



Introduction

- It is now standard of care to recommend bilateral CIs, at a very young age, for children with bilateral severe to profound hearing loss.
- This is in part to promote development of spatial hearing.
- Large variance in outcomes pertaining to spatial hearing in children with bilateral CIs has been observed in previous studies. ^{1,3,4}
- Many factors can impact benefits of bilateral CIs for improved spatial hearing abilities, including age of bilateral activation, and inter-implant delays.

Study Objectives:

- To examine speech intelligibility in noise and spatial release from masking in children with bilateral CIs.
- To examine the association between speech intelligibility in noise, spatial release from masking and
 - age of the child at time of activation of the 2nd CI
 - the time delay between the activation of the 1st CI and the 2nd CI

Participant Characteristics

- Children with bilateral CIs (age range 04-09 years), N=26
- Age at receiving the 1st CI = 07 to 62 months
- Age at receiving the 2nd CI = 07 to 80 months
- Inter-implant delay = 0 to 65 months
- All the participants received the first CI for the right ear

CRISP Speech Intelligibility Test

- A closed-set four alternative forced choice task² (Figure 01).
- Each target spondee had a corresponding picture to indicate the response.
- Maskers were at 55 dB SPL.
- Target was initially presented at 60 dB SPL and then varied following an adaptive tracking procedure (3-down/1-up rule).
- 3-down/1-up rule - Three consecutive correct responses result to decrease the intensity level of the target and a single incorrect response result to increase the intensity level of the target.
- Each adaptive track ended after five reversals.
- After each reversal, the step size was halved, and the minimum step size was limited to 2dB.
- Speech Reception Thresholds (SRTs) were measured for Quiet, Co-located and Asymmetric Right conditions and 20 trials were used in each test condition.

