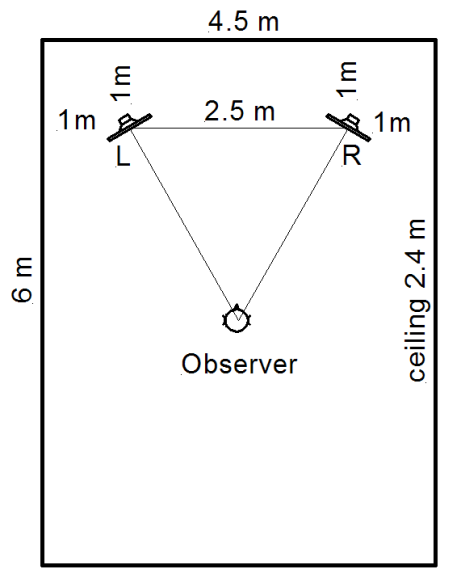
127th AES Convention, New York
October 9-12, 2009
Session P20: LOUDSPEAKERS IN ROOMS
P20-4: Siegfried Linkwitz

(Sound track: www.linkwitzlab.com/publications.htm)

The challenge to find the optimum radiation pattern and placement of stereo loudspeakers in a room for the creation of phantom sources and simultaneous masking of real sources




Two-channel playback in a normal living space can provide an experience that is fully satisfying. Loudspeakers and room disappear and the illusion of listening into a different space takes over.

I challenge the audio engineering community to scientifically verify, dismiss or refine what has been observed about the perceptual effects of radiation pattern and loudspeaker room placement

The optimum radiation pattern
for a loudspeaker and
the optimum placement of
two loudspeakers in a room
are not generally known and
understood

Radiation patterns are omni, dipole, bipole, directional and non-directional, or combinations thereof

Loudspeakers are placed in corners, on shelves, into the wall, against the wall, on stands, out in the room, etc.

Rooms are treated with absorbers, diffusors, are lively, dead, or in between

It all works to some degree

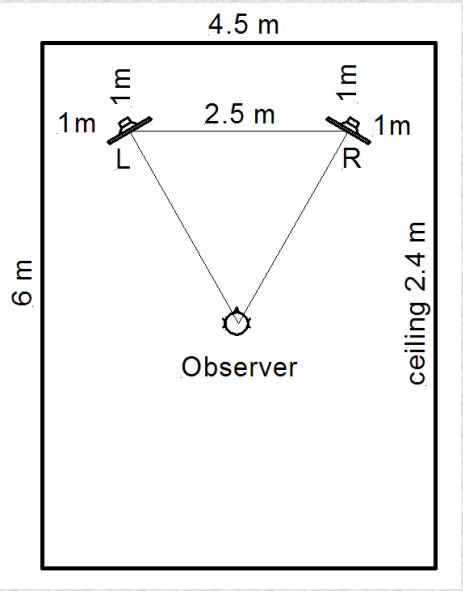
There is no clear choice, but agreement that:

A symmetrical loudspeaker setup is best for sound stage balance & phantom imaging

Electrostatic loudspeakers often excel in sonic detail, clarity and openness though they have dynamic range and placement problems

Rooms are problematic

The room is not the problem!
The loudspeaker's polar response is the problem!



