

聲響遊樂場



Sonic Playground

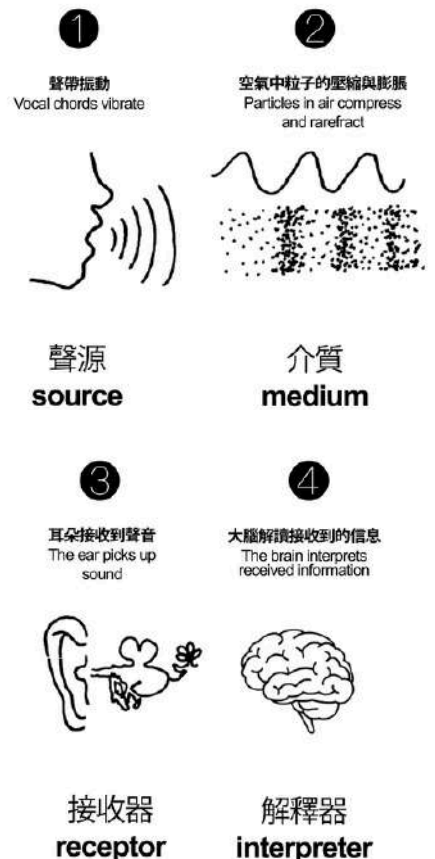
漫遊榕樹廣場

徐亞英，我已故的祖父，他熱愛以簡單且有趣的方式和所有人分享他對聲學的熱情。從我小時候起，他就鼓勵我透過遊戲的方式，細心觀察周遭環境，培養對聲音與空間互動的敏銳度，特別是聲音如何和空間產生互動。他曾告訴我，當時和建築師法蘭馨·侯班合作，在設計榕樹廣場的聲學時，他選擇決定強調並展現這片空間的聲學挑戰，而非試圖將它隱藏起來。他希望大家能將這個空間視為一個聲響遊樂場來欣賞，並細細品味。這個工作坊的靈感正是受到他的願景啟發，我們將一起探索這個公共空間迷人的聲學特性。希望你們可以像他所期望的那樣，享受其中的聲學樂趣。祝大家玩得開心!

A soundwalk through the Banyan Plaza

Albert Yaying Xu, my late grandfather, loved sharing his passion for acoustics in a simple and engaging way with everyone. Since I was little, he encouraged me to become more aware of my surroundings—especially how sound interacts with space—by observing and engaging with my environment in a playful manner. He once told me that, together with architect Francine Houben, he chose to celebrate and enhance the acoustic challenges of Banyan Plaza rather than conceal them. He expressed his hope that people would enjoy this space as a sonic landscape. This workshop is inspired by his vision, exploring the fascinating sonic qualities of this public space. I hope you enjoy it as much as he would have wanted. Have fun!

從聲波到聲音 From wave to sound



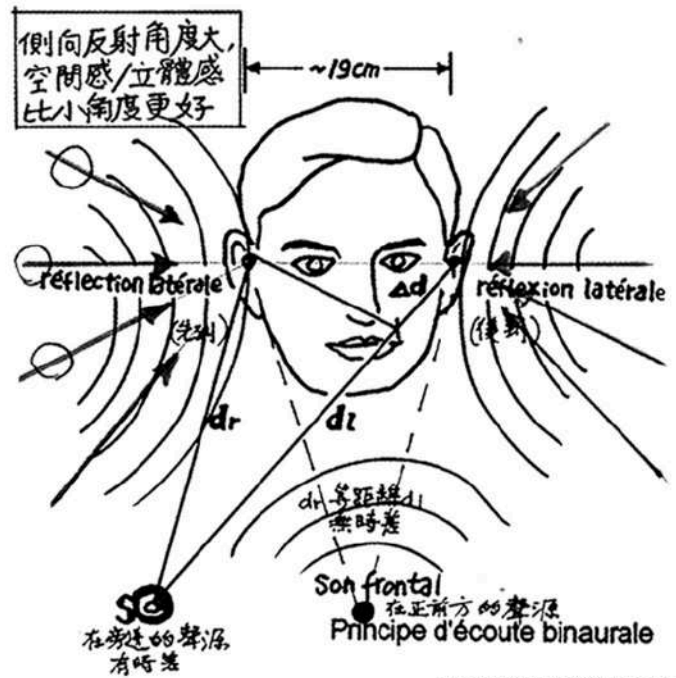
心理聲學

人類如何感知聲音的研究被稱為心理聲學。這門科學在我們的日常生活中有許多實際應用。在建築設計中，空間可以被設計成“乾燥”以獲得清晰的音效，“溫暖”以增強豐富度，或者“親密”以讓聽眾感到更貼近表演。徐亞英對心理聲學有著深厚的興趣。他經常與音樂家和指揮家合作，深入研究如何設計能夠增強音樂情感表達的空間。

