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Puffball Bibble and magical voice-altering berries

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Abstract
In Barbie's Mermaidia, the 7th Barbie film, we see Barbie, also known as Elena, exploring the treacherous and unknown underwater environment of Mermaidia [1]. In her quest to find the famous 'Immunity Berry' which supposedly makes the consumer of the berry immortal, she is accompanied with her puffball sidekick, known as Bibble. In their quest, they come across an underwater magic sea fruit cavern, where Bibble finds himself amazed by the collection of fruits and berries and starts eating them one by one. These mystical fruits are able to change his voice which later helps the duo retrieve the Immunity Berry from goblins. This paper delves into the science behind the voice altering effects of these magical fruits on Bibble's voice.

Keywords: *Film; Biology; Physics; Acoustics; Voice Alteration; Barbie: Mermaidia*

Introduction
In the underwater world of Mermadia, Bibble's ability to alter his voice after consuming the fruits from the underwater garden captivates both imagination and curiosity. This paper aims to understand the mechanisms underlying Bibble's vocal versatility by examining potential scientific explanations and embracing the charm of Mermadian lore.

Factors affecting Bibble's vocal range:

- The environment in which Bibble eats the fruits. We will treat this medium as air to make it simpler and also because of the fact that Mermaidia is a fantasy underwater land where the possession of or eating of a fruit enables mammals to breathe underwater [1]. For simplicity, Bibble is considered a mammal in this paper.
- Biochemical interactions – The berries consumed by Bibble could contain compounds that temporarily affect the vocal chords of muscles involved in producing speech. These compounds might alter the tension or flexibility of the vocal chords, leading to changes in pitch, tone or resonance.
- Neurological influence – The compounds in the berries could also have effects on the neurological signals that control vocalisation. By affecting the brain's communication with the muscles involved in speech production, the berries might enable Bibble to manipulate his voice in various ways.

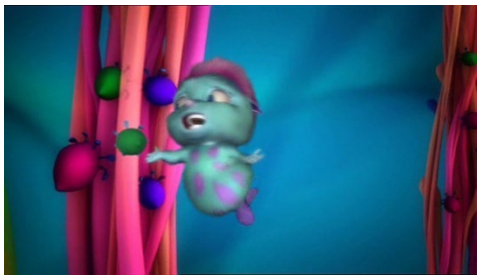

Figure 1 – Depicting Bibble breaking into song after eating one of the fruits (berry in this case) in the magic sea fruit cavern [2].

Biochemical Interactions
In the movie, Bibble's voice travels through a range of different pitches [1]. After eating each kind, he is able to perform a variety of things with his voice, such as, master the range of an opera singer, sing to his heart's content as a yodeller, and go as deep as humanely possible, much to Elena's surprise [1]. As mentioned before, compounds found in the fruit could possess characteristics that temporarily modify the tension, elasticity, or vibrational patterns of Bibble's vocal cords. These in turn induce shifts in Bibble's voice, resulting in change in pitch, tone, or resonance. The figure below depicts different pitches that Bibble is able to reach.

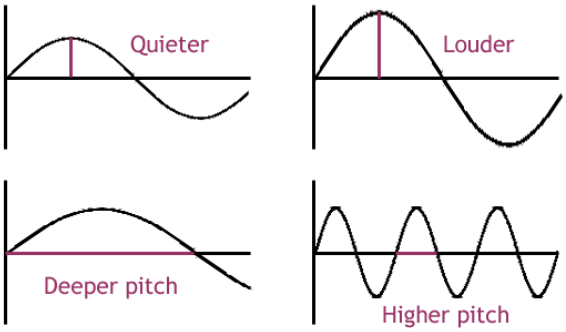

Figure 2 – Depicting the range of pitches as waves [3]. Note the bottom right image denoting higher pitch also denotes a higher frequency.

The predicted frequencies of Bibble's vocal sounds undergo a remarkable transformation after consuming the magical fruits. Initially falling within a range of about 100 Hz to 300 Hz [4], his voice expands dramatically. Hz represents Hertz, which is the unit of frequency, measuring the number of cycles per second in a periodic phenomenon such as sound waves. We assume this value as Bibble sounds like an infant with a high-pitched voice [1]. He reaches opera singer-like frequencies of 200 Hz to 1000 Hz [5], yodeller ranges of 150 Hz to 600 Hz [6], and even achieves depths as low as 50 Hz to 200 Hz as his voice goes changes after consuming a type of fruit.

The compounds mentioned before might interact with receptor sites on the surface of vocal cord cells, triggering intracellular signalling pathways that modulate the expression of genes involved in muscle contraction, elasticity, and tension regulation. Additionally, they could affect the production or activation of key enzymes and proteins involved in vocal cord function, such as those responsible for maintaining structural integrity or facilitating neurotransmitter release at neuromuscular junctions. The compounds present in the berries might also have a direct effect on Bibble's nervous system, particularly the neural pathways involved in vocalisation.

Neurological Influence:

Compounds found in the fruit could also possess the ability to cross the blood-brain barrier and interact with neurotransmitter receptors or neural pathways involved in speech control. Such modulation could enhance Bibble's vocal range and precision by fine-tuning neural dynamics and influencing perception, memory, and attention. This neurological stimulation could also result in heightened sensitivity and responsiveness of the vocal cords, allowing Bibble to modulate his voice with greater precision and expressiveness. The figure below demonstrates the neuroscience of human vocal pitch. The dorsal laryngeal motor cortex is The dorsal laryngeal motor cortex (dLMC) is a region of the brain that is involved in controlling the muscles responsible for voice production, particularly those related to the larynx (voice box) [7]. It specifically plays a role in coordinating the movements of muscles involved in phonation, pitch modulation and other aspects of vocalisation [7].

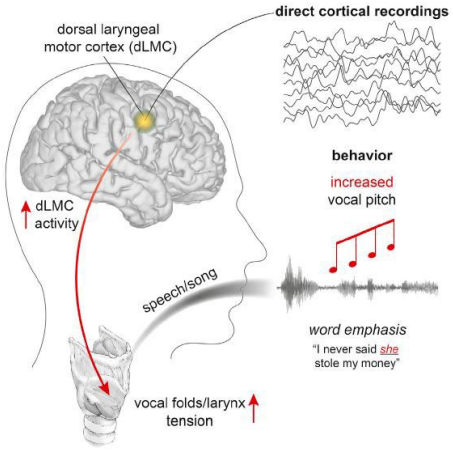

Figure 3 depicts how the human dorsal laryngeal motor cortex encodes the ability to control vocal pitch during both speech and singing [7].

Instead of the berries directly changing his vocal cords, they could be affecting the signals that the dLMC sends to the muscles controlling vocal folds and larynx tension. This results in alterations in the tension and coordination of these structures, thus allowing Bibble to produce different vocal pitches and qualities. Furthermore, the berries could enhance the activity or the plasticity of the dLMC, leading to an extremely improved control over vocal pitch modulation which enables him to sing like an opera singer.

Conclusion

In conclusion, analysing biochemical and neurological factors reveal how Bibble's vocal versatility arises. Biochemical interactions modify vocal cords directly, while neurological influences enhance vocal control, by modulating signals sent from the dorsal laryngeal motor cortex to the muscles involved. These interactions between the biochemical compounds and neurological processes enable Bibble's voice to undergo remarkable changes.

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