Stereo is about creating an **Auditory illusion**

Anything that distracts from creating the illusion must be minimized

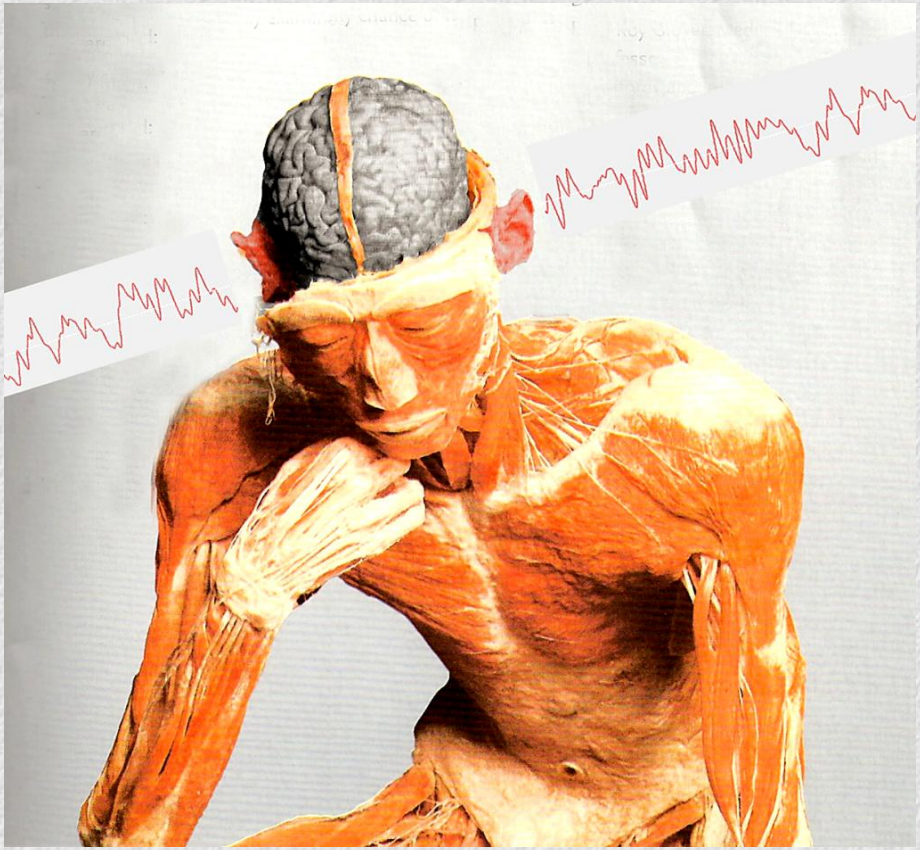
Auditory Scene

Hearing evolved in an environment with multiple sources and reflections

- Direction
- Distance
- Size

- Tracking
- Meaning
- Attention

Hearing happens between the ears, using:

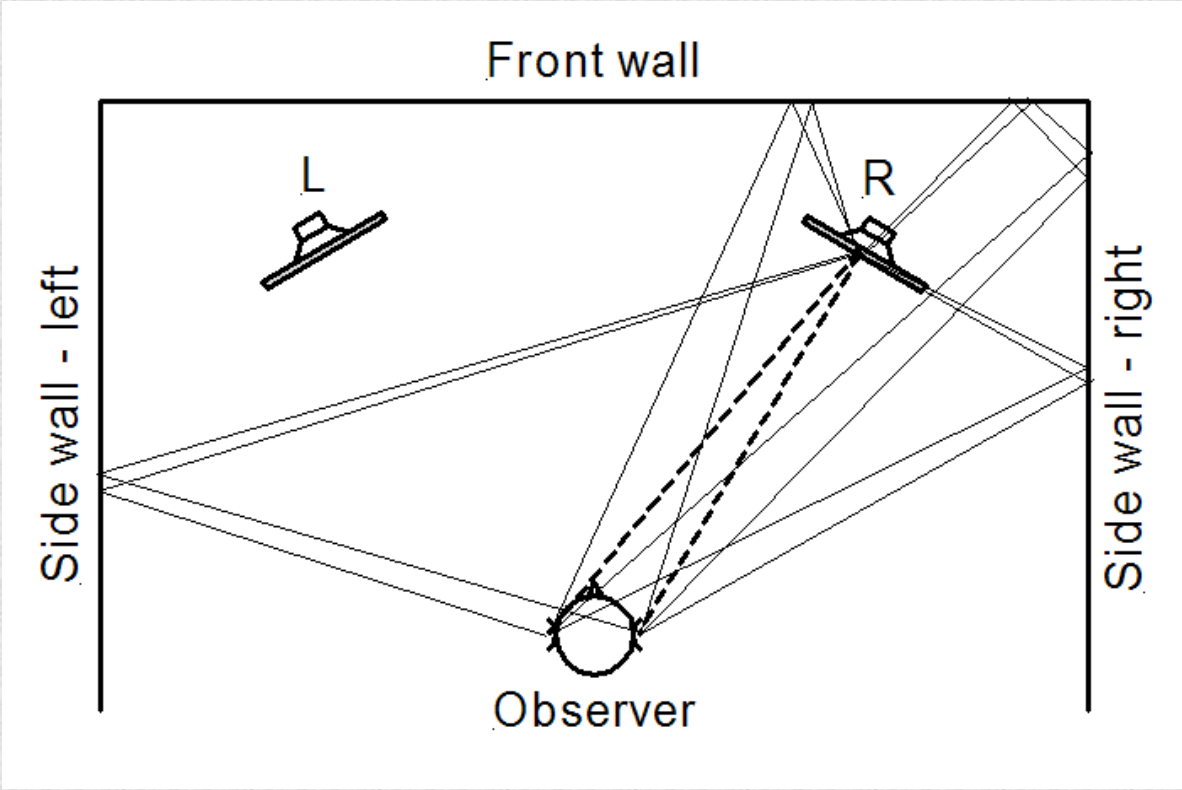


- Intensity differences
- Arrival time differences
- Envelope variations
- Spectrum masking

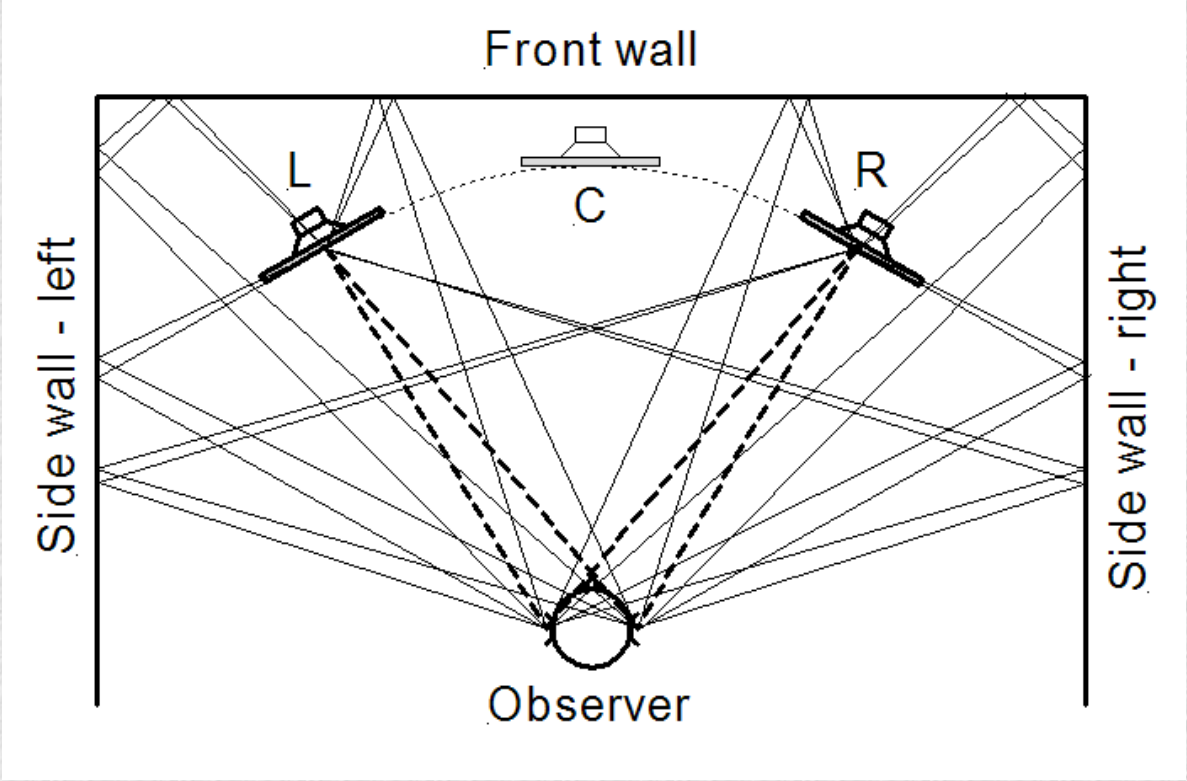
- Stream segregation
- Pattern recognition
- Attention
- Learning