Methods

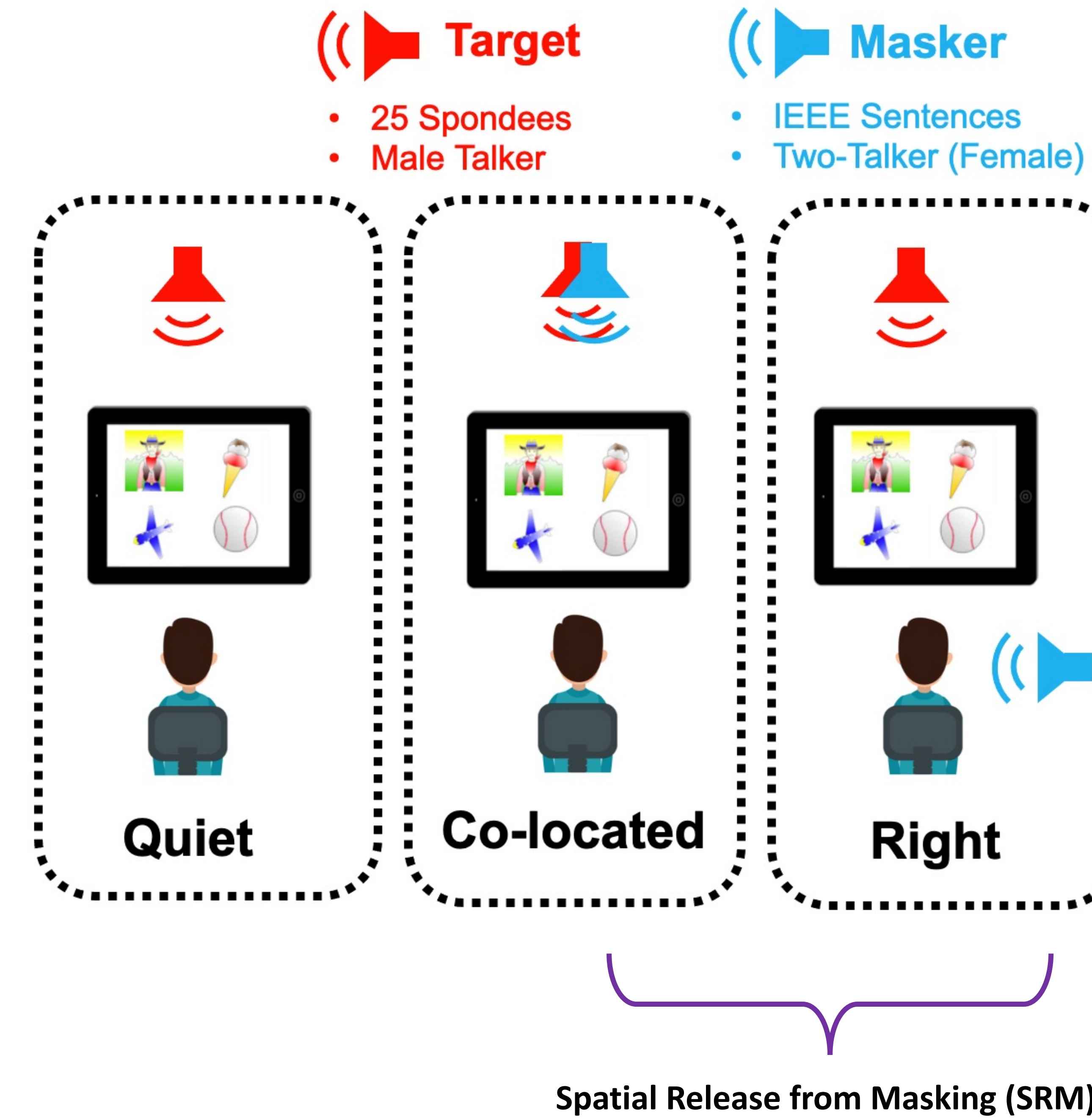


Figure 1: Children's Realistic Index for Speech Perception (CRISP) Task

- Spatial release from masking (SRM): $SRT_{Co-located} - SRT_{Right}$

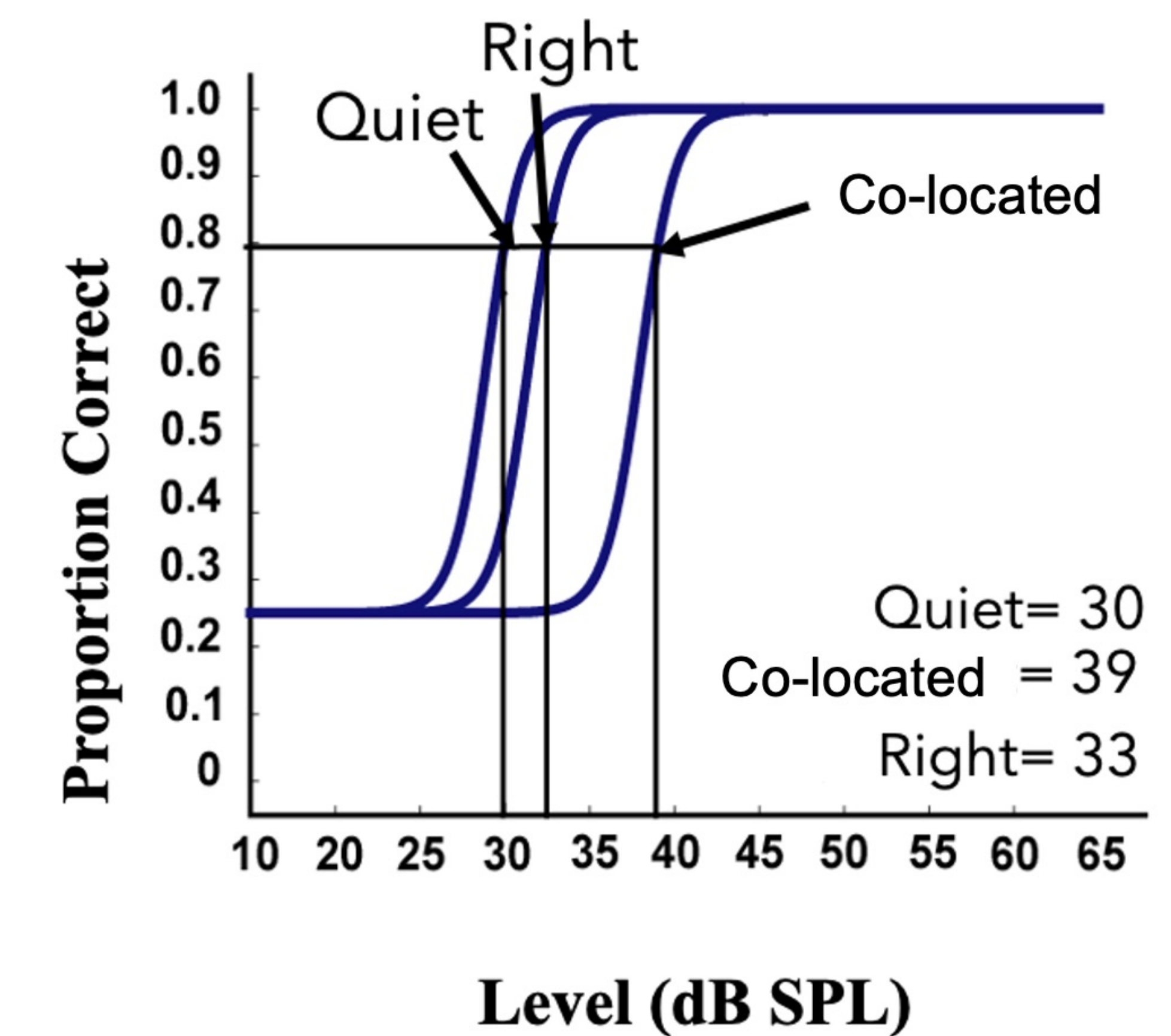


Figure 2: Threshold Estimation for Children's Realistic Index for Speech Perception (CRISP)

- SRTs were calculated using maximum likelihood estimation and finding the point on the psychometric function where performance was estimated at **79.4%** (Figure 2).
- The lower bound of the psychometric function was fixed at the level of chance performance of 25%.

