sound and recording

Workshop by Milena Kipfmüller and Klaus Janek (sounding-situations.com) funded by Goethe Institut Kigali / institut francais hosted by RAI, Kigali on april 2019

DAY 1 - THEORY

What is sound? / How does sound travel?

Sound is the energy things produce when they **vibrate** (move back and forth quickly). If you bang a drum, you make the tight skin vibrate at very high speed (it's so fast that you can't usually see it), forcing the air all around it to vibrate as well. As the air moves, it carries energy out from the drum in all directions. Eventually, even the air inside your ears starts vibrating—and that's when you begin to perceive the vibrating drum as a sound. In short, there are two different aspects to sound: there's a *physical* process that produces sound energy to start with and sends it shooting through the air, and there's a separate *psychological* process that happens inside our ears and brains, which convert the incoming sound energy into sensations we interpret as noises, speech, and music. We're just going to concentrate on the physical aspects of sound in this article.

Sound is like light in some ways: it travels out from a definite source (such as an instrument or a noisy machine), just as light travels out from the Sun or a light bulb. But there are some very important differences between light and sound as well. We know light can travel through a vacuum because sunlight has to race through the vacuum of space to reach us on Earth. Sound, however, cannot travel through a vacuum: it always has to have something to travel through (known as a **medium**), such as air, water, glass, or metal.

more on https://www.explainthatstuff.com/sound.html

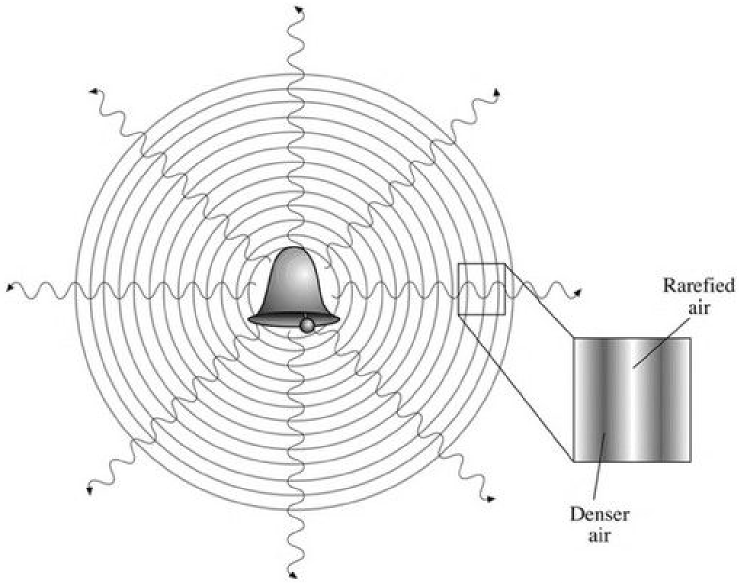


Figure 3.1 Sound waves in air are waves of greater or lesser air density.

graphic copied from: The Music Instinct: How Music Works and Why We Can't Do Without It - Philip Ball

What is music?

Sounds are all around us, from birds chirping and waves lapping against a coastline to cars honking in traffic. But sometimes sounds are put together in purposeful ways to create a specific atmosphere or to express ideas or emotions. Such organized sounds are called music.
Music is a collection of coordinated sound or sounds. **Making music** is the process of putting sounds and tones in an order, often combining them to create a unified composition. People who make music creatively organize sounds for a desired result, like a Beethoven symphony or one of Duke Ellington's jazz songs. Music is made of sounds, vibrations, and silent moments,

and it doesn't always have to be pleasant or pretty. It can be used to convey a whole range of experiences, environments, and emotions.

Almost every human culture has a tradition of making music. Examples of early instruments like flutes and drums have been found dating back thousands of years. Ancient Egyptians used music in religious ceremonies. Many other African cultures have traditions related to drumming for important rituals. Today, rock and pop musicians tour and perform around the world, singing the songs that made them famous. All of these are examples of music.

More https://study.com/academy/lesson/what-is-music-definition-terminology-characteristics.html

What is Listening? How does it work?

Many small neurons located in the brain are responsible for the processing of auditory information. By passing through various auditory pathways, the signals are decoded into sounds that we are familiar with and make sense to us.

Once the hair fibres of the cochlea, the snail shell-resembling organ of the inner ear, have sent electrical signals to the auditory nerve, these impulses are transferred to the auditory centre of the brain.

In the auditory brain, several groups of neurons receive the impulses and translate them into a language that our brain understands. This translation occurs in order to cause a conscious perception of the sounds that we receive.

The Auditory Brain

Transformation and processing of sound generally occurs on three levels in the brain: As a reflex, in the auditory cortex and in other brain areas.

Thus, the arrival of the message may first of all trigger a reflex and cause us to jump or turn our head. Thereafter, the processing might also unfold in the auditory cortex, where the sound is consciously perceived.

Other brain areas can allow the perception to become conscious as well and hence recognise the sound by relating it to those that have been memorised in the past. This assessment is followed-up by an appropriate voluntary response.

Primary Auditory Pathway

The processing of decoded sound material starts within the primary auditory pathway. This pathway carries messages from the cochlea to a sensory area of the temporal lobe called the auditory cortex.