Head movements
Tactile & visual inputs

A single loudspeaker in the room: A real source



Two loudspeaker in the room: Real and phantom sources



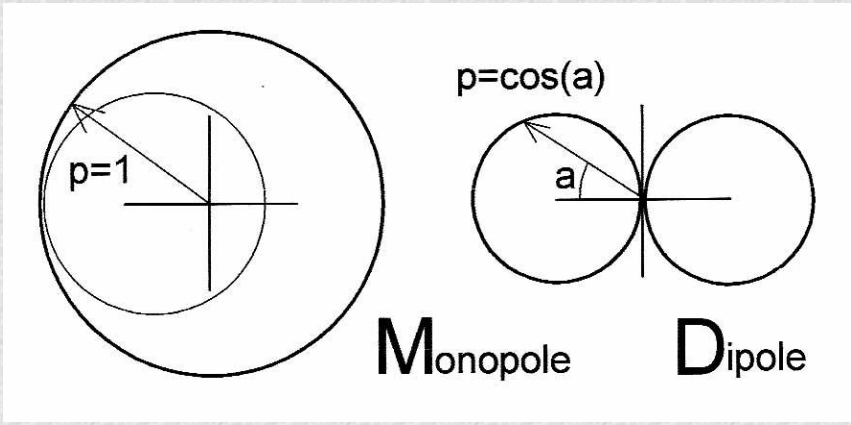
Observations after 30+ years of designing loudspeakers to please myself

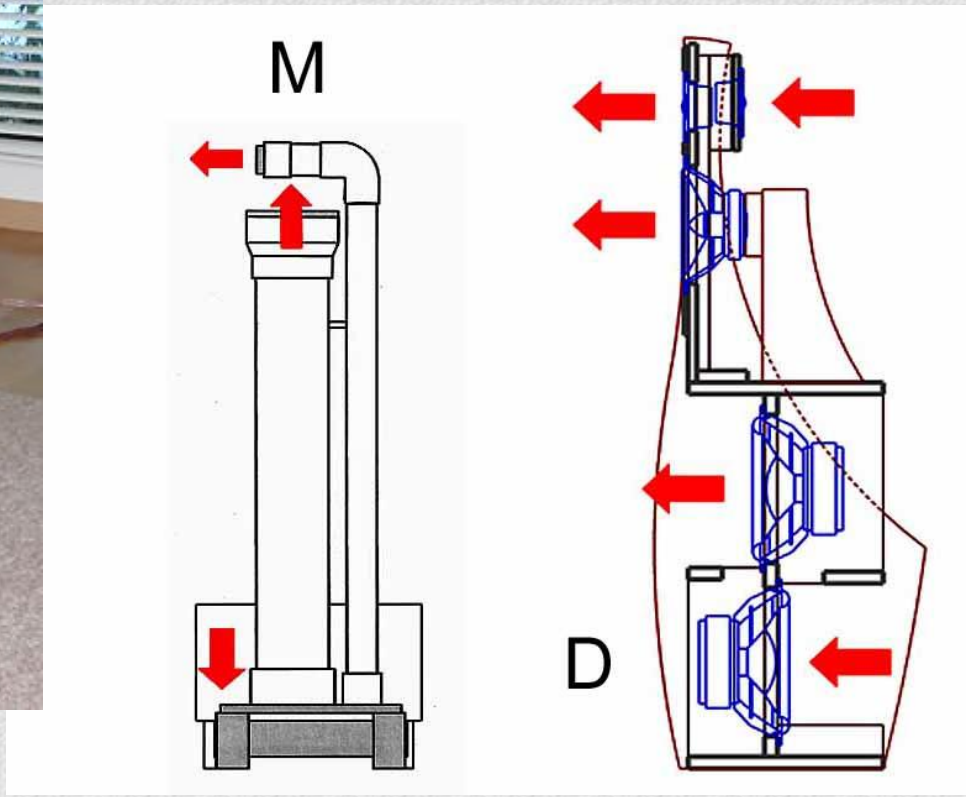
Dipolar and monopolar loudspeakers
sound almost identical in
spectral balance and clarity
despite their differences in measured
room response and burst response.

