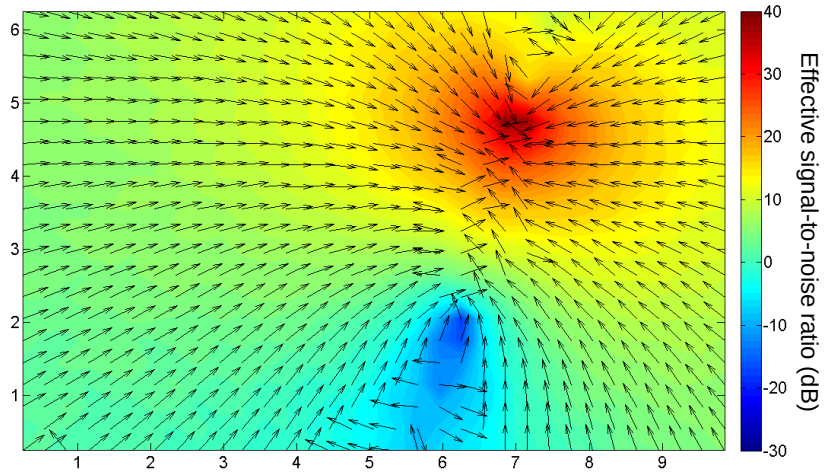
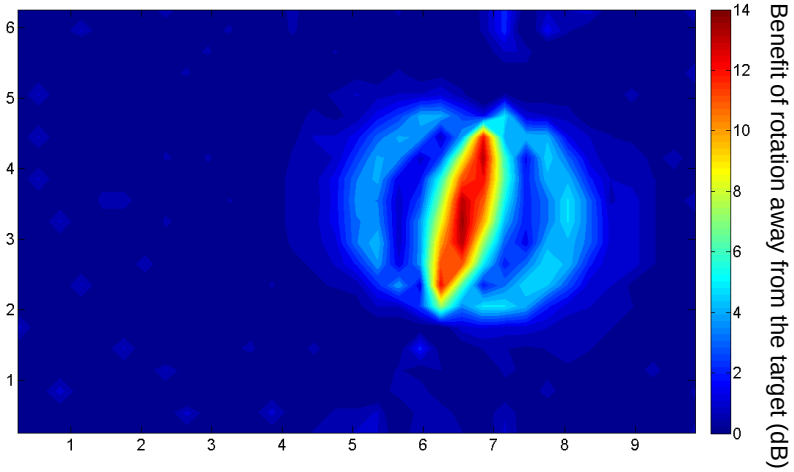
The importance of head orientation

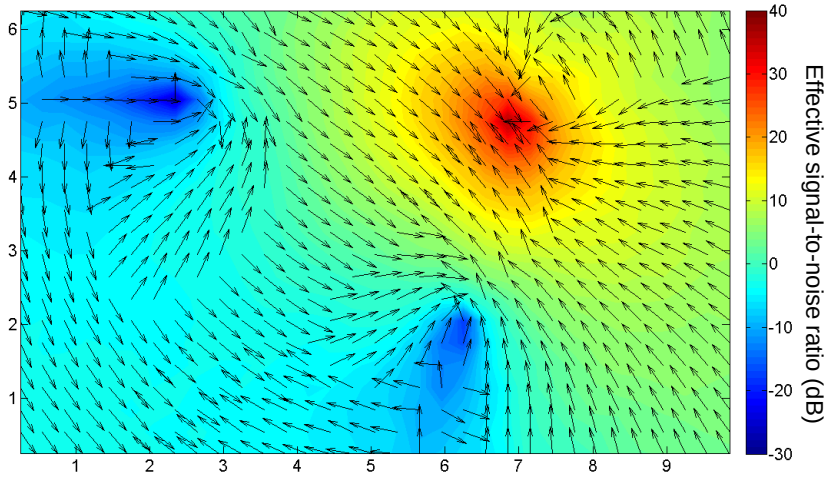
Optimum head orientation is not always to face the target…



