The importance of communication to development

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All children need:

- language
- means of communication
- community

What can deaf people achieve?

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What do we know about how the brain processes language in deaf people?

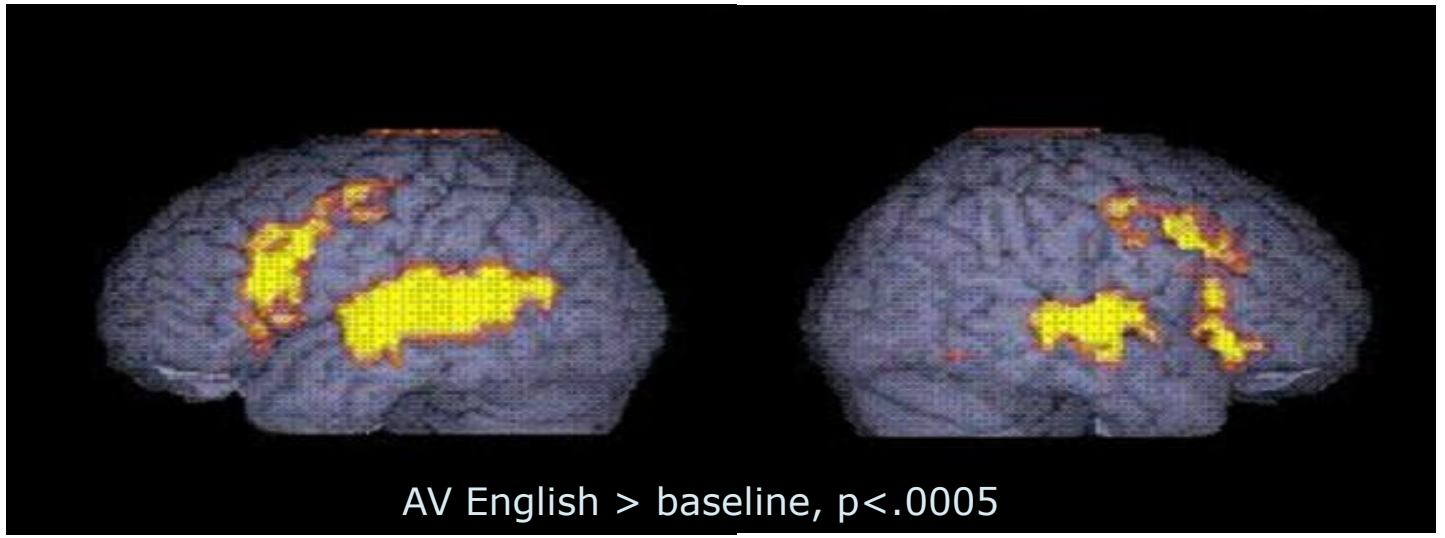
- sign language?

What do we know about how the brain processes language in deaf people?