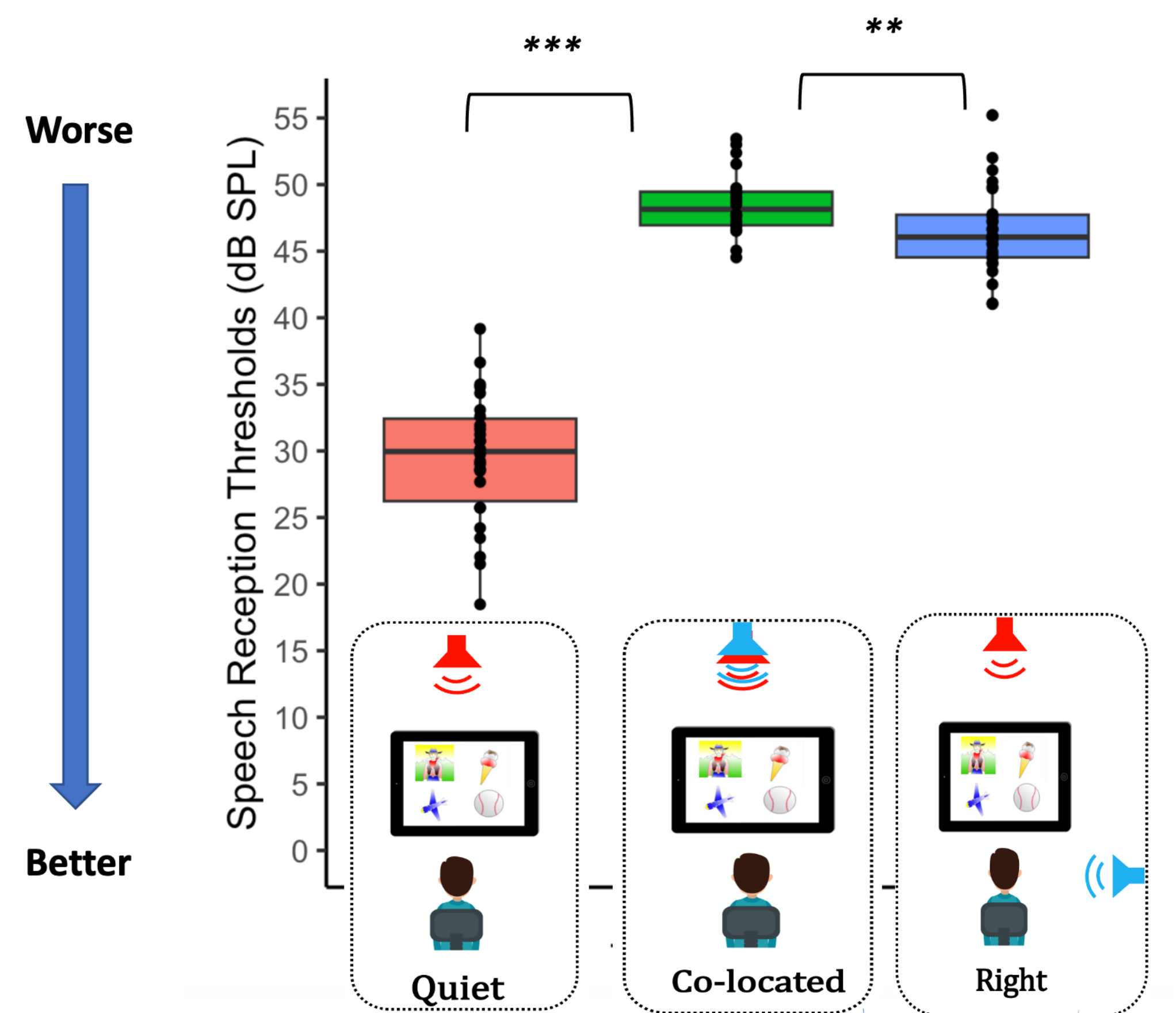


Figure 3: Speech Reception Thresholds in Quiet, Co-located and Right Conditions for Children with bilateral CIs

Significant difference in SRTs between quiet and co-located conditions when comparing within-subject SRTs ($t(25) = 23.19, p < 0.001$).

Significant difference in SRTs between co-located and right asymmetric conditions when comparing within-subject SRTs ($t(25) = -3.89, p < 0.01$).

Evidence for spatial separation of the target and masker in children with bilateral CIs.