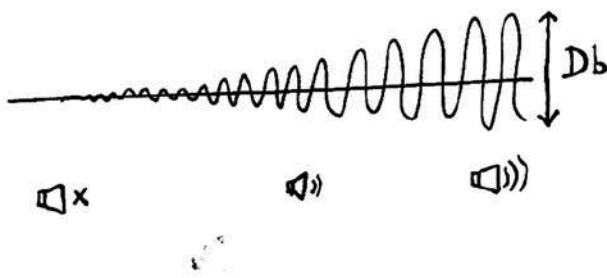
Psycho Acoustics

The study of how humans **perceive sound** is called psychoacoustics. This science has practical applications all around us. In **architecture**, spaces can be designed to sound “dry” for clear sound, “warm” to enhance **richness**, or “intimate” to draw the listener **closer** to the performance.

Albert was deeply fascinated by psychoacoustics. He frequently collaborated with musicians & conductors to study in detail how to design spaces that would **enhance** how their music can evoke specific **emotions**.



亞英關於雙耳聆聽的手稿
Drawing of binaural listening by Yaying



音量

聲音的「音量」是指它聽起來有多大聲。由空氣壓力的變化造成。表現在聲波圖中的振幅上。以分貝 (dB) 測量。

Volume

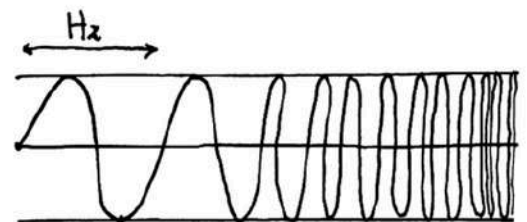
The “volume” of sound is how **loud** or **soft** it feels. It is caused by changes in **air pressure** and appears as the **amplitude** in a sound wave graph. It is measured in **decibels** (dB).

頻率

聲音的「頻率」決定了音調的高低，也稱為音高。它是由聲源振動的速度所造成的，並以赫茲 (Hertz, Hz) 為單位測量，表示每秒的波數。

Frequency

The “frequency” of sound is how **high** or **low** it feels, also known as the **pitch**. It is caused by the **speed of vibrations** in the sound **source**. It’s measured in **Hertz** (Hz), which the amount of waves per second.



殘響時間

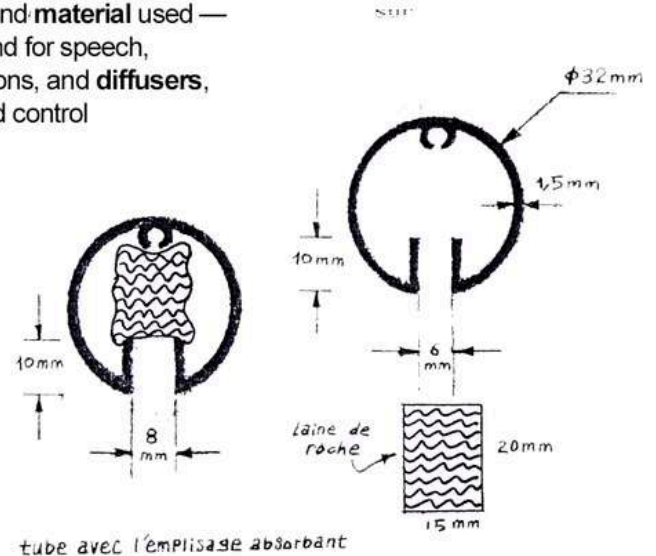
材料、形狀與尺寸

聲音在房間中的表現取決於空間的大小、形狀和所使用的材料，有點像設計一件樂器。為了確保聲音能夠被清晰的傳遞，空間可以使用窗簾和地毯等吸音材料來減少反射，並使用擴散器（通常可見於講堂和音樂廳）來散射聲波，從而控制殘響和回聲。出於設計考量，有時吸音材料和擴散器會被設計得不那麼顯眼，因為它們可能占用大量空間。徐亞英不得不找到方法來創造「隱形聲學」，發明新的材料和結構來「隱藏」它們，並同時保持其功能性。

Material, shape & size

How sound will behave in a room will depend on the **size**, **shape** and **material** used — a bit like when designing a **music instrument**. To ensure clear sound for speech, spaces use **absorbers** like curtains and carpets to minimize reflections, and **diffusers**, often seen in lecture and concert halls, to **scatter sound waves** and control reverberation and echoes.

