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P2_3 "We Scare Because We Care"

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Abstract

In the *Disney Pixar*^{TM} film, *Monsters, Inc.*, it is stated that *laughter has ten times the energy of screams*. We investigated this claim and found, that even with laughter lasting longer than screams, the higher decibel level of screams allowed them to produce more energy than laughter by a factor of 8000.

Introduction

Monsters, Inc., the *Disney Pixar*^{TM} animated film from 2001, portrays a world in which the energy source is children's screams. The film focuses on the monster pairing; Sulley, the *Scarer*, and his coach, Mike. It is the job of the *Scarer* to enter a child's bedroom whilst they sleep and scare them in order to obtain their screams, which are then stored in *Scream canisters*. At the end of the film, Sulley says to Mike, "laughter has ten times the energy of screams" [1]. We will investigate whether this claim is true.

Theory

Sound levels are measured in decibels, dB. They can be converted into intensity, of unit Wm^{-2}, using Equation (1) [2].

$$I = I_0 10^{L_1/10} \tag{1}$$

Where L_1 is the decibel value of the sound and I_0 is the background reference intensity in Wm^{-2}. The standard reference intensity is usually taken to be 10^{-12} Wm^{-2} [3].

The decibel range of a scream from a child aged between 9 months and 6 years is $99-120$ dB [4]. If we assume the highest level is reached due to a monsters roar, the intensity of this sound is 1 Wm^{-2}. Similarly for a childs laughter, the range is $60-65$ dB [5]. Taking the higher limit results in an intensity of 3.16 x 10^{-6} Wm^{-2}.

To obtain the power, we required the surface area of the cylindrical canister, Equation (2).

$$A = 2\pi rh + 2\pi r^2 \tag{2}$$

Here, r is the radius of the canister and h is the height.

The numerical values we used were based off reference images of Mike next to the 2 year old character, Boo. The average height of a 2 year old is roughly 86 cm [6] and Mike is slightly taller than her and of a similar height to the canister, so we assumed the canister to be of height 1 m. When seen in stills from the movie, the canister diameter seems to be similar to the span of a hand, thus the radius was taken to be 0.1 m [7]. These values give a surface area of 0.69 m^2. The power obtained from screams and laughter is then 0.69 W and 2.18 x 10^{-6} W respectively.

Discussion

When we were considering this problem, we agreed that a situational based approach would

allow for a more realistic answer. We considered the time it would take for a parent to intervene upon hearing their child either screaming or laughing.

It was estimated that a parent's reaction time to screaming would be 15 seconds. It is also assumed, for this analysis, that the scream begins at the start of the monster's roar. By contrast, according to a parenting site [8], if a child is heard laughing (or talking to themselves) during the night, intervention should occur after 20 minutes, allowing the child to self-sooth first. However, it is unrealistic to expect laughter to be continuous for this time period, so it is assumed that 10 minutes would be spent laughing, whilst the remaining 10 minutes would be the child catching their breath.

The time period spent creating either of these sounds is important as it is required in order to calculate the energy produced; Equation (3).

$$E = Pt \tag{3}$$

Where E is the energy in joules, P is the power and t is the time in seconds.

Conclusion

The energy from the childs scream is calculated to be 10.35 J in comparison to 1.31 x 10^{-3} J from laughter. In reference to the claim made in the movie, laughter does not produce 10 times more energy than screams. It in fact generates approximately 8000 times less energy.

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