First stop on this journey is taken in the brain stem, where a decoding of basic signals such as duration, intensity and frequency takes place. Subsequently, the message passes two additional relays that play an important role in the localisation of the sound.

The next stop occurs in the thalamus, an ovoid mass of grey substance situated at the base of the cerebrum. The thalamus integrates the sensory systems in the body and hence functions as an essential factor in the preparation of a motor response e.g. vocal response.

The last neuron of the primary auditory pathway connects the thalamus with the auditory cortex. At this stage the message has already been largely decoded. However, in the auditory cortex the signal is moreover recognised, memorised and may eventually result in a response.

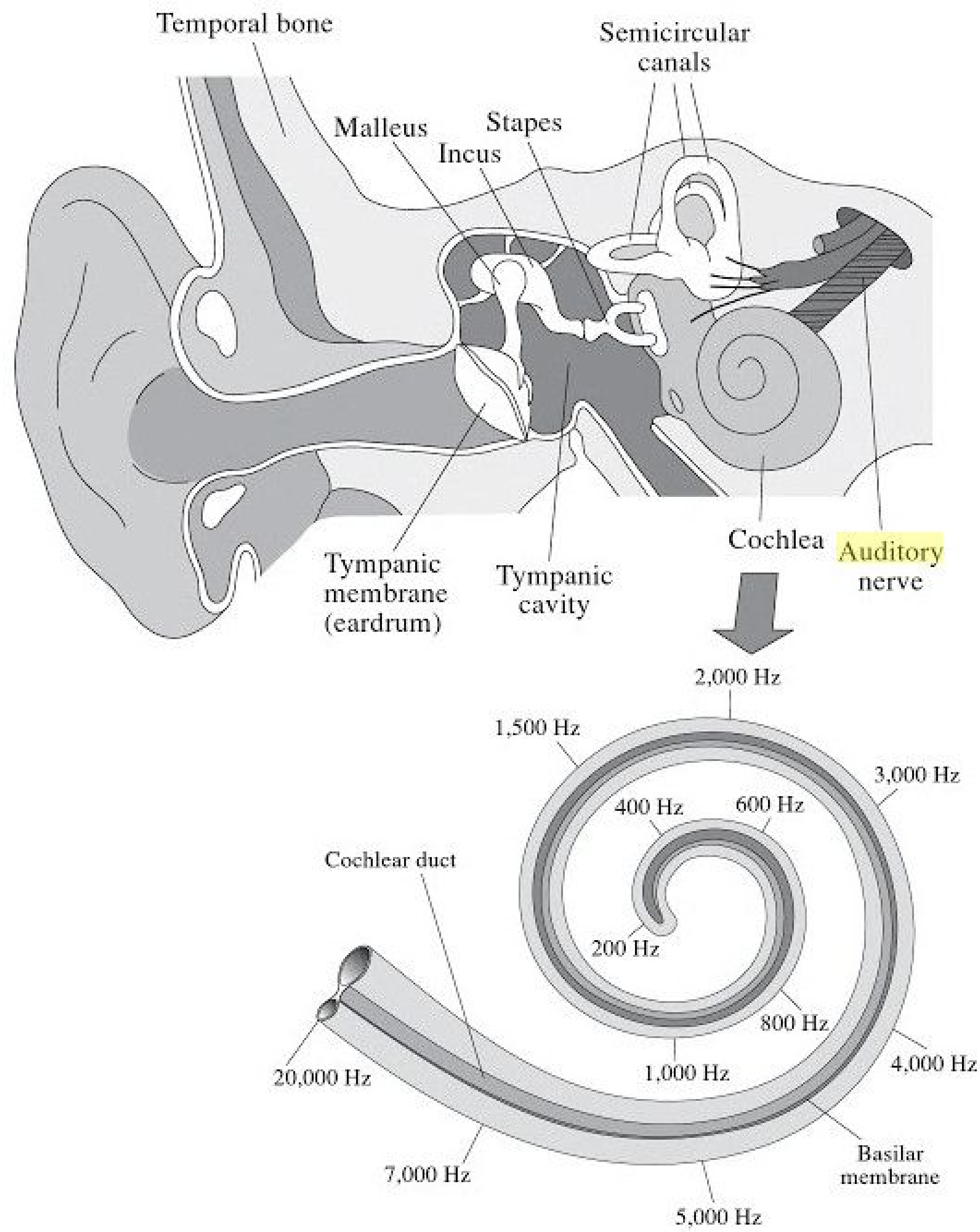
Non-primary Auditory Pathways

In contrast to the primary auditory pathway, non-primary auditory pathways process all sorts of sensory messages. The core function of these pathways is hence to choose the type of sensory message to be treated first. For example, when reading a newspaper while listening to the radio, this system permits the person to focus on the most vital task.

The processing of sensory data within the non-primary auditory pathways also starts in the brain stem. Hereafter, the auditory information passes through the reticular formation, a region in the brain stem consisting of more than a hundred small neural networks.

In the reticular formation, the information that should be treated as a priority is selected in accordance with the wake and motivation centers and further treated. Finally, the messages continue to the thalamus and end up in the sensory areas located in the cerebral cortex, the outer layer of our cerebrum.