Sometimes, for design reasons, absorbers and diffusers are made less noticeable, as they can take up a lot of space. Yaying had to find ways to create “invisible acoustics,” inventing new materials and structures to “hide” them while maintaining their effectiveness.



亞英隱形吸音材料的原型 (巴黎羅浮宮)
Prototype of Yaying's invisible absorbers (Louvre, Paris)

殘響

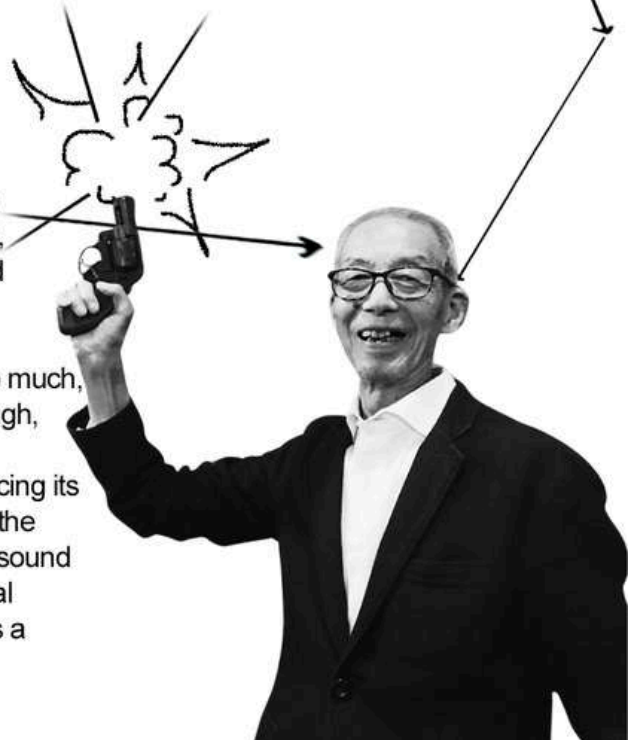
每當徐亞英進入一個空間時，他都會透過拍手來估算殘響時間。拍手後，聲音會停留一段時間在表面反射，並混合成一系列的反射聲，這就叫做殘響。殘響對我們如何聽到和解讀聲音有很大影響。如果殘響過多，會模糊語音，使得單詞更難理解。如果殘響不足，一段浪漫的音樂可能聽起來不夠生動。在音樂廳中，殘響至關重要，它塑造了音樂的「感覺」，在經過精心設計時增強其豐富性和情感深度。

RT60是指聲音在聲源停止後衰減 60 分貝所需的時間，是設計空間時的重要參數。為了測量 RT60，徐亞英使用一把沒有子彈的槍來發聲，而不是拍手！

Reverberation

Everytime Yaying would enter a space, he would **clap** his hands to estimate the **reverberation**. Right after the clap, the sound **lingers**, bouncing off surfaces and **blending** into a mix of **reflections** called **reverberation**.

Reverberation affects a lot how we hear and **interpret** sound. If too much, it can **blur** speech, making words harder to understand. If not enough, a romantic piece of music could sound **unlively**. In concert halls, reverberation is crucial, as it shapes the way music **feels** — enhancing its **richness** and **emotional depth** when carefully designed. **RT60** is the time it takes for sound to decay by 60 decibels in a space after the sound source stops, indicating how long reverberation lasts and is a crucial parameter when designing a space. To measure RT60, Albert uses a sound gun instead of clapping (with **no bullet**, only **sound!**)