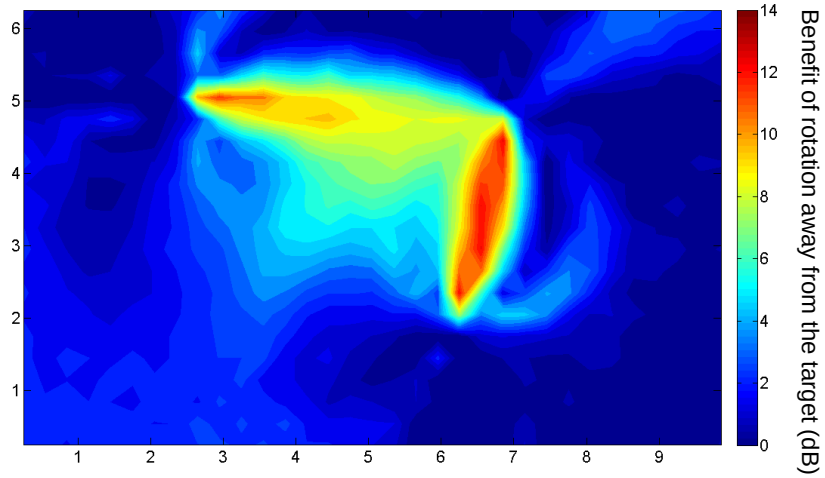
… and orienting the head can be very, very helpful.



With two noise sources, optimum head orientation shows a complex pattern...

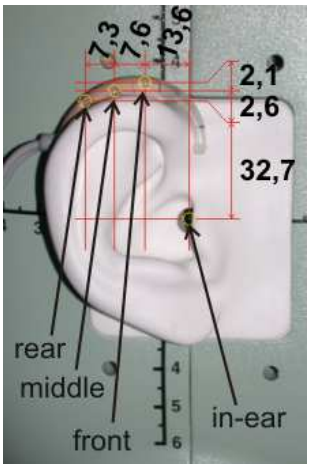


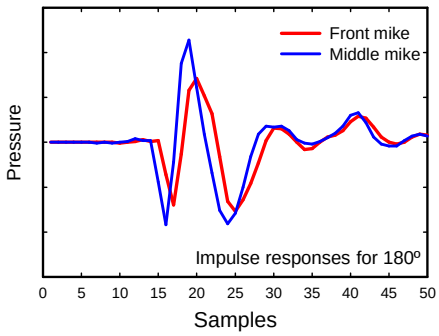
…and the effects are more widespread.



Application to directional hearing-aid microphones

The middle and front microphones on the Siemens Acuris hearing aid are 7.6 mm apart, which is close to 1 sample at 48 kHz (~7.2 mm).

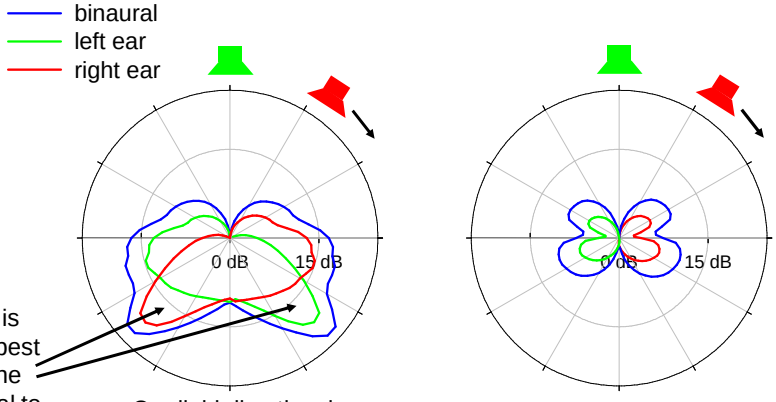




So, a crude simulation of a fixed cardioid response can be created by a one-sample delay to the impulse response of the middle mike and subtracting it from the impulse response of the front mike.

Predictions of spatial release from masking with a directional microphone: target in front

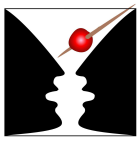
The fixed cardioid directional response (left) shows better spatial release from masking than the omnidirectional response of the front mike (right) when the masker is in the rear hemifield.