More here https://www.hear-it.org/How-the-brain-processes-auditory-signals



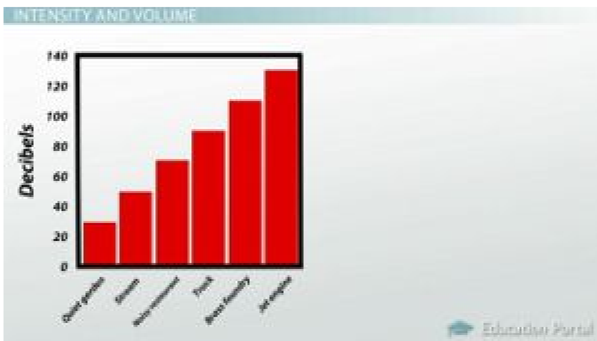
graphic copied from: The Music Instinct: How Music Works and Why We Can't Do Without It - Philip Ball

- (Milena) Biology : the sound – the ear – the head // the microfone – the playback – the spaeker

„auditive zero level“

The auditive perception seeks for a zero level: this means all hums and noises which are not relevant, because of its nature, and the fact that they can not / will not cause harm to the listener are “leveled” out of the consciousness. This in order to preserve the decoding attention to the evaluation of the potentially incoming emergency case.

What is Volume?



The energy in a sound wave has to travel over a certain area in a certain amount of time. We detect sounds as being louder when we're standing closer to the source and quieter when we're standing further away. The amount of energy we detect is known as the intensity. Intensity is measured in units of energy over the area and time. In other words, it's the amount of energy that is carried over a certain area in a certain amount of time. We describe different levels of intensity using the decibel scale, a logarithmic scale for measuring the intensity of sound waves. Normal conversation generally falls around 60 decibels. A whisper is more like 20 decibels, while a vacuum cleaner runs as loud as 80 decibels. You may be more familiar with decibels as a measure of volume. When talking about sound waves, the volume is the perception of loudness from the intensity of a sound wave. The higher the intensity of a sound, the louder it is perceived in our ears, and the higher volume it has. Since intensity is a function of energy, and energy is related to amplitude, then we can make the conclusion that the volume of a sound is proportional to the amplitude of the sound wave.

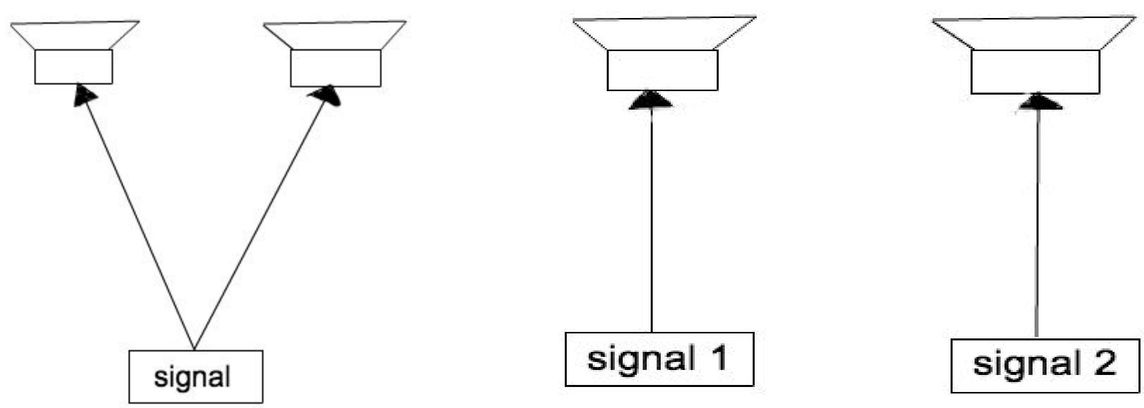
More here https://study.com/academy/lesson/pitch-and-volume-in-sound-waves.html

What is stereo / mono

The difference is in the number of channels (signals) used. Mono uses one, stereo uses more than one.
In monaural sound one single channel is used. It can be reproduced through several speakers, but all speakers are still reproducing the same copy of the signal.

In stereophonic sound more channels are used (typically two). You can use two different channels and make one feed one speaker and the second channel feed a second speaker (which is the most common stereo setup). This is used to create directionality, perspective, space.
Here is an example using a two speaker setup.

Mono Stereo



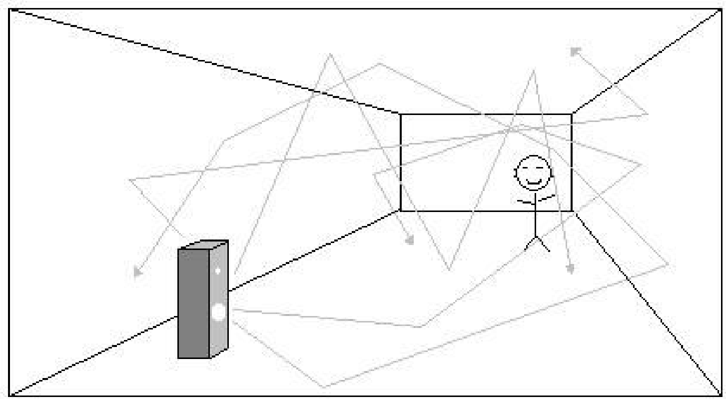
More technically, true stereo means sound recording and sound reproduction that uses stereographic projection to encode the relative positions of objects and events recorded.

