

Spatial hearing abilities in children and adults with Down Syndrome

Poster# 078

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Introduction

- Down syndrome (DS) occurs in 1/700 live births, with approximately 6,000 infants with DS born in the USA each year^[1]. DS is a leading known genetic cause of intellectual and developmental disability (IDD) (World Health Organization, 2020). Hearing impairments are strikingly common (up to 80% reported) in children with DS and can result from anatomical abnormalities in the peripheral auditory system, and/or central auditory system deficits^[2]. The neurocognitive phenotype associated with DS includes relative impairments in language, memory, and executive functioning^[3]. Very little is known about how deficits in auditory functioning in DS drive this unique profile of neurocognition, and vice versa. Understanding these associations in childhood have relevance for interventions, given greater plasticity in the developing brain, and because childhood is an optimal period for altering learning trajectories.
- Our goal is to understand real-world functioning in the spatial hearing domain. Our recent study in adults with DS showed that speech reception thresholds were higher (worse) than TD adults, sound localization abilities were similar to the TD group^[4].
- Although there is some indication that spatial hearing is delayed in young children with DS^[5], there is a dearth of data on this topic.
- In TD individuals, there are indications that spatial hearing matures starting at birth, into childhood^[6], however, developmental studies that assess age-related changes throughout adolescence and into adulthood are lacking.

Current project:

- Study 1:** Age-related changes in spatial hearing, using Right/Left (R/L) discrimination paradigm, in a large cohort of TD individuals (5-24 years of age).
 - Study 2:** Pilot data comparing performance in children and adults with DS with findings from the TD cohort in Study 1.
- We posit that spatial hearing abilities should be measured at supra-threshold levels of performance (between 70-100% correct), to understand how sensitivity changes throughout childhood, into young adulthood.

Predictions

- Spatial hearing performance continues to mature until adulthood.
- Participants with DS will have lower performance than TD peers.
- R/L discrimination shows a larger gap between individuals with DS compared with TD peers in the child groups than in adult groups.

Method

Participants:

Study 1:

Group	N	Age range (years)	Mean age $\pm$ SD (years)
Children	66	5-17	11.12 $\pm$ 1.27
Adults	54	18-24	20.97 $\pm$ 1.64

Study 2:

Group	N	Age range (years)	Mean age $\pm$ SD (years)	Hearing loss present	Hearing aid use
Children with DS	6	12-17	14.33 $\pm$ 1.97	4	2
Adults with DS	7	18-25	23.43 $\pm$ 1.4	4	-
TD children	8	12-17	14.63 $\pm$ 2.33	-	-

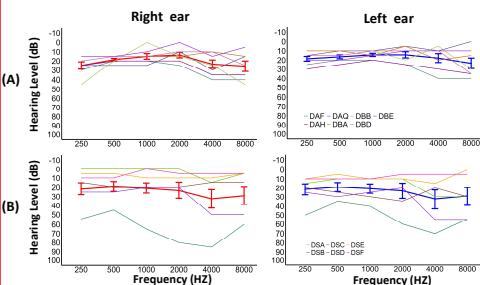


Figure 1: Right and left ear air conduction thresholds in dB HL for adults (A) and children (B) with DS

Method

Procedure:

- Testing was conducted in a sound-attenuated booth (IAC; dimensions of 2.90 x 2.74 x 2.44m).
- Loudspeakers were symmetrically positioned at $\pm 10^\circ$, $\pm 5^\circ$, and $\pm 2.5^\circ$ relative to the midline, and were hidden behind an acoustically transparent curtain.
- Visual images of a yellow or green shape were placed on the curtain to indicate the locations. These images also appeared on a tablet in front of the participant to select the perceived location on each trial.
- Testing consisted of separate 20-trial blocks at each angle, beginning at 10° , followed by 5° , and then 2.5° .
- Prior to the main task, familiarization was implemented at angles of 20° or larger for 5-6-year-old TD children and for all participants with DS.
- Stimulus was pink noise presented at 65dB SPL.
- d-prime (d') was calculated at each angle as a bias-free measure of performance.