Phantom imaging is very similar, precise,
but with greater depth for the dipole.

Loudspeakers and room “disappear”

Two types of loudspeakers





POSTULATE #1

To minimize misleading cues from the room requires:

- Spectrum of reflections = direct sound
- Delay of reflections >6 ms ($\Delta l > 6$ ft)
- Symmetry of reflections rel. to direct sounds

POSTULATE #2

To optimally illuminate the room requires a frequency-independent polar response as from:

- Omni-directional loudspeakers
- Bi-directional, dipolar loudspeakers
- Uni-directional, cardioid loudspeakers

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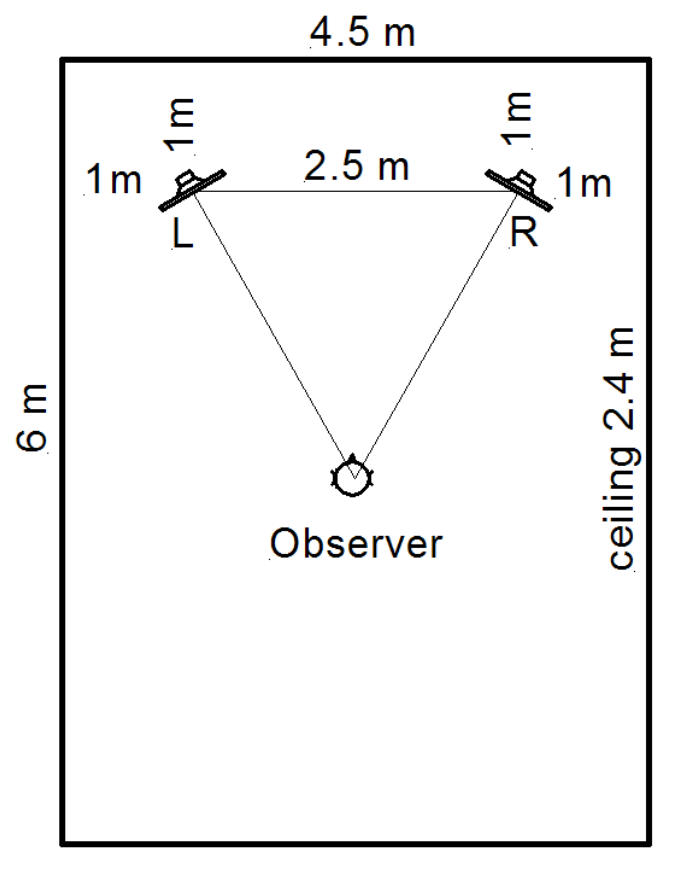
Test requirements



1. Room of at least 6 x 4.5 x 2.4 m
2. Dipole & box loudspeaker types
3. Tweeters at least 1 m from walls
4. Listeners familiar with acoustic sounds in closed/open spaces

Listener Qualifications

Able to listen for the naturalness of sounds rather than for particular preferences

Having auditory memory/experience of unamplified sounds

Able to recognize the naturalness of sounds in space (direct-reflected-reverberant in 3D)

The Task

For the specified setup and for the two loudspeaker types:

1 - Characterize the differences in phantom image creation and loudspeaker/room masking

2 – Determine the sensitivity of the results to loudspeaker placement closer to, or further away from the walls