In a common stereo setup of two channels: left and right, one channel is sent to the left speaker and the other channel is sent to the right speaker. Now, by controlling to which channel you send the signal you can control the position of the sound. You'll hear sounds coming from different directions depending on which speaker you send the signal to, or in which proportion (you can send just a little more to the right speaker, so the sound is positioned just a little bit to the right). Sounds with equal proportions on both speakers will appear to come from the center.

In other words, stereo opens the possibility of playing with sound localization.

More here https://music.stackexchange.com/questions/24631/what-is-the-difference-between-mono-and-stereo

room acoustics?



When a longitudinal sound wave strikes a flat surface, sound is reflected in a coherent manner provided that the dimension of the reflective surface is large compared to the wavelength of the sound. Note that audible sound has a very wide frequency range (from 20 to about 17000 Hz), and thus a very wide range of wavelengths (from about 20 mm to 17 m). As a result, the overall nature of the reflection varies according to the texture and structure of the surface. For example, porous materials will absorb some energy, and rough materials (where rough is relative to the wavelength) tend to reflect in many directions—to scatter the energy, rather than to reflect it coherently. This leads into the field of architectural acoustics, because the nature of these reflections is critical to the auditory feel of a space. In the theory of exterior noise mitigation, reflective surface size mildly detracts from the concept of a noise barrier by reflecting some of the sound into the opposite direction. Sound reflection can affect the acoustic space.

From https://en.wikipedia.org/wiki/Reflection_(physics)#Sound_reflection

The topic of room acoustics is complicated. In order to have a better understanding please check out this relatively simple explanation of what happens with frequencies in space: https://www.youtube.com/watch?v=JPYt10zrclQ
A big topic is the “market” of room optimizing products - this topic is discussed a lot on blogs. But just take in consideration, that easy ways to compensate “bad” room acoustics include placing of cloth, textiles, even record voices into the wardrobe in order to avoid the first reflection of sound wave (you place the microphone into the wardrobe facing out, so that the voice/ sound direction faces the inside of the wardrobe)

In general there are two possibilities to handle soundwaves inside a space:

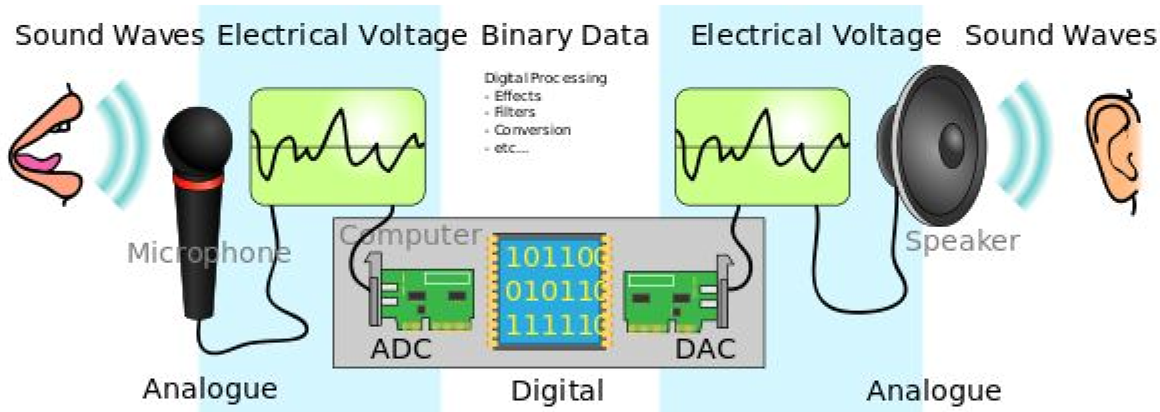
1. Control/avoid/limit the reflections (textiles, carpets, furniture, absorber, diffusors) in order to reduce reflections in the room
2. Reduce the quantity and volume of sound (for example use speakers on a low volume and reduce the distance from speaker to ear) therefor the developing mass of reflection.

In the linklist you will find the link to the gear slutz network, a community who is dedicated to distribute knowledge of effective and inexpensive recording and music producing gear.
8) WALK
9) Feedback

DAY 2 - TECHNICAL KNOWLEDGE OF RECORDING

1) Questions from yesterday?

From mouth to ear via gear



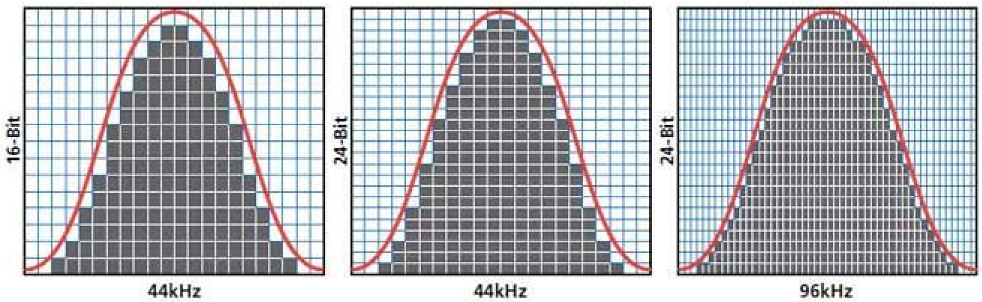
An analogue sound wave is picked up by a microphone and sent to an Analogue to Digital (ADC) converter in the form of analogue electrical signals. The ADC converts the electrical signals into digital values which can be stored on a computer.