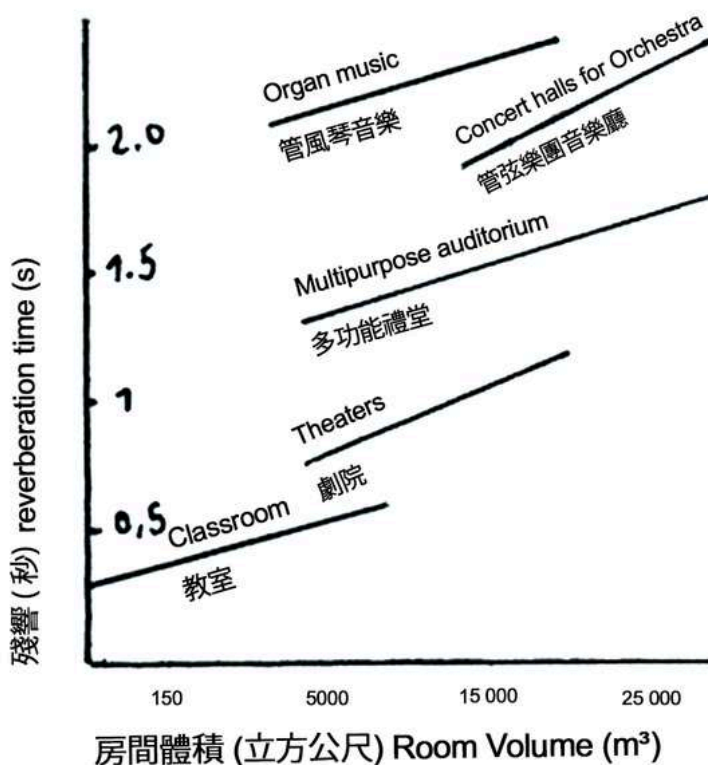
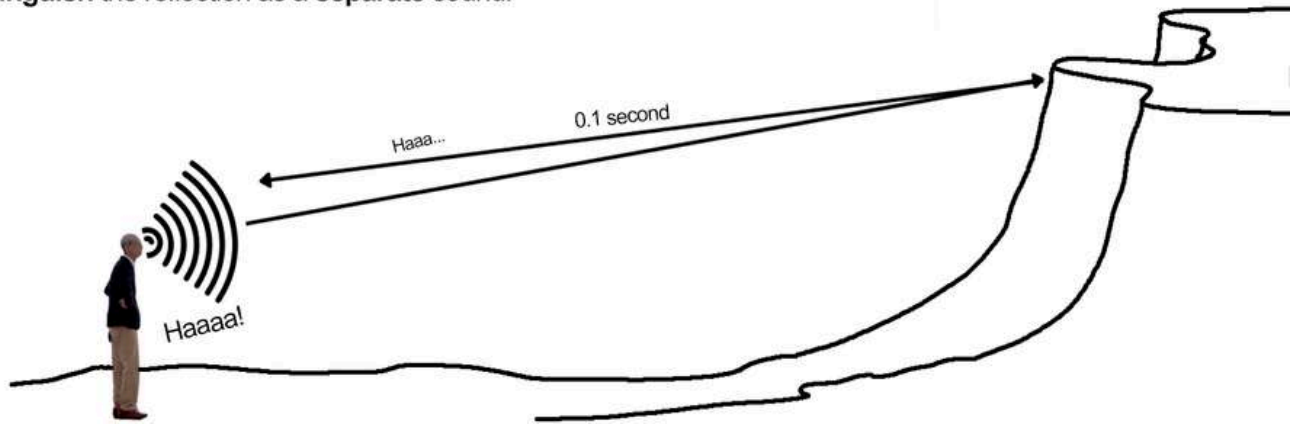


回音

你有沒有在山谷中喊叫過，然後聽到自己的聲音回響？回音是當聲波反射到一個表面後返回到聽者耳中，並作為一個清晰且獨立的重複聲音出現的現象。不像殘響，它是多個反射聲音的連續混合；回音是一個明確而獨立的重複。要產生回音，聲音需要有足夠的時間從表面反彈並傳回你的耳朵。反射的表面也必須是堅硬的，例如峽谷的牆壁或隧道的內部。為了能感知回音，反射聲音必須在原始聲音發出至少 0.1 秒後到達你的耳朵，這樣的延遲才足以讓你的大腦將反射聲與原始聲音區分開來。

Echo

An echo happens when a sound wave **reflects** off a **surface** and returns to the listener as a **distinct repetition**. Unlike reverberation, which is a **continuous blend** of **reflected sounds**, an echo is a **clear and separate repeat**. For an echo to occur, the sound needs enough time to bounce off a surface and travel back to your ears. The surface also needs to be **hard**, like the walls of a canyon or the interior of a tunnel. To perceive an echo, the reflected sound must reach your ears at least 0.1 seconds after the original sound. This delay is long enough for your brain to **distinguish** the reflection as a **separate sound**.

