, Soft Rubber Dots (Figure 4)



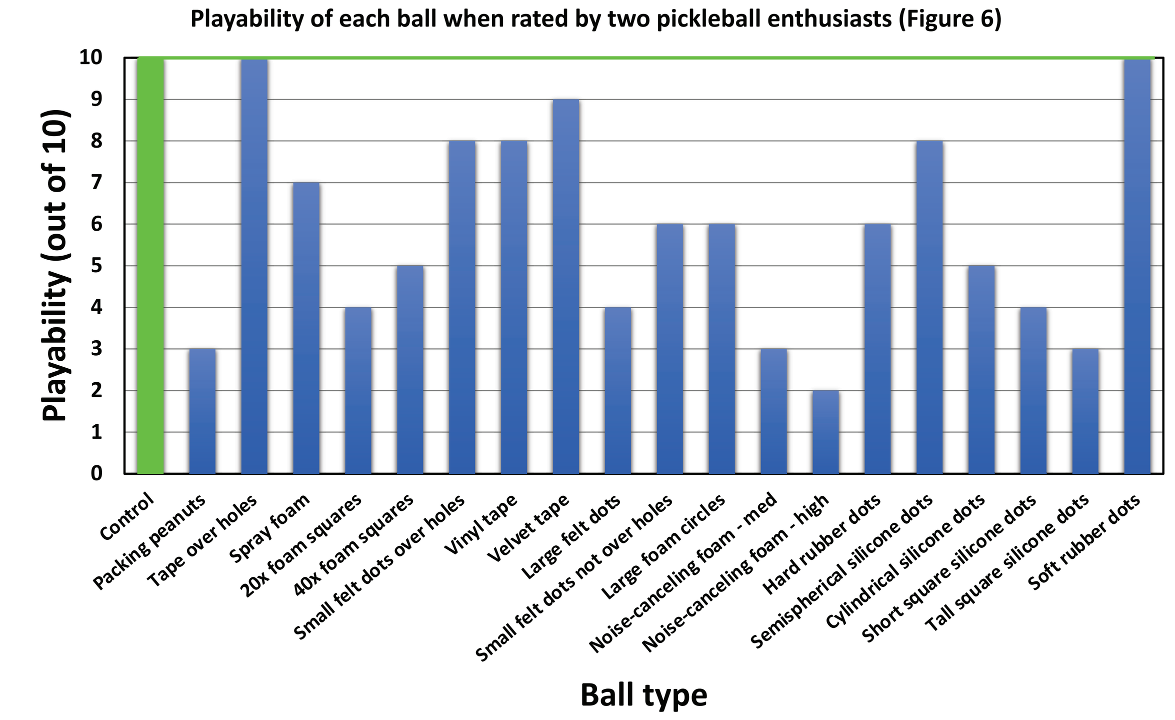
(Above) These are waveforms of a sound recording of the control ball (top) and the most successful ball, Soft Rubber Dots. (bottom)

(Above) This is a frequency analysis of those two recordings. This shows the dominant frequency (circled in green) of each ball. The dominant frequency of the Control recording is 2286 Hz, while the dominant frequency of the Soft Rubber Dots ball is 334 Hz, which is much lower.

Mass of each ball compared to the control (Figure 5)



Playability of each ball when rated by two pickleball enthusiasts (Figure 6)