Once in a digital format you can edit sounds with programs such as audacity.
To play digital audio you convert the sound from digital values into analogue electrical signals using the DAC, these signals are then passed to a speaker that vibrating the speaker cone, moving the air to create sound waves and analogue noise.

More here: https://www.explainthatstuff.com/microphones.html

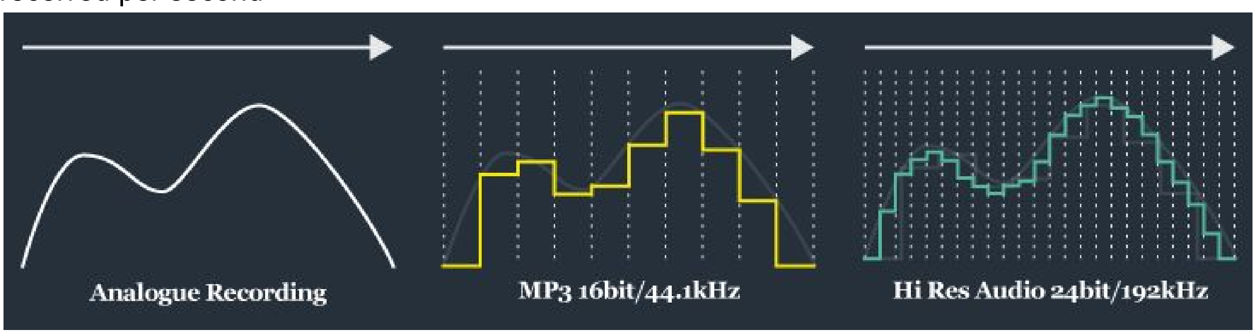
Air → Membrane → Electromagnetic Impulse → soundcard (tranformation into digital) → computer → processed → transformation into analog → Electromagnetic impulses → speaker (magnet moves membran) → membran moves air → air reaces ear → electromagnetic impulses reach brain.

Digital qualities



As bit depth and sample rate increase, more information is captured—resulting in higher-quality audio

Bit depth affects [bit rate]() and file size. Bits are the basic unit of data used in computing and digital communications. Bit rate refers to the amount of data, specifically bits, transmitted or received per second



High-Resolution Audio, or High-Res Audio, as you can probably guess, is audio signal that's delivered at a higher quality than the CDs, MP3s and streaming services.
CDs, for example, are only standardised at 44.1kHz/16bit while the most commonly used High-Res Audio specifications are 24bit/96kHz and 24bit/192kHz, providing a noticeable improvement in sound quality.
Downloaded music sold as high res is mastered as 24 bits in sampling rates up to 192kHz. The 'up to' in that sentence is important because 192kHz material is still generally very rare. Even studio masters of many albums are not produced at this level as the processing required and the size of the files just aren't going to be an option for most people! Albums mastered at 24/44.1, 24/88.2 and 24/96 are rather more common. Studios commonly work with these sampling rates so that the files are smaller and much more practical to download and stream via a wireless network. They might be compact but they still carry many times the information that a 16/44.1kHz sized CD file can.

16 bit / 48.000Hz

More here: https://www.cambridgeaudio.com/de/node/397

Different ways of recording digitally

Lavalier microphone to mobilephone on to an app

On a handheld recorder

On a computer through a soundcard

Different types recorders

If you search for a handheld recorder you will encounter brands like Sony, Tascam, Zoom, Olympus, Maranz, and many others. It is very complicated to find a product which suits you, due to the enormous choice somebody has. Take in consideration following thoughts:

1. The cheapest might not have the quality components what you are looking for, and might also not last that long vs the most expensive might have a famous name, which you pay as well.
2. Companies like Zoom tend to produce devices with many features, but the quality could be lacking. Please doulbe check on online test..
3. Think first hand what do you need from a handheld (build-in-microphones? Inputs for external microphones? Slot for external memory? ecc)
4. A big recommendation is to buy always a case to the handheld. The device will thank it to you and live double as long, as if you don’t have a case
5. Search for a device which is easy to handle (no double functions on nobs, a good leveling wheel)

Check for good tested devices. I just randomly found this test
https://www.wirerealm.com/guides/top-10-best-portable-recorders

Different recording apps for mobile phone

We can not give you any recommendation, because we are not using this system, but while checking it out for the Workshop we figured, that not all apps are made android and vice versa for IOS. The microphone brand Rode produces good Lavalier microphones for recording, but delivers them only with IOS apps and not for Android, but there is apps who accept the combination of Rode mic and android - but you have to search for it.

Different types of sound cards

There are a few general types of sound cards: internal, PCI cards and external cards.

Internal sound cards are the once every computer incorporates. Sometimes you have a 3.5 mm Mini Jack input and a same format output. This means it should be possible to attach a microphone to the computer, and attach speakers on to the output - this would be a very simple form of studio setting. Please notice that the sound cards in most of the time don't reach professional standards, but this system is good enough to be experimented with.