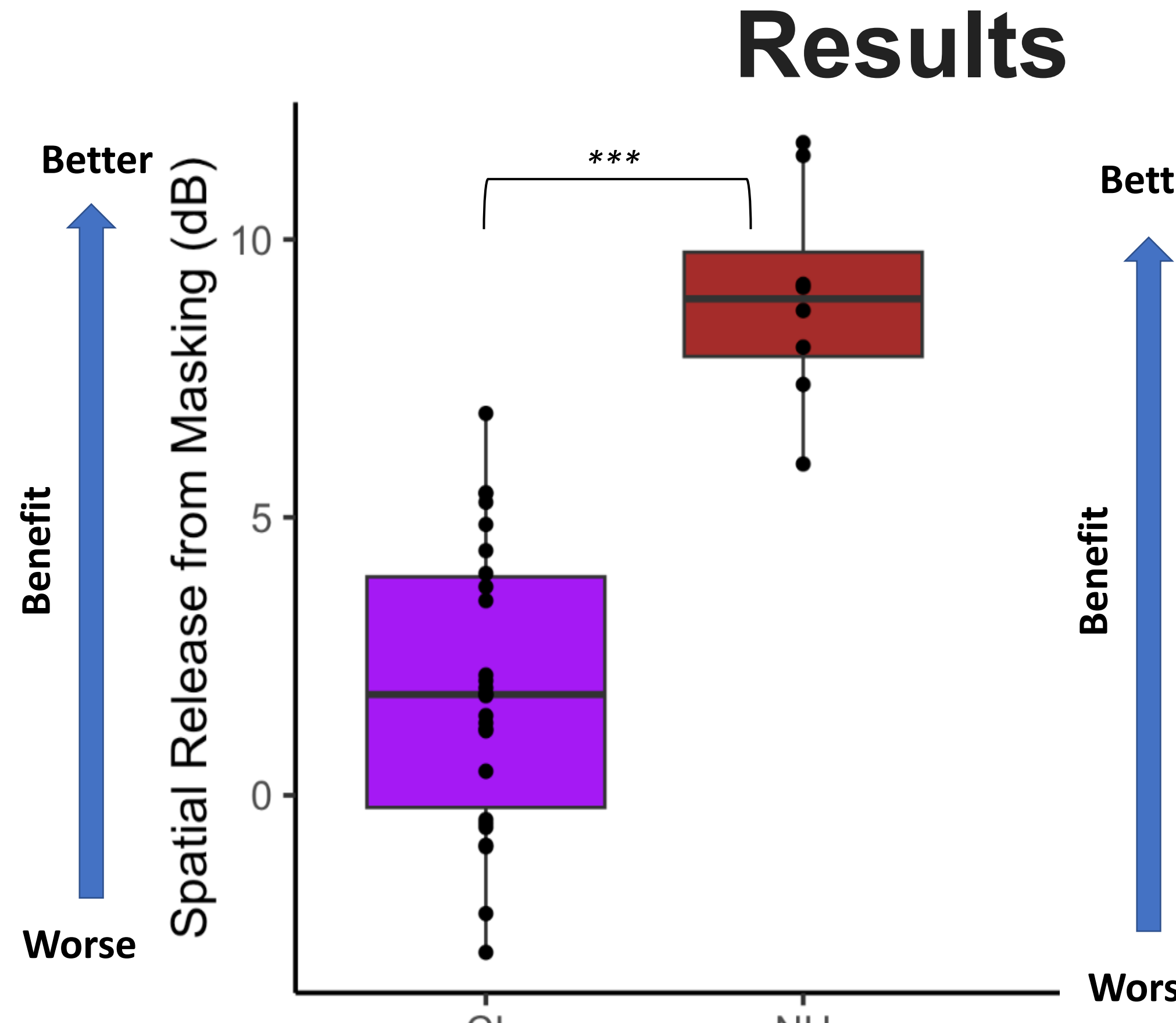


Figure 4: Spatial Release from Masking in Children with bilateral CIs and normal hearing

Significant difference in SRM between children with bilateral CIs and normal hearing (NH) children ($t(32) = -7.15, p < 0.001$).

Limited SRM shown for children with bilateral CIs.

