Effects Single-Sided Congenital Deafness on the Brain

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Unilateral (sequential) CI children: better and poorer ear

In postlingual deafness, interimplant delay not crucial outcome factor

Lazard et al., 2012; Tavora-Vieira et al., 2013
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Implantation age on 1st ear: 1-2 years
Interimplant delay > 5 years

Peters et al., 2007, Otol Neurootol
Graham et al., 2009, Cochlear Impl Int
Gordon et al., 2011, Cochl Impl Int
Tavora-Vieira & Rajan, 2015, Audiol Neurootol
Arndt et al., 2015, Audiol Neurootol
Illg et al., 2013, Otol Neurootol
Illg et al., 2019, Hear Res

Review in Gordon & Kral, 2019, Hear Res
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Monosyllabic test [%]

Mean performance first ear
Duration of binaural experience [years]
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Extensive and durable effect!
Single-sided and binaural deafness

Controls:
Congenitally deaf cats (7)
Normal hearing cats (7)

Single-sided animals:
Congenitally single-sided deaf cats (4)
CI cats (8)
What is the consequence of single-sided deafness on the central representation of both ears and binaural hearing?

**Controls:**
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What is the consequence of single-sided deafness on the central representation of both ears and binaural hearing?

Functional test with binaural cochlear implants: irrespective of hearing status of the cochlea

**Controls:**
- Congenitally deaf cats (7)
- Normal hearing cats (7)

**Single-sided animals:**
- Congenitally single-sided deaf cats (4)
- CI cats (8)
Stronger & weaker ear in SSD

A) Hearing cat
Response to ipsilateral ear

B) Congenital single-sided deaf cat
Response to ipsilateral (hearing) ear

C) Hearing & binaurally deaf

D) Congenital single-sided deaf

Kral et al., 2013, Brain
Kral et al., 2013, Front Syst Neurosci
Stronger & weaker ear in SSD

A) Hearing cat
Response to ipsilateral ear
Response to contralateral ear

B) Congenital single-sided deaf cat
Response to ipsilateral (hearing) ear
Response to contralateral (deaf) ear

C) Hearing & binaurally deaf

D) Congenital single-sided deaf

Stronger and a weaker ear representation

Kral et al., 2013, Brain
Kral et al., 2013, Front Syst Neurosci
Stronger & weaker ear in SSD

A) Hearing cat
Response to ipsilateral ear
Response to contralateral ear

C) Hearing & binaurally deaf

Stronger and a weaker ear representation

B) Congenital single-sided deaf cat
Response to ipsilateral (hearing) ear
Response to contralateral (deaf) ear

D) Congenital single-sided deaf

There is a sensitive period of ~ 4 months for the effect

Kral et al., 2013, Brain
Kral et al., 2013, Front Syst Neurosci
Comparison of ITD and ILD, single sites

HEARING CONTROL

![Graph showing interaural time difference](image-url)

Tillein et al., 2010, Cereb Cortex
Comparison of ITD and ILD, single sites

HEARING CONTROL

Interaural Time Difference

Uncrossed earlier

Crossed earlier

Interaural Level Difference

Uncrossed stronger

Crossed stronger

H31907_Mch4_14_R_Ctx

Peristimulus time [ms]
Comparison of ITD and ILD, single sites

HEARING CONTROL

Interaural Time Difference

Uncrossed earlier

500

0

Crossed earlier

500

Interaural Level Difference

Uncrossed stronger

10

Crossed stronger

10

CONGENITALLY DEAF

Interaural Time Difference

Uncrossed earlier

500

0

Crossed earlier

500

Interaural Level Difference

Uncrossed stronger

10

Crossed stronger

10

Peristimulus time [ms]
ITD and ILD are differently affected

SSD: Ipsilateral (left) cortex

SSD: Contralateral (right) cortex

Tillein et al., 2016, Cereb Cortex
ITD and ILD are differently affected

SSD: Ipsilateral (left) cortex

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Tillein et al., 2016, Cereb Cortex
ITD and ILD are differently affected

SSD: Ipsilateral (left) cortex

Interaural time difference

Uncrossed earlier

Crossed earlier

[μs]

500

0

Crossed stronger

SSD: Contralateral (right) cortex

Interaural level difference

Uncrossed stronger

Crossed stronger

[μs]

500

-25 0 25 50 [ms]

Tillein et al., 2016, Cereb Cortex
ITD and ILD are differently affected

SSD: Ipsilateral (left) cortex

SSD: Contralateral (right) cortex

Tillein et al., 2016, Cereb Cortex
Aural preference syndrome

Follows periods of developmental single-sided hearing within an early sensitive period

Gordon et al., 2015, Pediatrics
Gordon & Kral, 2019, Hear Res
Aural preference syndrome

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With both auditory nerves preserved

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Prominently weaker auditory performance & slow learning on the second ear

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www.neuroprostheses.com
Visual vs. auditory deprivation: weaker auditory effects

Mower et al., 1983, Science
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It is not like amblyopia - the weaker ear is not lost completely!