PCI card, are sound cards which are used in modular computer settings, like towers, minitowers ecc. You can buy different qualities of sound cards, also with break out boxes (boxes which incorporates the possibility of attaching more jacks, like 8 Inputs, 8 outputs for example)

External sound cards. In this field you will be amazed how many products are out there and for what enormous price ranges.. Just to give you a few names of companies specialized in sound cards: RME, Apogee, Motu, Presonus, Tascam, Fokusrite and many others. In general I would recommend to think about what you will really need and search for it according to it (how many inputs, how many outputs)
In most of the cases a cheap product means a decreased quality in the A/D D/A (Analog/Digital) transformers, but a high price could mean good transformers but also a famous brand name to pay for.. Again in this field I detected a company similar to Zoom in the handheld section, which delivers loads of features but a quality of components which has to be double checked on: Behringer.
There are many test blogs on external sound cards in the internet. Here again a random one to give you an example:
https://www.technobezz.com/best/top-best-sound-cards-music-production-buy/

Different types of microphones

Again the same though as in previous chapters, please check exactly what you need. In this case there is an important aspect to consider: if you are in audio/music production you should consider the fact, that investing in a microphone is to recommend. A good microphone (and using it in a good way) increases the quality of the work, and distinguishes a good studio from a mediocre studio. Also if you tread a microphone well, it will last you forever (it might be checked after 15 years) Again here the recommendation of buying with the microphone right away a case for it - microphones hate to be dropped on floors!!
Again a few brands what can be check out: Neumann, Schoeps, AKG, Sennheiser, Rode, dpa, Shure..

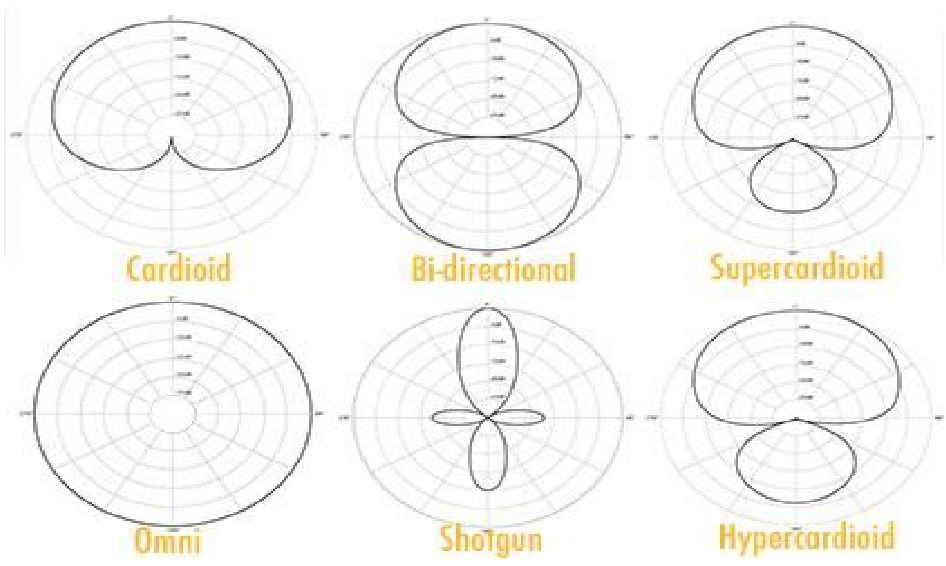
Mikrophone studies

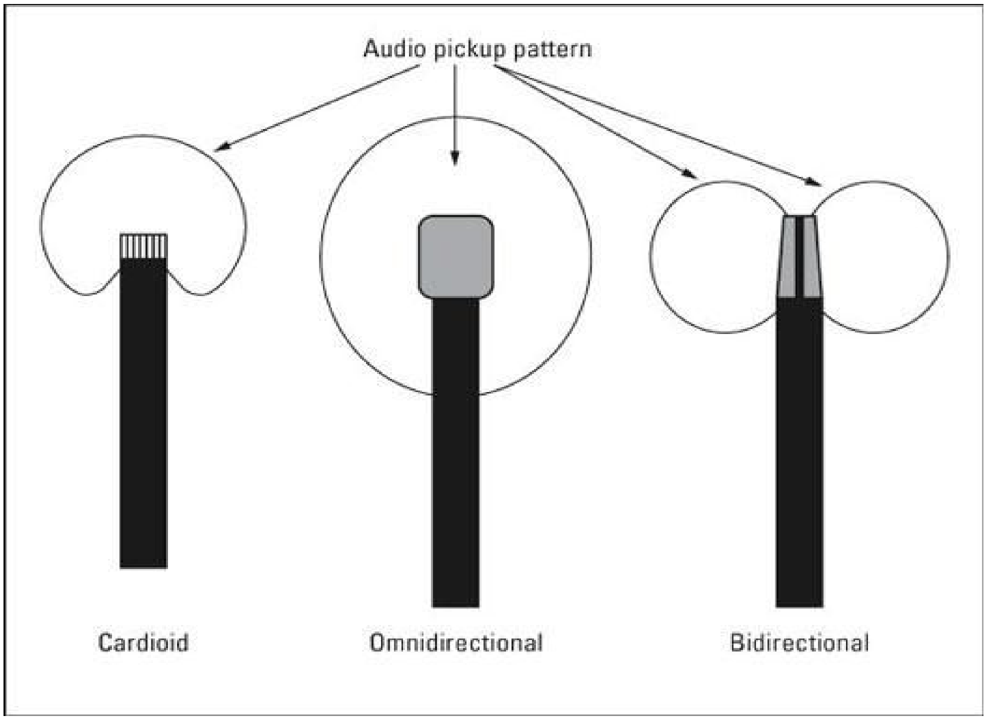
In general you divide two microphone categories:
Dynamic microphones and Condenser microphones