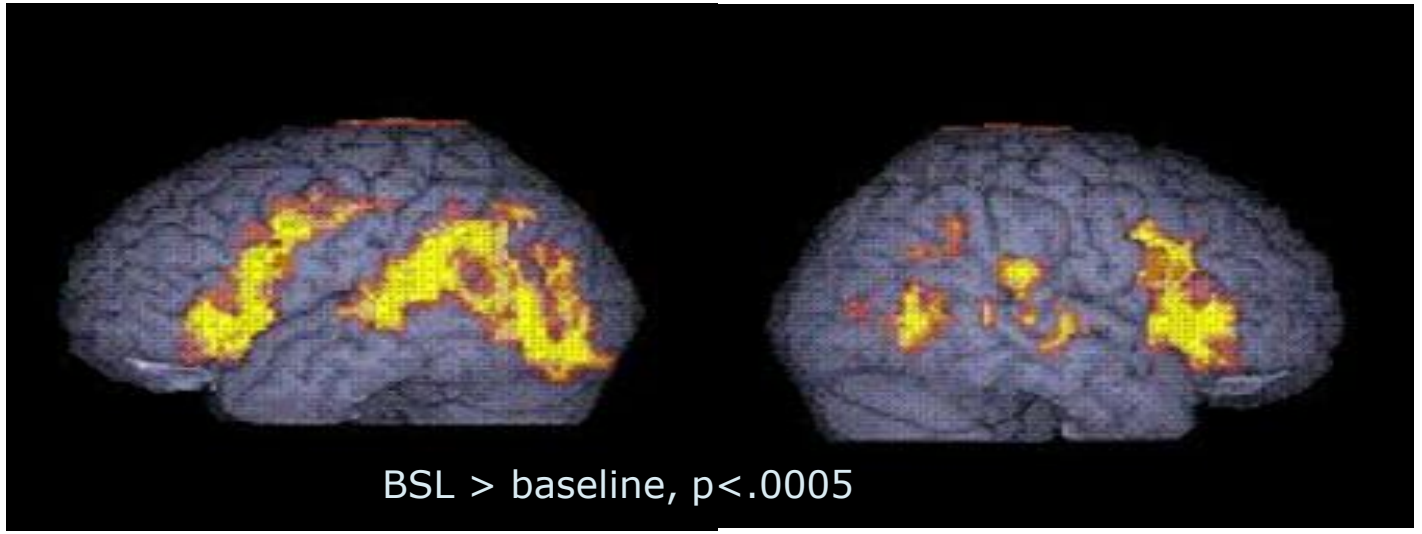
- sign language

Very similar networks engaged during sign language processing and spoken language processing in *native users*

Hearing speakers



Deaf native signers



(MacSweeney et al., 2002)

What if a signed language is learnt late?

- all hearing children *build* a second language (L2) on the solid neural foundations of their first language (L1).

- for many deaf children it's not appropriate to talk about a signed language as an 'L2' – since their L1 skills are often not robust.

What if a signed language is learnt late?

Group studies

- Only 2 published brain imaging studies of deaf adults who learnt a signed language late

  – both show differences in left inferior frontal regions between deaf early and late learners of a signed language (MacSweeney et al., 2008; Mayberry et al., 2011)

- More research needed to separate the effects of age of acquisition and language proficiency

What if a signed language is learnt late?

Case studies

- 2 teenagers who moved from Central America to the US – no schooling and 'no language' Ramirez et al., 2014; Ferjan Ramirez et al., 2016) -

- Neural systems supporting ASL processing – *very* different to those seen in native signers

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COMMENTARY

The consequences of very late exposure to BSL as an L1*

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As Mayberry and Kluender indicate, research with deaf individuals provides a unique opportunity to explore core areas of linguistic and cognitive theory. For many deaf children, a spoken language is the only language they are exposed to during the CP, in the belief that simultaneous exposure to a sign language will have a negative impact on their acquisition of a spoken language, and in the belief that sign language can be easily acquired at any age. For a child who, even in the context of early intervention, does not acquire a spoken language, the danger is that they will never have native-like mastery of any L1. Research in

Consequences of language deprivation

- Critical period of language acquisition
- Genie (Aitchinson, 1998)
- Martin (Mayberry & Kluender, 2017)
- M (Woll & Atkinson, 1999)

What does it mean to communicate? What does it mean to have language?

- Communication and language isn't 'fixed', 'rigid'. It definitely isn't speech vs. sign.
- There are many ways to communicate
- Communication choices are a consequence of having access to a FULL language

Language Acquisition

Language acquisition versus language teaching

Language Developing

Up

Pick me

Lift me up there

Give me a boost up there

Can you pick me up so I can get the apple

Ages and stages of development

Striking similarities between language development in sign and spoken languages

Same types of mistakes and overgeneralisations

Similar developmental and acquired disorders that affect language

Developmental Milestones

Spoken language development

- Pre linguistic communication, up to 1 year of age
- First word 10 to 14 months
- Word joining 18 months + vocabulary spurt
- 500 word vocabulary by 3
- Reception age (4)
- Adult like language finally mastered at age 11

Sign language development

- Pre linguistic communication, up to 1 year of age
- First sign 10 to 14 months
- Sign joining 18 months + vocabulary spurt
- 500 sign vocabulary by 3
- Reception age (4)
- Adult like language finally mastered at age 13