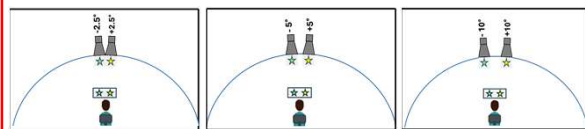


Figure 2: Testing apparatus for the R/L discrimination task

Results

Study 1: Typical development- the effect of age on R/L discrimination ability

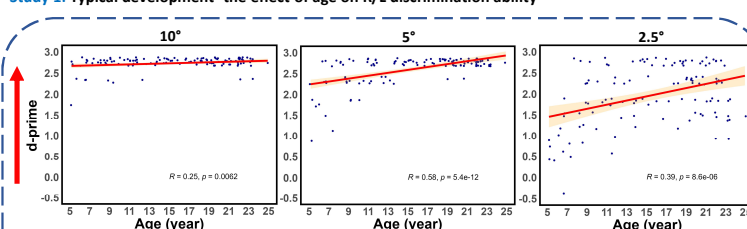


Figure 3: d' values are shown as a function of age for each of the three angles tested.

- Performance improved significantly with age (d' values increased with age).
- The effect of age was more prominent at smaller testing angles.

Study 2: Comparing performance between children with Down syndrome (DS) and Typically developing (TD) peers

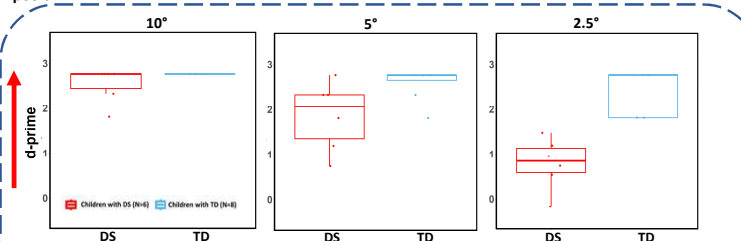


Figure 4: d' values are shown for children with DS and TD age-matched peers

- Children with DS showed lower performance than age-matched TD children.
- The difference between the two groups increased as the testing angle became smaller.

Results

Study 2: Comparing performance between adults with Down syndrome (DS) and Typically Developing (TD) peers

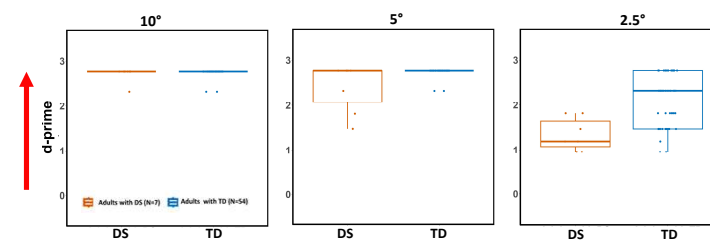


Figure 5: d' values are shown for adults with DS and TD adult peers

- Almost a similar performance was observed between adults with DS and TD peers at 10° and 5° .
- Group differences mainly emerged in the smallest testing angle (2.5°), although some overlap in performance was observed.

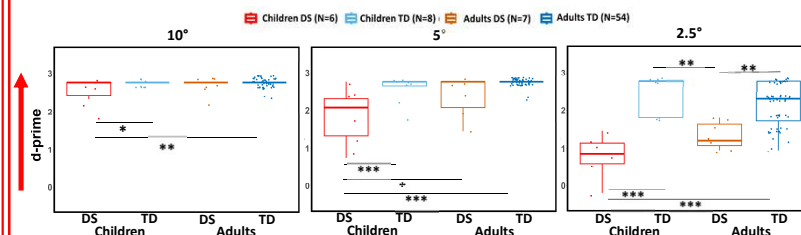


Figure 6: d' values are shown for children and adults with DS and TD peers

- One-way repeated measure ANOVA confirmed significantly lower d' in children with DS compared to age-matched TD peers and TD adults in all three angles tested.
- However, d' of adults with DS was significantly lower than that of TD peers only at 2.5° .

Conclusions

- Spatial hearing abilities (R/L discrimination) undergo maturation into adulthood in both participants with DS and TD individuals.
- Children with DS showed poorer R/L discrimination than age-matched TD peers, suggesting delayed maturation of spatial hearing.
- Adults with DS performed more similarly to TD adults in the conditions with the largest angles, suggesting continued maturation of spatial auditory processing into early adulthood, with the possibility that hearing loss has an impact on performance.
- Ongoing studies are needed to understand associations between spatial hearing, speech understanding and cognition, along with brain imaging in pathways that drive spatial hearing, directing interventions aimed at improving developmental outcomes and community integration for children and adults with DS.

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Acknowledgement

This Work was supported by NIH-NIDCD R01 DC019511 and R01 DC019511-S (R.Y. Litovsky, A. Alexander, S. Hartley, and A. Sterling), and in part by a core grant from NIH-NIDCD to the Waisman Center (PSOHD105353). Special thanks to all who helped with this project, including Eva Walsh, participants, and their parents.