Curiously, it is sometimes best to listen to the ear ipsilateral to the masker.

Cardioid directional

Omnidirectional

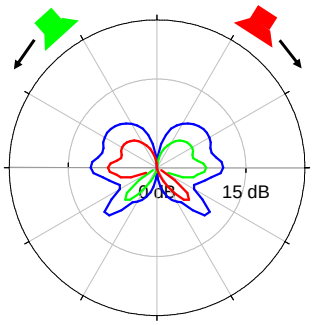


Predictions of spatial release from masking with a directional microphone: symmetrical configuration

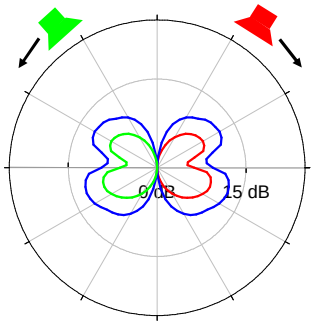
Even when the two sources are in the front hemifield, the omnidirectional response is now superior.

binaural
left ear
right ear

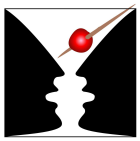
Head orientation can have a major influence on the performance of directional systems.



Cardioid directional



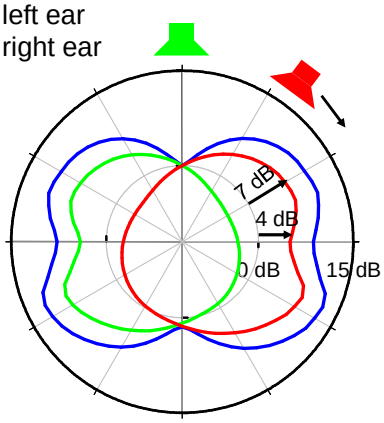
Omnidirectional



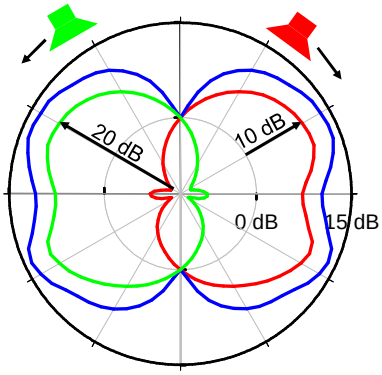
Spatial release from masking for unilateral and bilateral cochlear implantees.

Cochlear implantees have only the better-ear effect (outermost of red and green lines).