Importance of language

Language also influences:

- Emotional understanding (empathy, inhibition)
- Theory of mind (empathy, understanding other people's minds separate from your own)
- Executive function (inner speech, the ability to plan, inhibition)

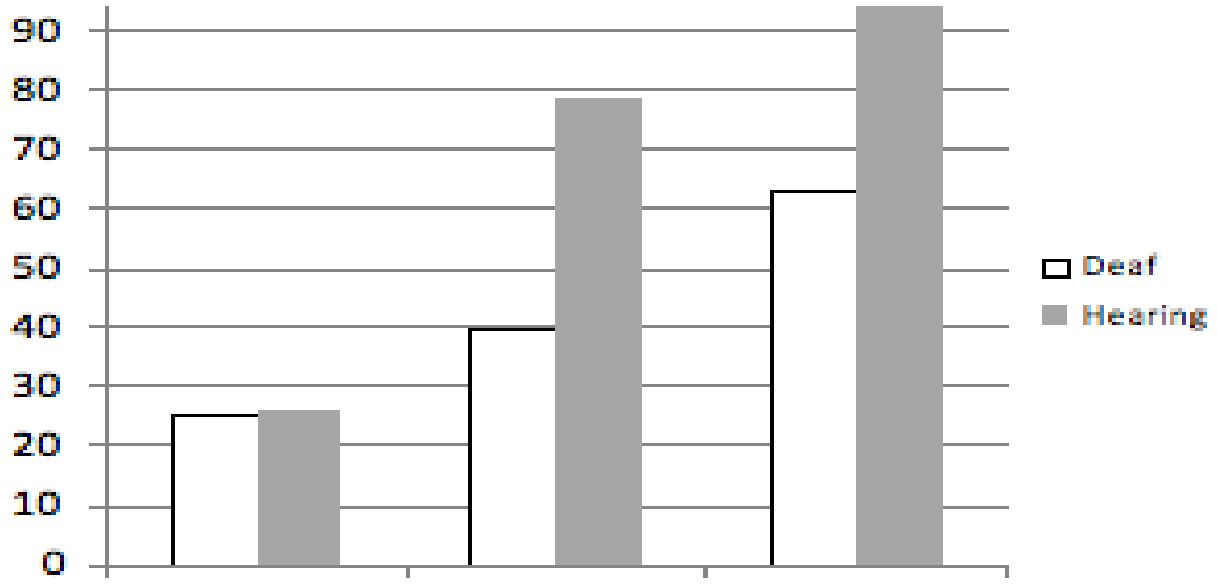
Emotional language

Understanding pretend emotions happens around 4 years old in typically developing children (Harris, 1996).

Development is influenced by how adults acknowledge and respond to children's feelings.

Children who manage their emotions are also better managers of their own behaviour.

Percentages from 8 tasks



Naming pretend actions, emotions (anger, sadness)

Participants: 75 deaf children with hearing parents (3-8 years,50 CI, & 25 Hearing Aids) and 75 hearing age-matched (control group)

What happens to auditory parts of the brain when they do not receive auditory input?

There is evidence of ‘crossmodal plasticity’

Neurons that usually process a certain type of sensory information adapt to process input from a different modality.

What happens to auditory parts of the brain when they do not receive auditory input?

- Evidence of plasticity in *primary* auditory cortex in congenitally deaf adults is limited
- Extensive plasticity in secondary auditory and auditory association cortices
- Auditory regions retain function – but apply to a different modality (Lomber et al., 2010; Ding et al., 2015; Bola et al., 2017; Benetti et al., 2017)
- But also evidence that left auditory 'association' areas are recruited for more complex visual processing in deaf people (Twomey et al., 2017)