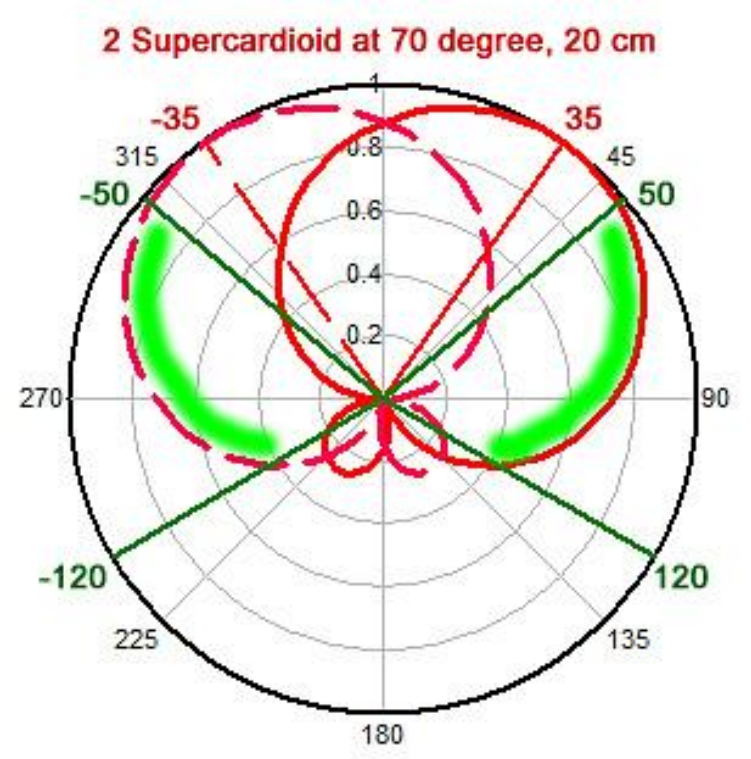
3 – Explain the results in psycho-acoustic terms

4 – Suggest improvements in the radiation pattern, implement them and verify their effectiveness

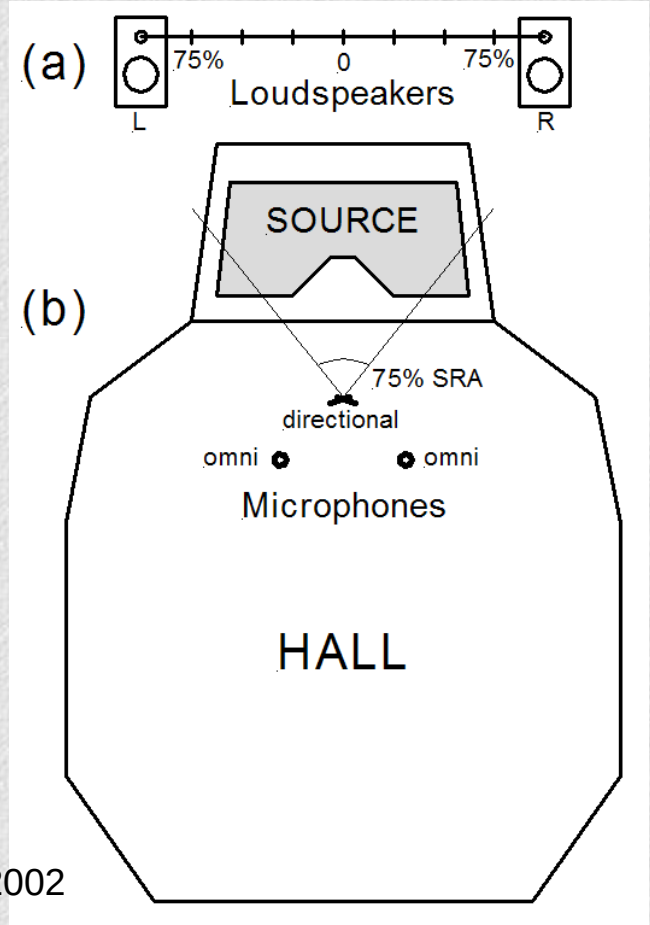
The need for sound recordings from a realistic perspective

Spatial cues about venue and orchestra

Mapping from Concert Hall to two loudspeakers



Stereo Recording Angle



H.Wittek, G.Theile, Munich AES, 2002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Thank you for your attention

Questions?