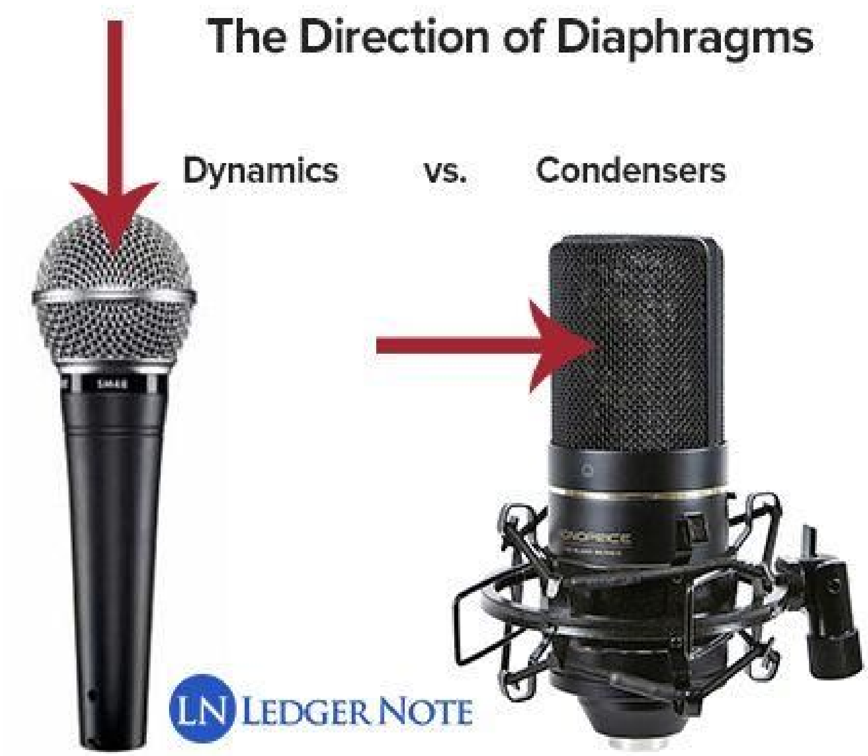
Dynamic microphones don't need an extra alimentation, and as a very general role you can use them for high volume inputs (trumpets, speeches..)
Condenser microphones are most of the time very sensitive and need an 48 V (phantom) alimentation, or might have a battery included.

A next level of categories divide microphones in normal and large diaphragm microphones. Most of the dynamic mics have small daphragma, the condenser have both types.

Another category of microphones talks about the sound caracteristics: we have following:

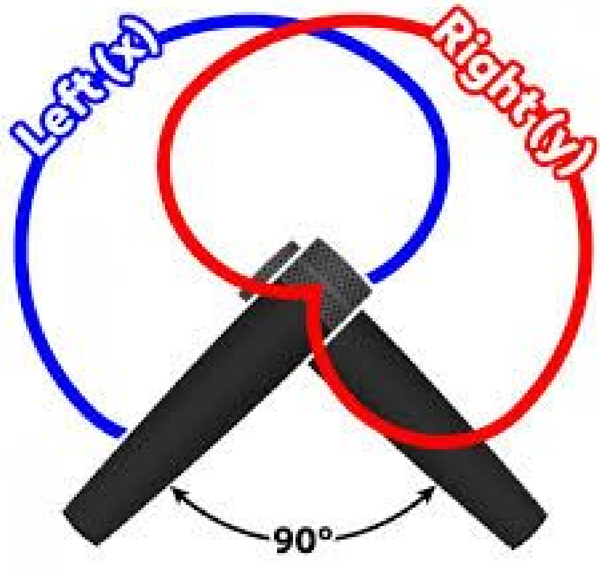


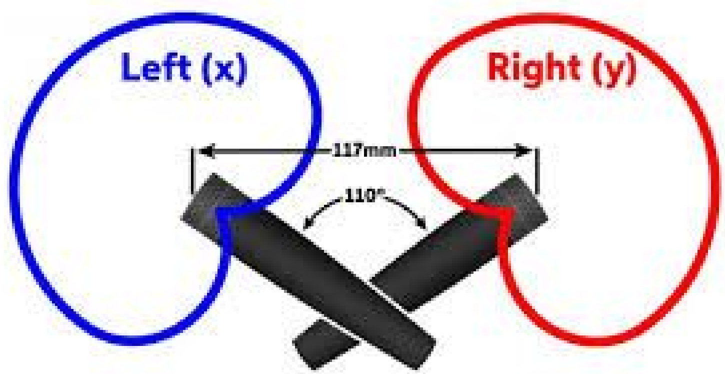


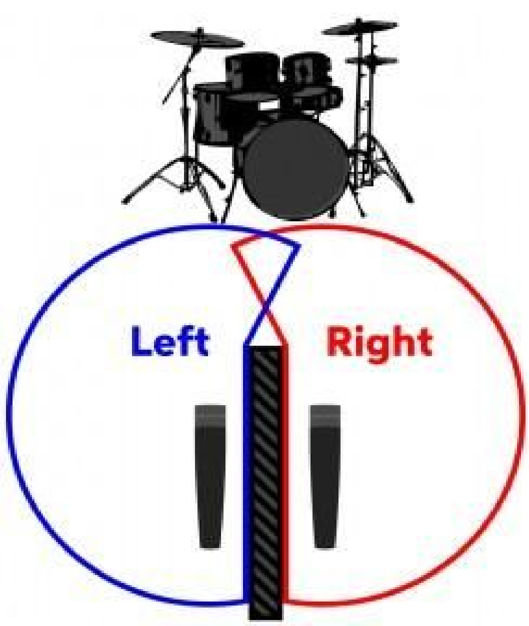


More here https://www.explainthatstuff.com/microphones.html and https://www.micreviews.com/info/how-microphones-work-and-their-parts

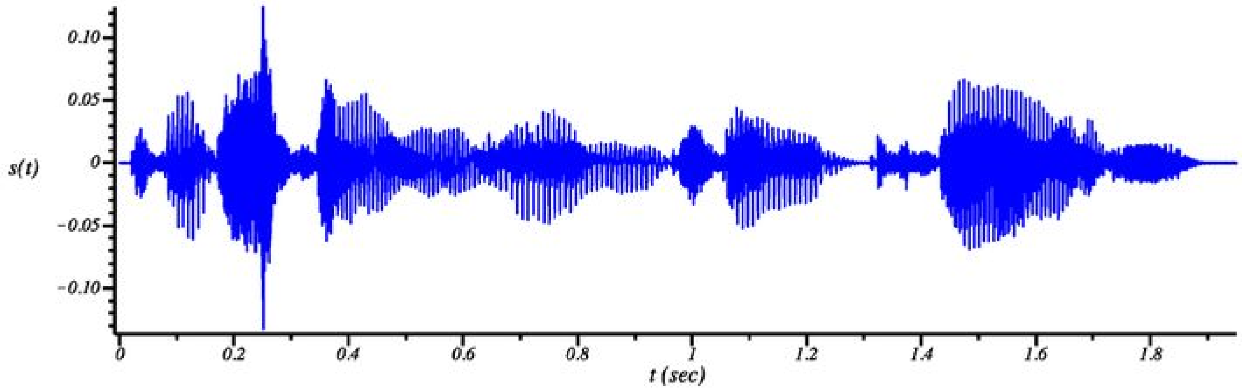
Different ways to record with a pair of microphones







Recording practice



1) Planning

who do I record? What is the persons characteristics and what equipment do I need and how do I gain the best interview results? Which content will be produced?
outside recording: windshild?, inside: Lavaliermicro, In public, privately at home, with his family, standing, walking, voice quality, social behaviour.. ecc

2) Preparation with equipmentcheck

Batteries, cable, adapters, windshield, microphones ecc

3) Set up on the place

- hello
- position/place
- microphone fixing/placement
- soundcheck of the recording (the interviewpartner speaks out long and as loud as it might go during the interview = a level is found and ideally not changed during the whole interview) and the listening (balance between the actual Headphone listening of the recording and the leveling on the meter)
    - RECORD (to be double checked)

Editing, Mixing, Mastering

A few examples of DWA softwares for editing:
Protools, Audacity (freeware), reaper (similar to protools but cheaper, around 60 US$)
(musicproduction softwares Logic, Cubase, Ableton and many more)

More here: https://www.howtogeek.com/howto/39681/the-how-to-geek-guide-to-audio-editing-the-basics/ and https://www.wikihow.com/Edit-Audio and https://manual.audacityteam.org/man/tutorial_editing_an_existing_file.html

These links will direct to audacity tutorials. The software is decent and amazing because of being for free. We recommend the software we are working with which is Reaper, but it is a personal taste. A software depends a lot if the user can relate to it regarding the workflow and functions.

In principle the **editing process** is the work of choosing files, "cleaning" them and assembling them chronologically. The **mixing process** levels the different samples and tracks, so that the all together can listen comfortable and joyfully. In this process you will equalize the different tracks - meaning balancing frequency sections so that the voice or instrument is highlighted on the frequency sections where information happens, and the other parts lowered. In this moment also other possibilities of increasing the quality of the track can be adopted: compressing, adding reverb, deesser and lots of other things. The mastering process works on the fact that the end product can be comfortably listen on all existing pa systems, like caraudio, homestereo, headphones ecc, and there are no big volume jumps.

Links

Sounding-situations.com website of Milena Kipfmüller and Klaus Janek
klaus-janek.de website of Klaus Janek
milenakipf.de website of Milena Kipfmüller
https://www.goethe.de/ins/rw/en/index.html funded the Workshop and DigiTales. Hosting the Tascam handheld device.
https://www.facebook.com/ifrwanda cofunded the Workshop and DigiTales, Hosting the Zoom handheld device.

Tutorial on analog to digital transformation
https://ehomerecordingstudio.com/digital-audio/

Audacity tutorial for beginners
https://www.youtube.com/watch?v=aCisC3sHneM

Forum for professional and amateur recording, mixing/mastering engineers to share techniques and advice. https://www.gearslutz.com/