A band-aid fixed bone-conduction hearing aid – the ADHEAR – a new and useful treatment option for children with conductive hearing loss*

Katrin Neumann[1,2,3], Christiane Völter[2,3], Jan-Peter Thomas[3], Stefan Dazert[3]

[1]Dept. of Phoniatrics and Pediatric Audiology, Cochlear Implant Center, [2]Clinic of Otorhinolaryngology, Head and Neck Surgery, St. Elisabeth-Hospital, Ruhr-University Bochum, Germany

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Objective

Permanent conductive hearing loss in children: malformations of the outer and middle ear, in particular ear atresia, syndromes, chronical draining ears

Hearing aids (HAs):

- **(Air conducion HAs)**
- **Bone conduction HAs**: softband, headband, hearing glasses

Problem: pressure on the head → fitting not before 6 mos. of age, sweating, cosmetic stigma, restricted transcutaneous transmission

Desirable: device which does not disturb children, apply pressure on the head, and stigmatize

ADHEAR study with children with conductive hearing loss

Controlled clinical study

Participants: 12 children with a permanent conductive hearing loss aged 0;8-9;8 years

unilateral ear atresia: 8

bilateral ear atresia 1

bilateral middle ear malformation with unilateral ear atresia: 1

Down syndrome with chronical draining ears: 1

Bilateral low-frequency conductive hearing loss, ciliary dyskinesia, chronical draining ears, intellectual disability: 1

Aim: evaluation of audiometric benefit, usage and patients' and parents' satisfaction

Design: ADHEAR system compared with a headband-integrated bone conduction hearing aid

Assessments: initially with both hearing devices and after 8 weeks with ADHEAR only

aided and unaided pure tone/behavioral observational audiometry and speech audiometry both in quiet and noise; questionnaires for parents and children