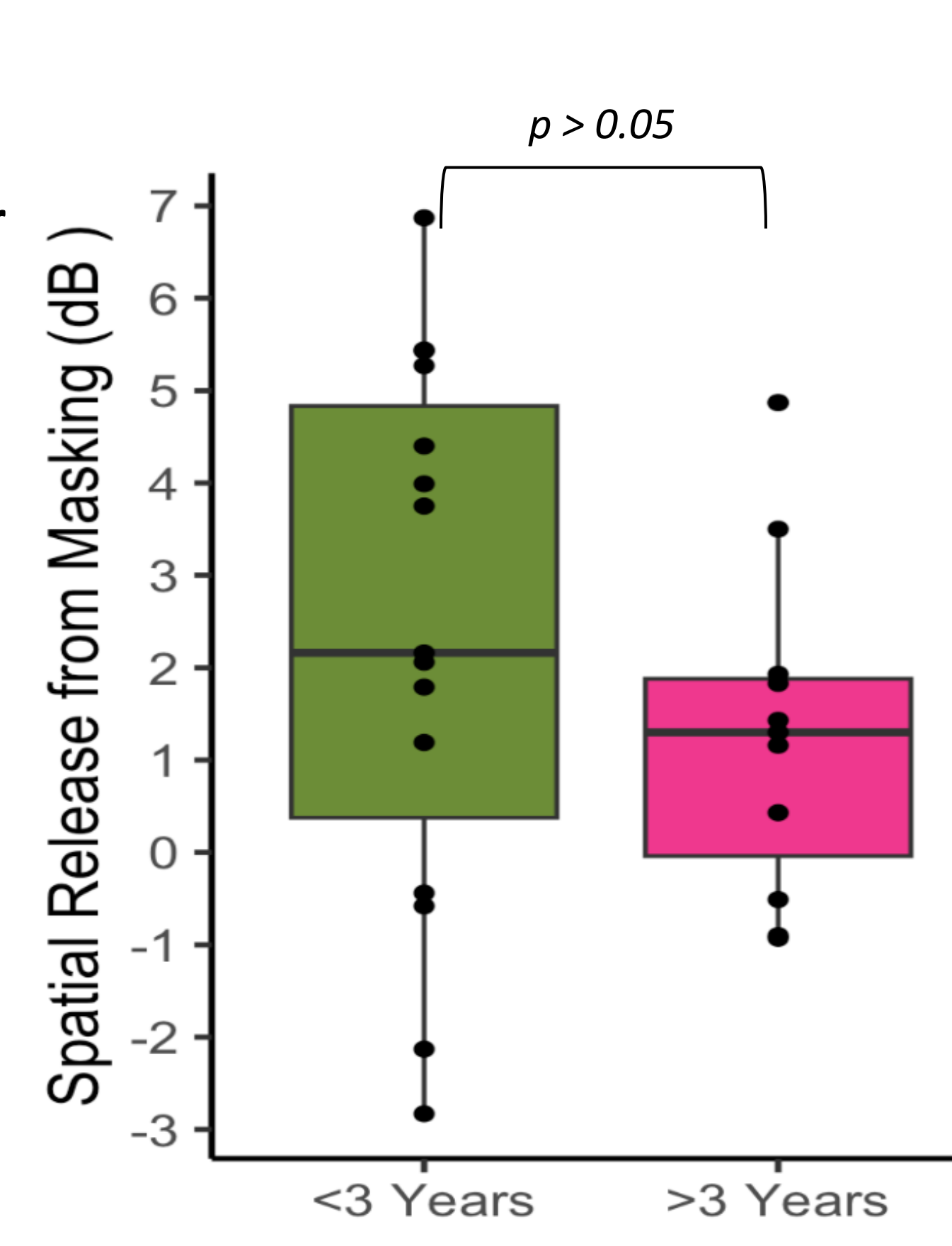


Figure 5: Spatial Release from Masking with the Age at receiving the Second CI

No significant difference in SRM between children received their second CI less than 3 years of age and children received their second CI after 3 years of age ($t(24) = 1.14, p = 0.27$).