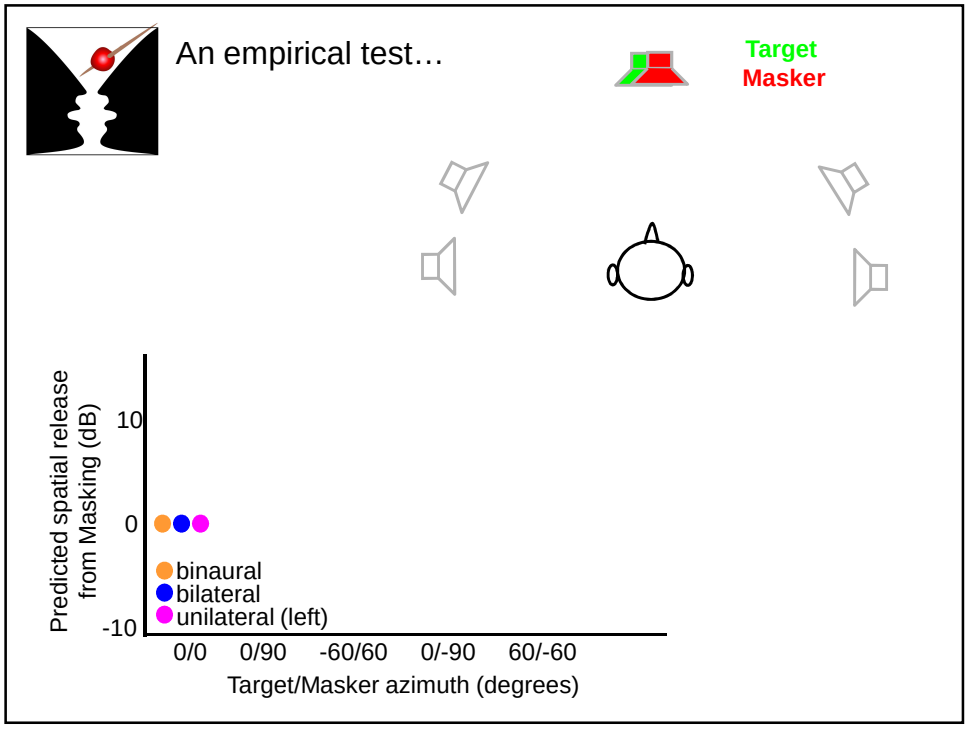
binaural
left ear
right ear

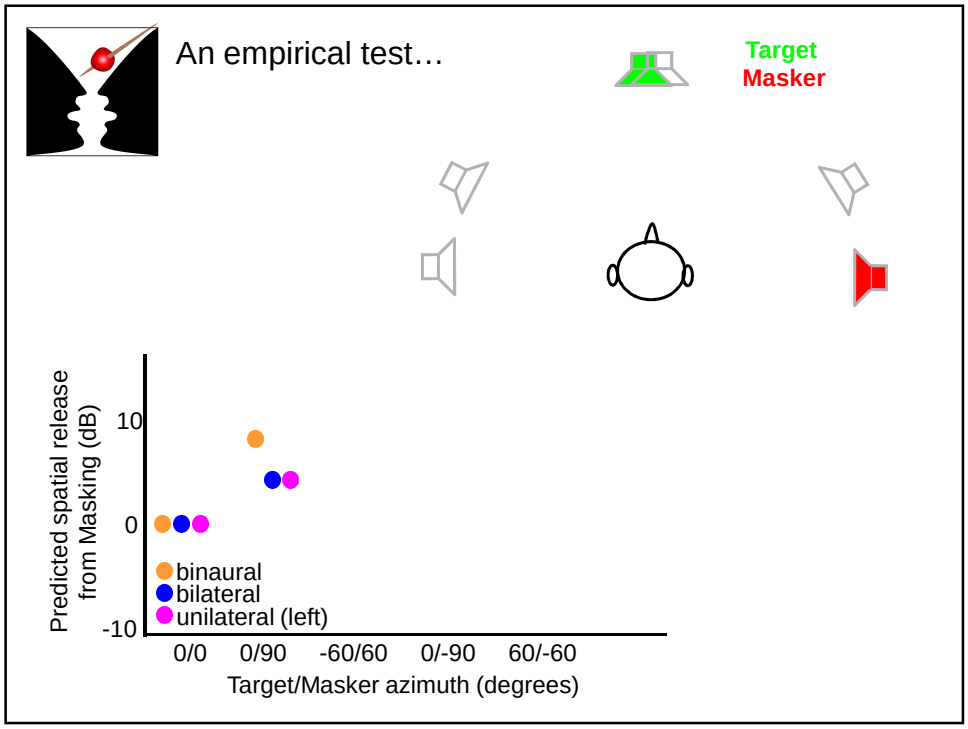


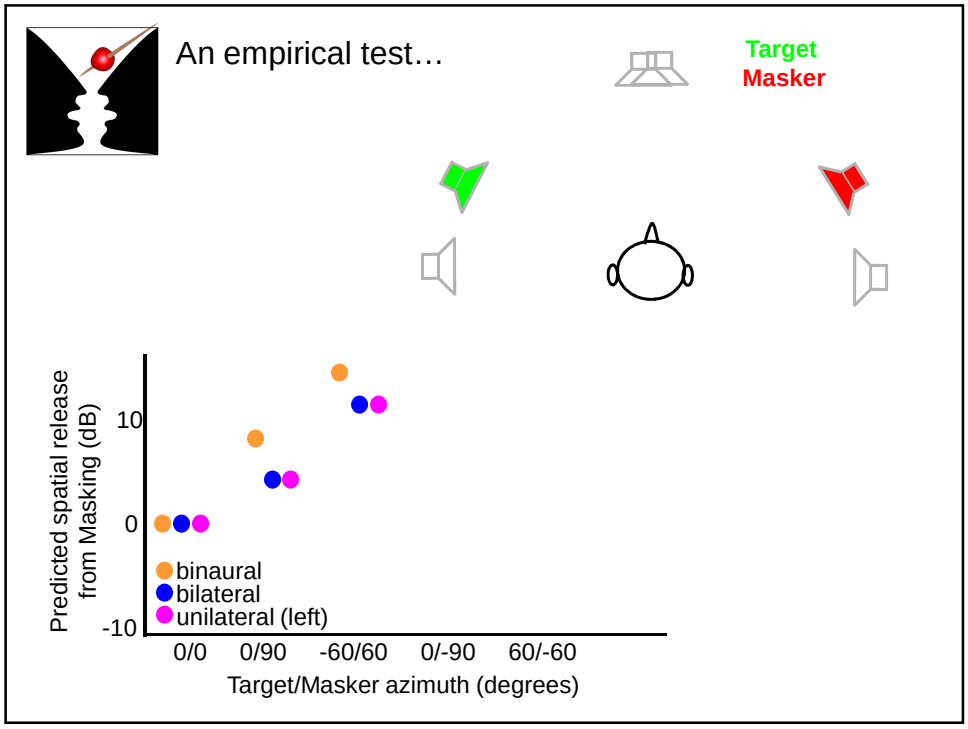
Target in front

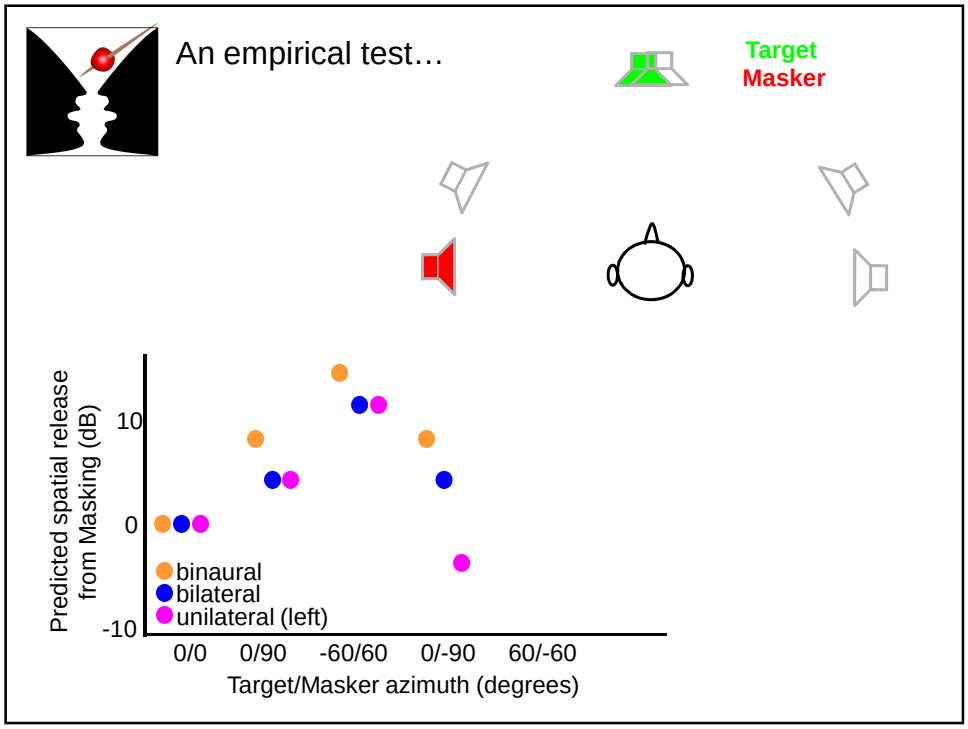


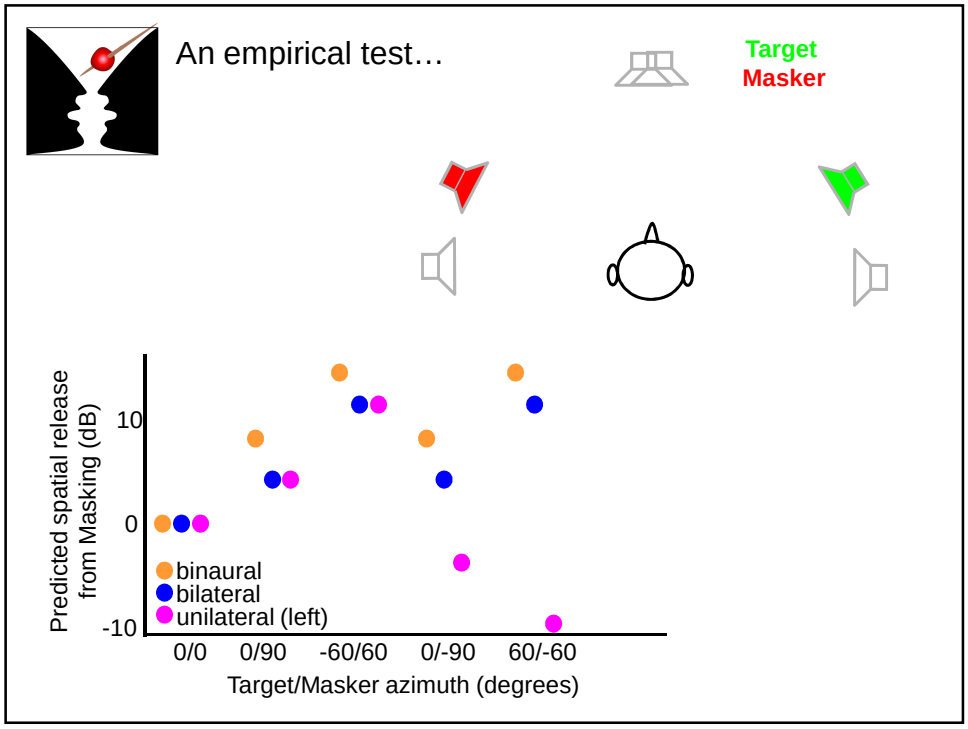
Symmetrical

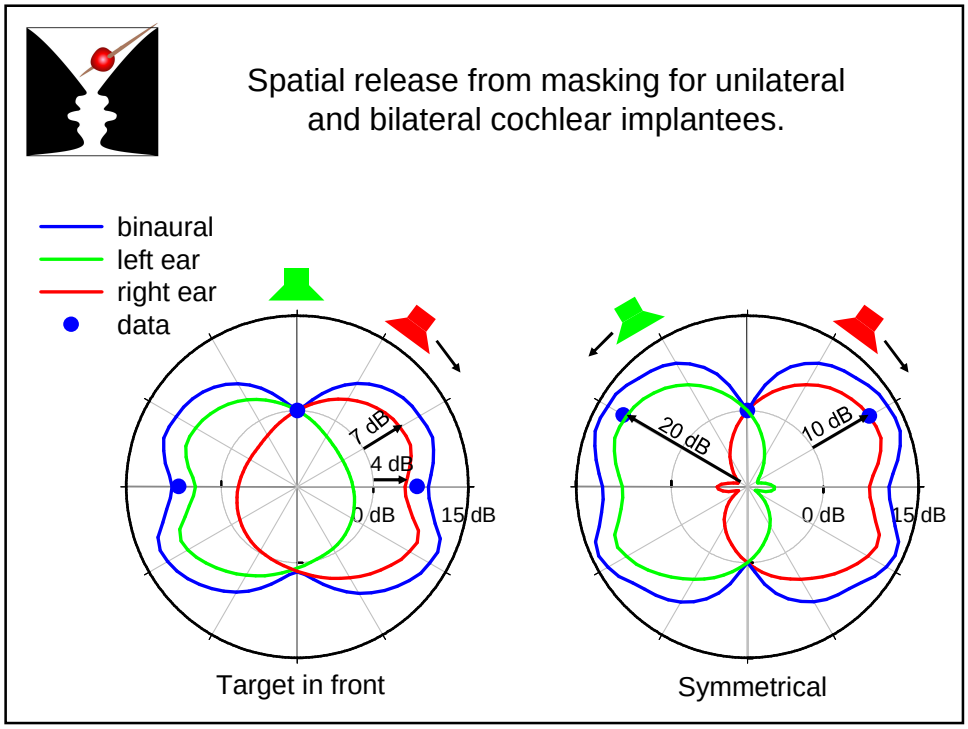

An empirical test…
Target
Masker
Predicted spatial release from Masking (dB)
10
0
-10
binaural
bilateral
unilateral (left)
0/0
0/90
-60/60
0/-90
60/-60
Target/Masker azimuth (degrees)

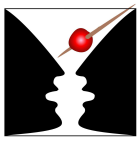

