

## Research briefing: The impact of childhood deafness on executive function

*In the below article, Anna Jones and Kathryn Mason from the Deafness Cognition and Language Research Centre (DCAL) at University College, London write about how deaf children can sometimes struggle with their 'mental control', known as executive function. They also outline some simple ideas for parents and professionals looking to support deaf children in this area.*

### What is executive function?

The ability to focus, hold and manipulate information in our minds, filter distractions and switch between tasks is similar to an air traffic control system at a bustling airport, constantly dealing with the simultaneous arrival and departure of countless aeroplanes. The air traffic control system in our brains is known as executive function (EF) – a set of skills, including working memory, inhibitory control and cognitive flexibility that help us regulate our behaviour and plan ahead. These skills are not only crucial in helping children learn (e.g. enabling a child to switch from using rules for multiplication to division), but also for developing physical and mental well-being.

### Do deaf children have executive function problems?

Most deaf children experience a delay in language acquisition resulting primarily from sensory difficulties that impact their language-learning environment. These language difficulties have been linked to difficulties in EF. Our research group at the ESRC funded Deafness, Cognition and Language Research Centre (DCAL), University College London and City University London, has looked at the relationship between language and EF in deaf children.

In a large group of deaf children (aged 6 – 11 years) with a mixture of communication backgrounds, we found improved EF and expressive vocabulary performance over a two-year period. We also found that the deaf children performed more poorly than hearing children on expressive vocabulary and some EF tasks, especially on tasks assessing working memory. No advantage was found for having a cochlear implant over a hearing aid in EF performance. Our key finding was that expressive language skills at the first time of testing predicted improvement of EF skills two years later, suggesting that language is crucial for EF development.

A second study showed that poor working memory is not an inevitable outcome of deafness; native signers (i.e. deaf children born to a deaf parent with early exposure to sign language) had equivalent performance to their hearing peers.

Together these studies highlight the importance of a rich language environment from birth in the development of deaf children's cognitive skills.

### How might expressive language skills help improve deaf and hearing children's executive function?

Language development is thought to provide the building blocks for the growth of cognitive skills. Young children often talk out loud to themselves when they play on their own or carry out a specific task – this is known as "self-talk". Children use "self-talk" in order to plan, monitor and regulate their behaviour (for example, keeping themselves focused on a task or coming up with a new way to solve a puzzle if their first attempt did not work). During the early school years, children switch from using overt "self-talk" and begin to use internal "inner speech", or verbal thought, which we all use in order to plan and monitor our actions.

Vocabulary knowledge is also important for EF skills, as being able to label experiences supports children's "representational thinking". For example, in order to understand concepts such as division in maths, children are first taught to physically share objects and express what they are doing using words and symbols. Using language in order to label and describe the process helps children to master the concept of division.

The results of our research support the idea that having good language skills increases your EF ability.

### Can we improve deaf children's executive functions?

We are not born with fully functional EFs, these skills begin to develop in infancy and continue into early adulthood. However, a person's EF skills are not fixed, but can be improved or "trained". EF skills are malleable and can be enhanced by different experiences. Activities such as physical exercise, mindfulness and meditation, playing memory or strategy games and musical training have all been found to have a positive impact on children's EF development.

A recent study at DCAL looked at the impact of a music-based intervention on deaf children's EF skills. Deaf children aged between 7-11 years old from 3 schools in London received 10 hours of music-based EF training and 10 hours of art classes (which acted as a control condition). The music-based EF sessions were designed specifically for deaf children, and included fun and engaging activities which aimed to challenge and train their attention, inhibition, memory and planning skills while engaging in musical games. The study found that the musical training and games had a positive effect on the children's memory and inhibition skills, highlighting the importance of music classes and their potential benefit to deaf children's cognitive development.

### Examples of tasks to help improve executive functions in primary school

There are many practical ways to help improve children's EF skills, both at home and at school. The following activities and strategies can be used to help improve EF skills and support children who may be struggling.

#### 1) Simplicity and Scaffolding.

- Adults can support children in carrying out complex or challenging tasks by using step-by-step instructions, visual aids, breaking tasks down into stages and offering advice on how to pause, plan and strategize. This technique is known as "scaffolding".
- As children become more independent and can manage the tasks by themselves, the adults can gradually remove these supportive mechanisms.

#### 2) Language and "Self-talk"

- The type of language that adults use with children can also support EF development. For example, using language which encourages children to use inhibitory control (e.g. "find something which is not green" rather than asking children to find a specific object/item); or utilize working memory skills (e.g. "name an animal that is black and orange and starts with a "T").
- Encouraging children to use "self-talk" as a way of thinking through and working out problems and plans helps avoid acting impulsively. By explicitly teaching children to stop and think through a problem, and even discuss their plan with others before acting, can support EF development.

#### 3) Activities and games that support EF development

There are many games available that are excellent at promoting EF skills:

- The card-game, “UNO”, is good for cognitive flexibility, as children need to switch between coloured and numbered cards.
- In the game, “Concentration”, children need to match pairs of cards, which are presented face down on a table. This helps to improve their working memory skills, and is also excellent for turn-taking and strategizing.
- “Simon says” is a fun game for children that challenges their inhibitory control skills. In this game, children are instructed to only perform an action if it is prefixed with “Simon Says” – e.g. “Simon says, touch your toes”. If the instruction is given without “Simon says” at the beginning, children must inhibit the impulse to perform the action.
- A rhythmic version of Simon Says (that was included in the music-based EF intervention study) is called “Don’t clap this one back”. The teacher claps a range of simple rhythms, using their hands, body, a drum or simple percussion instrument, or even on the floor, and the children have to copy the rhythms. However, if the teacher beats out the rhythm, “Don't clap this one back”, the children have to stop themselves and not repeat the rhythm.

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