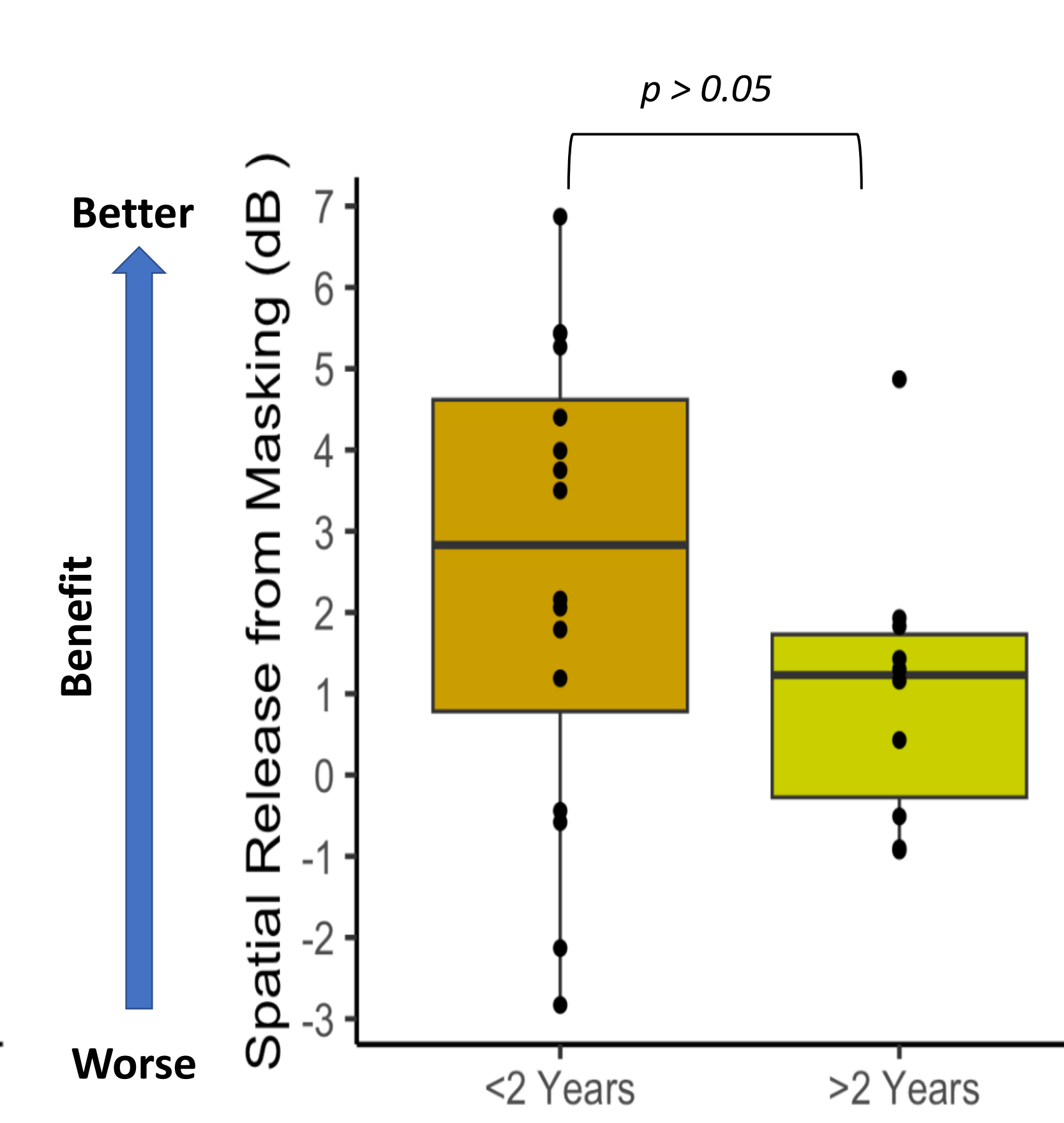


Figure 6: Spatial Release from Masking with the Inter-implant Delay

No significant difference in SRM between children with less than 2 years of inter-implant delay and children with more than 2 years of inter-implant delay ($t(24) = 1.42, p = 0.17$).

Discussion

- Children with NH showed significantly high benefit of spatial separation between the target and the masker, and this is on par with the SRM literature.
- The limited benefit of spatially separating target and maskers for children with bilateral CIs was observed and this may be due to several factors, including that the two CIs are not capturing the cues of inter-aural time and inter-aural level differences and therefore not synchronized during signal processing.
- Although not statistically significant, benefits of spatial separation of the target and maskers were larger in;
 - children received the second CI < 3 years of age
 - and
 - children with < 2 years of inter-implant delay
- Future work will focus on factors that may improve and provide further insight into spatial hearing including cognitive factors, synchronized processors and the use of sentence length stimuli.

References

- Hess, C.L., Misurelli, S. M., & Litovsky, R.Y. (2018). Spatial Release from Masking in 2-year-olds with Normal Hearing and with Bilateral Cochlear Implants. *Trends in Hearing*, 22, 1-13.
- Litovsky, R. Y. (2005). Speech intelligibility and spatial release from masking in young children. *The Journal of the Acoustical Society of America*, 117(5), 3091-3099.
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- Misurelli, S. M., & Litovsky, R. Y. (2015). Spatial release from masking in children with bilateral cochlear implants and with normal hearing: Effect of target-interferer similarity. *The Journal of the Acoustical Society of America*, 138(1), 319-331.

Acknowledgements

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