An empirical test…
Target
Masker
Predicted spatial release from Masking (dB)
10
0
-10
binaural
bilateral
unilateral (left)
0/0
0/90
-60/60
0/-90
60/-60
Target/Masker azimuth (degrees)


An empirical test…
Target
Masker
Predicted spatial release from Masking (dB)
10
0
-10
binaural
bilateral
unilateral (left)
0/0
0/90
-60/60
0/-90
60/-60
Target/Masker azimuth (degrees)


An empirical test…
Target
Masker
Predicted spatial release from Masking (dB)
10
0
-10
binaural
bilateral
unilateral (left)
0/0
0/90
-60/60
0/-90
60/-60
Target/Masker azimuth (degrees)

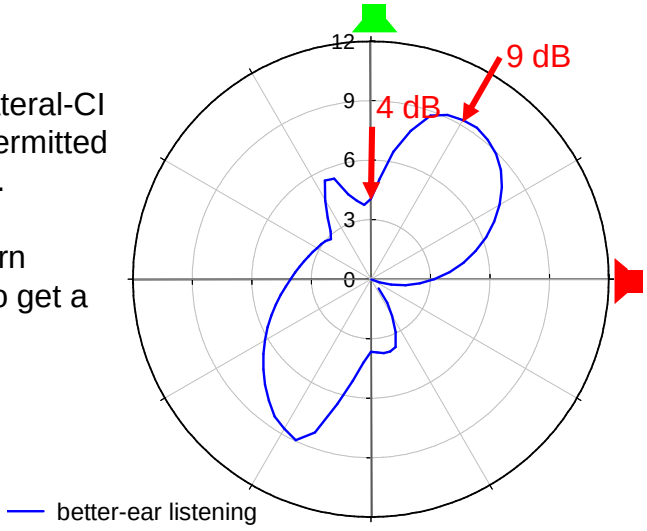

An empirical test…
Target
Masker
Predicted spatial release from Masking (dB)
10
0
-10
binaural
bilateral
unilateral (left)
0/0
0/90
-60/60
0/-90
60/-60
Target/Masker azimuth (degrees)

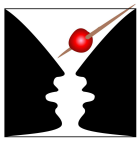

Spatial release from masking for unilateral and bilateral cochlear implantees.
binaural
left ear
right ear
data
7 dB
4 dB
0 dB
15 dB
Target in front
20 dB
10 dB
0 dB
15 dB
Symmetrical



Suppose those bilateral-CI experiments had permitted head movements…

How much head-turn would be needed to get a big benefit?





The role of head orientation has been neglected both in the assessment of bilateral cochlear implants and in the design of directional hearing aids.

Bilateral cochlear implants are much more beneficial than has previously been demonstrated.

The design of directional hearing aids may be improved by using the model to assess different designs – a directional pattern that enhances the effect of head orientation may prove beneficial.