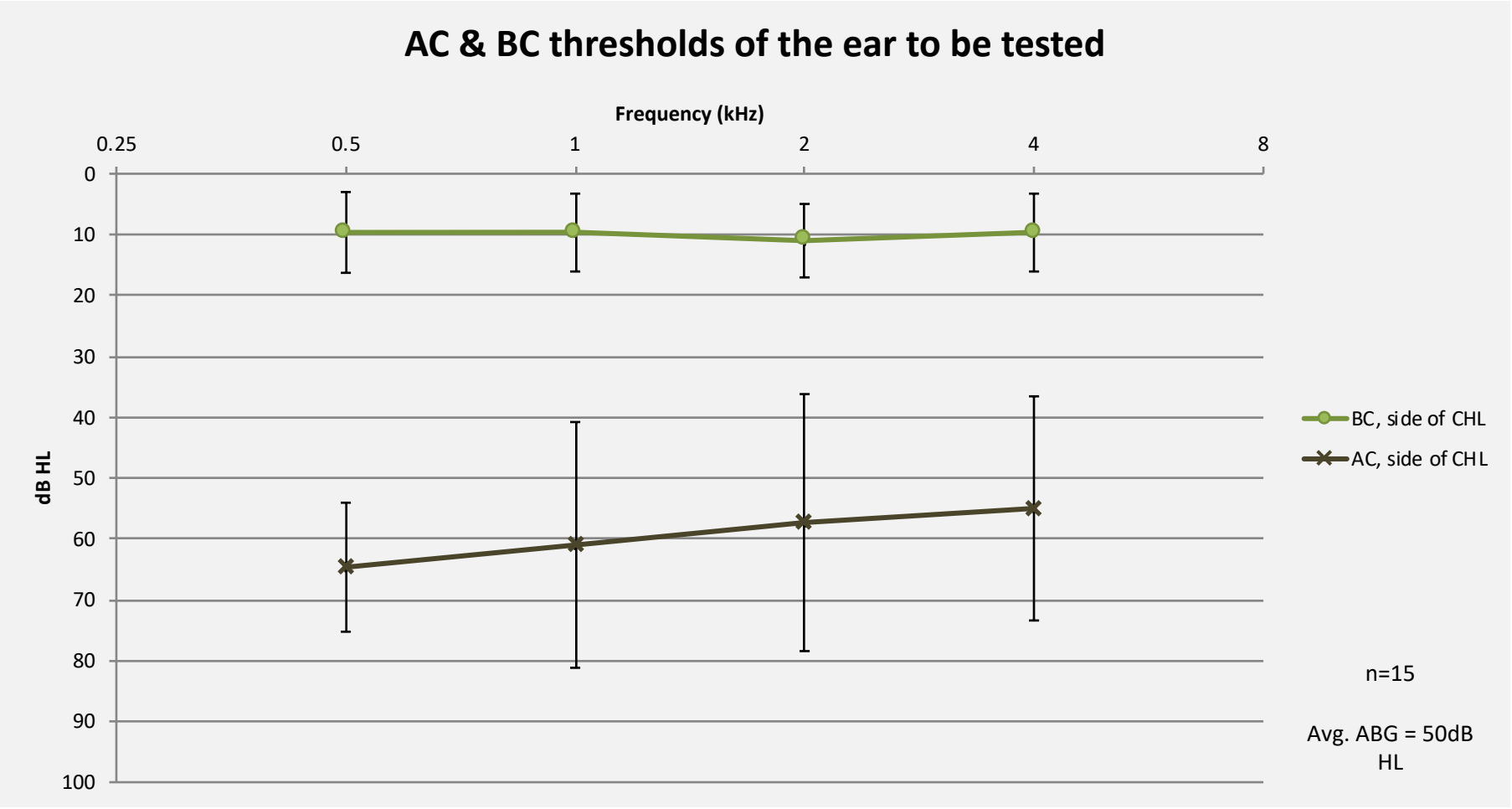
Participants

Mean age (year; month): 4;2

No.	Age	Indication	Treatment
1	9;8	Bilateral conductive hearing loss, Down syndrome, recurrent ear secretion	Air conduction hearing aids (ACHAs) bilateral (softband-integrated BCHAs not accepted)
2	8;9	Unilateral conductive hearing loss, ear atresia	Softband-integrated BAHA 4, because of stigmatization only rarely used
3	0;10	Unilateral conductive hearing loss, ear atresia	Untreated
4	3;9	Unilateral conductive hearing loss, ear atresia	Softband-integrated BAHA not well accepted
5	7;2	Unilateral conductive hearing loss, ear atresia	Softband-integrated BAHA because of stigmatization not accepted
6	3;10	Bilateral low-frequency conductive hearing loss, ciliary dyskinesia, ear secretion, intellectual disability	Softband-integrated BAHA not accepted
7	6;11	Unilateral conductive hearing loss, ear atresia	Softband-integrated Bruckhoff -HA regularly used
8	4;11	Bilateral conductive hearing loss, ear atresia	Softband-integrated BAHA well accepted
9	2;6	Unilateral conductive hearing loss, ear atresia	Untreated
10	0;8	Unilateral conductive hearing loss, ear atresia	Untreated
11	0;8	Unilateral conductive hearing loss, ear atresia	Softband-integrated BAHA not well accepted
12	0;8	Bilateral conductive hearing loss, ear atresia right, middle ear malformation left	Trial with softband-integrated BAHA right: not covered by health insurance→trial with softband-integrated Bruckhoff BCD – pressure marks on the head; trial with ACHA left – not well accepted