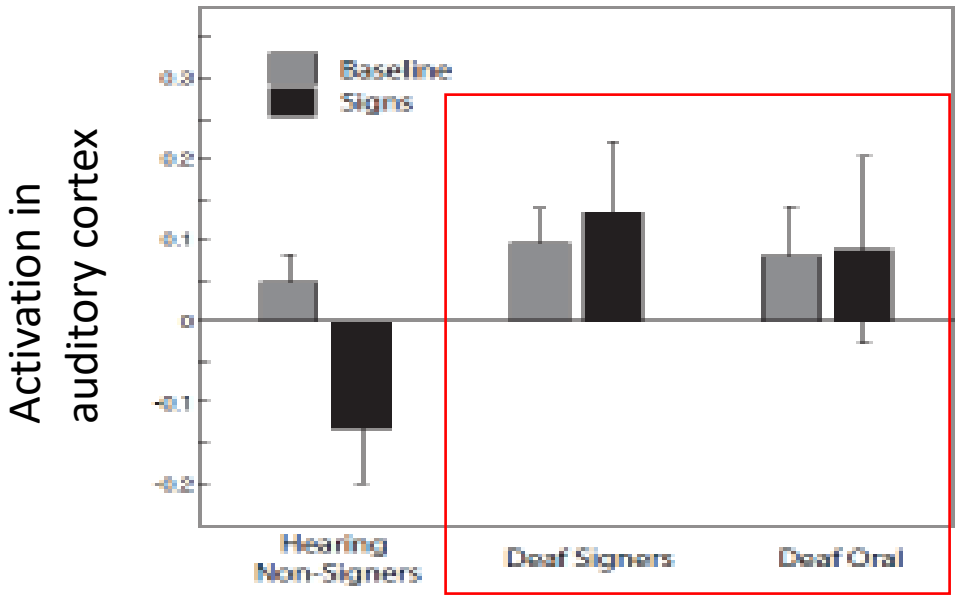
Implications of findings for practice?

‘The striking similarities between the animal and human studies suggest that … cross-modal recruitment {is} responsible for the well-documented difficulties in oral speech and language skills seen in late-implanted, congenitally deaf children.’

Kral and Sharma, TiNS, 2012

Evidence for increased ‘invasion’ of auditory cortex in signers?

Evidence for increased 'invasion' of auditory cortex in signers? No



Cardin et al.,, 2016

Cross-Modal Plasticity in Higher-Order Auditory Cortex of Congenitally Deaf Cats Does Not Limit Auditory Responsiveness to Cochlear Implants

Rüdiger Land,[1] Peter Baumhoff,[1] Jochen Tillein,[1,2] Stephen G. Lomber,[3] Peter Hubka,[1] and Andrej Kral[1,4]

JoN, 2016

Significance Statement

In a common view, the "unused" auditory cortex of deaf individuals is reorganized to a compensatory sensory function during development. According to this view, cross-modal plasticity takes over the unused cortex and reassigns it to the remaining senses. Therefore, cross-modal plasticity might conflict with restoration of auditory function with cochlear implants. It is unclear whether the cross-modally reorganized auditory areas lose auditory responsiveness. We show that the presence of cross-modal plasticity in a higher-order auditory area does not reduce auditory responsiveness of that area. Visual reorganization was moderate, spatially scattered and there were no interactions between cross-modally reorganized visual and auditory inputs. These results indicate that cross-modal reorganization is less detrimental for neurosensory restoration than previously thought.

frontiers in
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Cochlear implantation (CI) for prelingual deafness: the relevance of studies of brain organization and the role of first language acquisition in considering outcome success

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deaf children are exposed to sign language in early infancy. Moreover, no studies to date have examined sign language proficiency in relation to cortical organization in individuals with CI. Given the paucity of such relevant findings, we suggest that the best guarantee of good language outcome after CI is the establishment of a secure first language pre-implant—however that may be achieved, and whatever the success of auditory restoration.

Remaining point of contention … ….

After CI the auditory cortex needs auditory input to learn how to process sound.

- drop visual language totally and focus on auditory training? …

or …

- treat it like ‘piano’ practice, in the context of the communication preferences of the child and the family?

All children need:

- language
- means of communication
- community

- stick with your values – stand up for the child's rights to a full language, a means of communication and communication partners

- if you see a casualty developing – triage early

- continue to offer the best audiology and speech and language therapy

- the aim is for those deaf children who learn a sign language to also develop excellent English skills

To learn language, brains need language input .. and lots of it!!
From parents, teachers, friends .. Everyone in a child's environment.