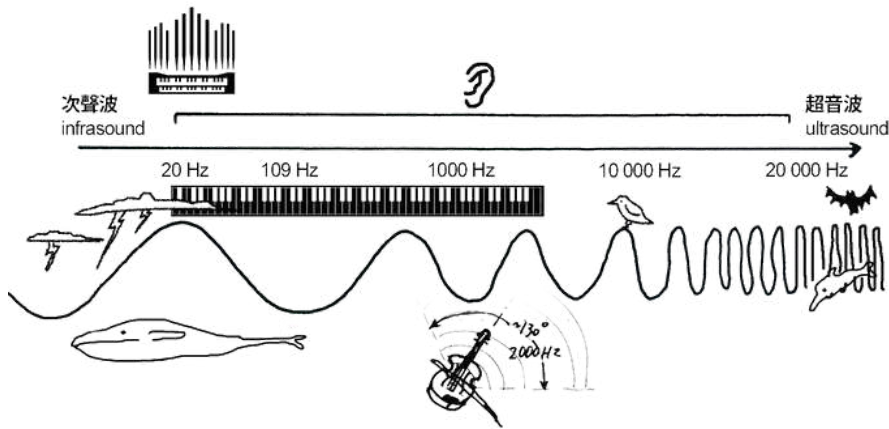


音樂

我們出生後過一段時間才開始能夠看見，但早在懷孕20週時，我們就已經能夠聽見聲音。聽覺是人類作為生命體最早發展的感官之一。從一開始，我們便伴隨著跳動的心臟成長，聆聽著懷胎者的聲音以及周圍環境中的其他聲音。這就是為什麼音樂成為如此強大的聯繫工具，能夠跨越文化與語言，穿越歷史歲月的原因。

Music

Our hearing is one of the **first senses** we develop as human beings. We begin to see only some time after birth — but we are able to hear as early as **20 weeks into the womb!** From the very beginning, we grow next to the sound of a **beating heart** — hearing the **voice** of the person carrying us and other sounds in our surroundings. This is why music is such a **powerful connector**, transcending cultures and languages throughout the years.



1

聲音的容器

注意空間的形狀、大小和材質。你觀察到哪些影響聲音呈現的可能要素呢？

Vessel of sound

Notice the shape, size, and materials of the space. What can you observe that might influence the acoustics?

2

深度聆聽*

在榕樹廣場時，你可以聽到多少種不同的聲音呢？

Deep listening*

How many different sounds can you hear while being in the Banyan Plaza?

3

玩樂與探索!

以下是一些建議，讓你可以遊玩並探索這個空間的聲學特性。如果你喜歡，也可以單純聆聽其他人的聲音。只要盡可能打開你的耳朵，放鬆身心，讓思緒隨著這次聲音漫步自由徜徉！

Play & Explore!

Here are some suggestions to play and explore the acoustics of the space. If you prefer, you can also simply listen to others. Just open your ears as wide as possible and let your mind & body wander freely on this sonic walk!

- 一邊走路一邊跺腳。
WALK WHILE STAMPING YOUR FEET
- 使用樂器即興演奏，或是彈鋼琴！
USE AN INSTRUMENT TO PLAY AROUND OR USE THE PIANO!
- 唱出你最喜歡的歌，想多大聲就多大聲！
SING AS LOUD AS YOU WANT
- 跑起來並大聲吶喊
SHOUT WHILE RUNNING
- 什麼聲音聽起來很近，但其實很遠？
WHAT SOUND APPEARS CLOSE BY BUT IS FAR AWAY?
- 站在廣場的正中央或靠牆，注意聲音的不同。
STAND IN THE MIDDLE OF THE PLAZA OR AGAINST A WALL AND NOTICE THE DIFFERENCE
- 發現空間中的回音
FIND THE ECHOS IN THE SPACE
- 模仿動物的聲音
MAKE ANIMAL SOUNDS
- 什麼聲音你能聽到，但看不到？
WHAT SOUNDS CAN YOU HEAR, BUT NOT SEE?

4

Trumpet

Listen to the trumpet player and follow him.

小號

聆聽小號手的演奏，然後跟隨他。



* 賈琳·奧利維洛，美國作曲家，創立了一種名為「深度聆聽」(Deep Listening) 的練習，這是一種通過專注而深入的聲音體驗來加深對環境的覺察與連結的練習。

* Pauline OLIVEROS, an American composer, pioneered Deep Listening, a practice of intentional and immersive engagement with sound to deepen awareness and connection to the environment.