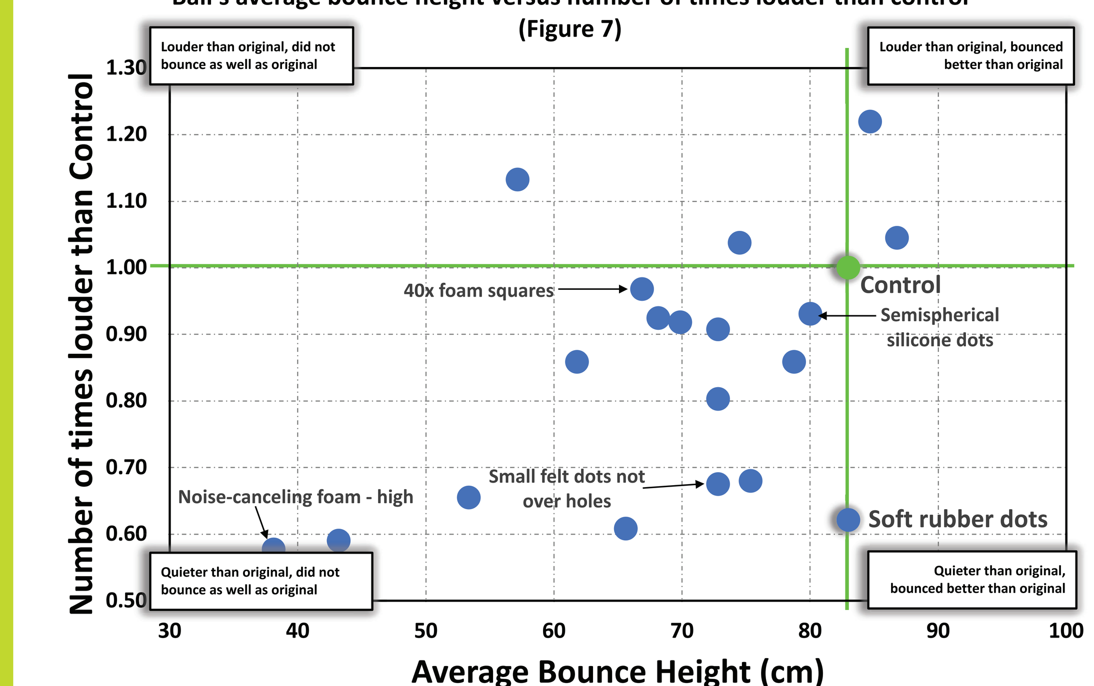
Discussion

As there were many goals for this project (noise, bounce height, playability), instead of focusing on just one goal I decided to find the design that was the most well rounded.

First, I plotted the average noise of each ball in dB compared to the control as it was the primary goal for this project. **Figure 1** shows that most balls are quieter than the control, with the exception of vinyl tape, packing peanuts, and tape over the holes. The quietest balls were the ones covered in the noise cancelling foam and the Soft Rubber Dots. This figure disproves my first hypothesis, because packing peanuts and tape over holes did not reduce the noise; in fact they were even louder than the control.

I calculated how many times louder/quieter the balls were compared to the control. I learned that, to find how many times louder/quieter something is, simply use the formula $t = 2^{c/10}$, where t is the # of times louder something is, and c is the change in dB.[8] Using this formula, I came to the conclusion that the noise canceling foam had the quietest impact noise (**Figure 2**). However, when I looked at the bounce height (**Figure 3**) the noise canceling foam performed poorly, while tape over holes, spray foam, and Soft Rubber Dots performed the best. This means that I could not further investigate hypothesis number 2 because I was trying make a well rounded ball, and hypothesis number 2 resulted in balls that were quiet but did not bounce well at all.

Ball's average bounce height versus number of times louder than control (Figure 7)



I made **Figure 7** because Figures 2 and 3 only told one side of the story. Figure 7, however, combines the data. This shows me the most well rounded design, Soft Rubber Dots. It had the same bounce height as the control but was almost half as quiet. Calculating the noise relative to the Soft Rubber Dots, it means that the control ball is roughly 1.61 times louder than the optimal ball design.

Soft Rubber Dots was also compared to the original ball in terms of dominant frequency, explained in the Methods section. The recording of the control ball turned out to have a dominant frequency of 2286 Hz, while the Soft Rubber Dots had a dominant frequency of 334 Hz, as shown in **Figure 4**. To the human ears, higher-pitched frequencies sound louder, so this means that the Soft Rubber Dots would sound even quieter.

Figure 5 shows the mass of each ball, as the closer the mass is to the control, the more likely it is that the gameplay will not change. While all of the balls were heavier than the control, the mass of Soft Rubber Dots was only 5.4g heavier than the control.

As playability was an important factor in this experiment, two pickleball enthusiasts played a game with each ball and then rated each ball on a scale of 1 to 10. As shown in **Figure 6**, Soft Rubber Dots was one of only two non-control pickleballs that got a perfect score. The other pickleball that got a 10 was Tape Over Holes, which also bounced well. However, Tape Over Holes was nearly 1.25 times as loud as the control ball, which means that Soft Rubber Dots was the best pickleball, as it was quieter, bouncy, and was extremely playable.

Conclusions

Now that we know that there can be a quieter ball, we can expect that potential communities would like this because it is a peaceful compromise that allows the community to have their peace and allows players to play without having to alter their gameplay. Also, these tests were done using 40 hole pickleballs, 32 hole pickleballs might have different results. However, now knowing the cause of the loudness, as long as the ball is the same material it should not matter that much.

Hopefully, my pickleball design can end the conflict between pickleball players and their communities.

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