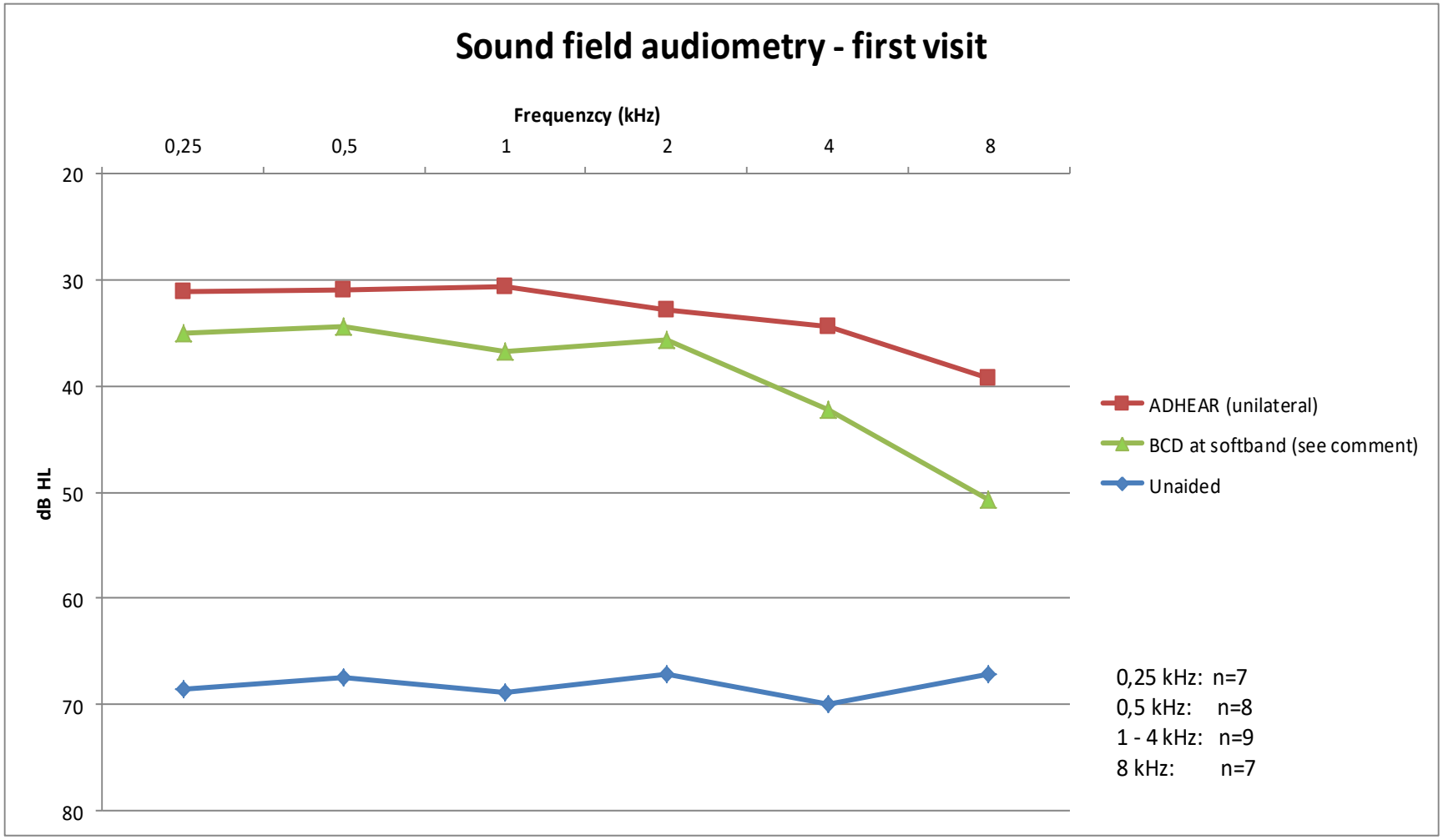
Results

Pure tone audiometry (PTA) or auditory brainstem response (ABR) thresholds



Results

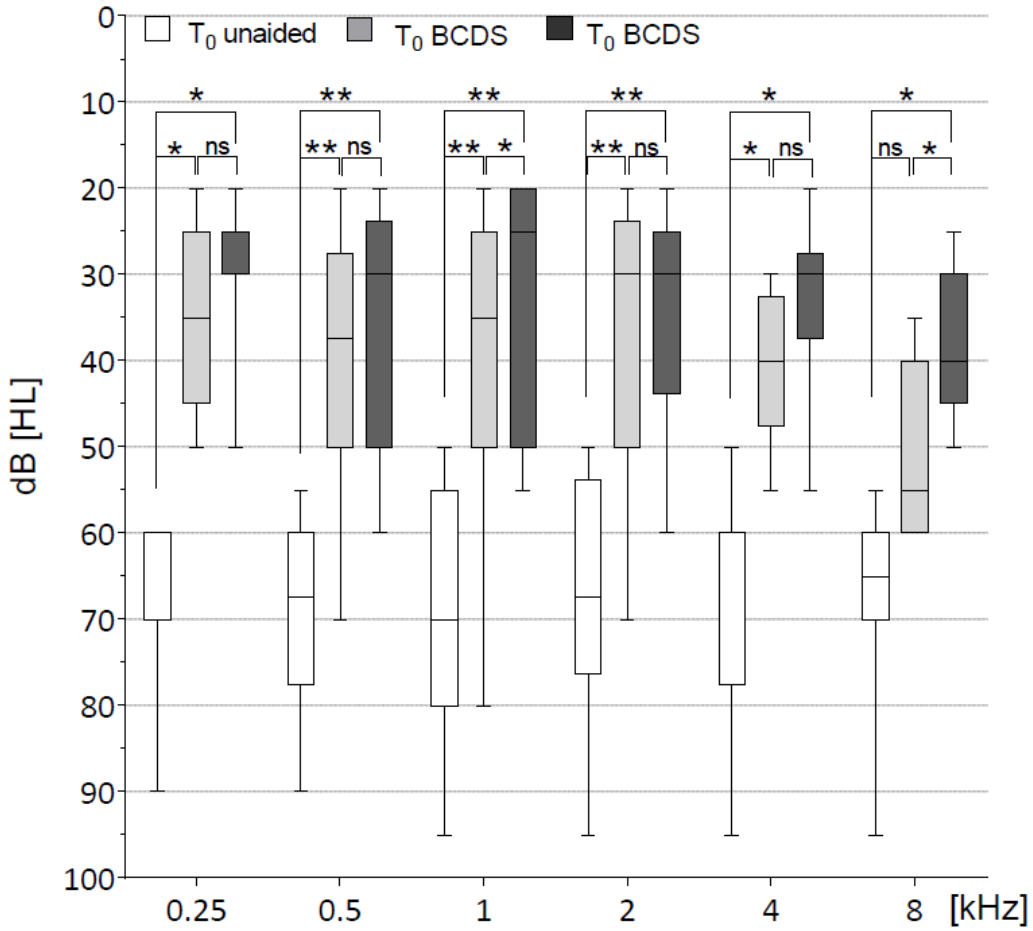
Soundfiled audiometry (initial recording)



Comment:
2 of 9 childen used their own BCD at softband (well fitted) which they were accustomed to.
One child of these was tested with bilateral BCD at softband, while ADHEAR was fitted unilateral.

Results

Soundfiled audiometry (initial recording) (Neumann et al., submitted)



Unaided

Aided with BCD-S

ADHEAR

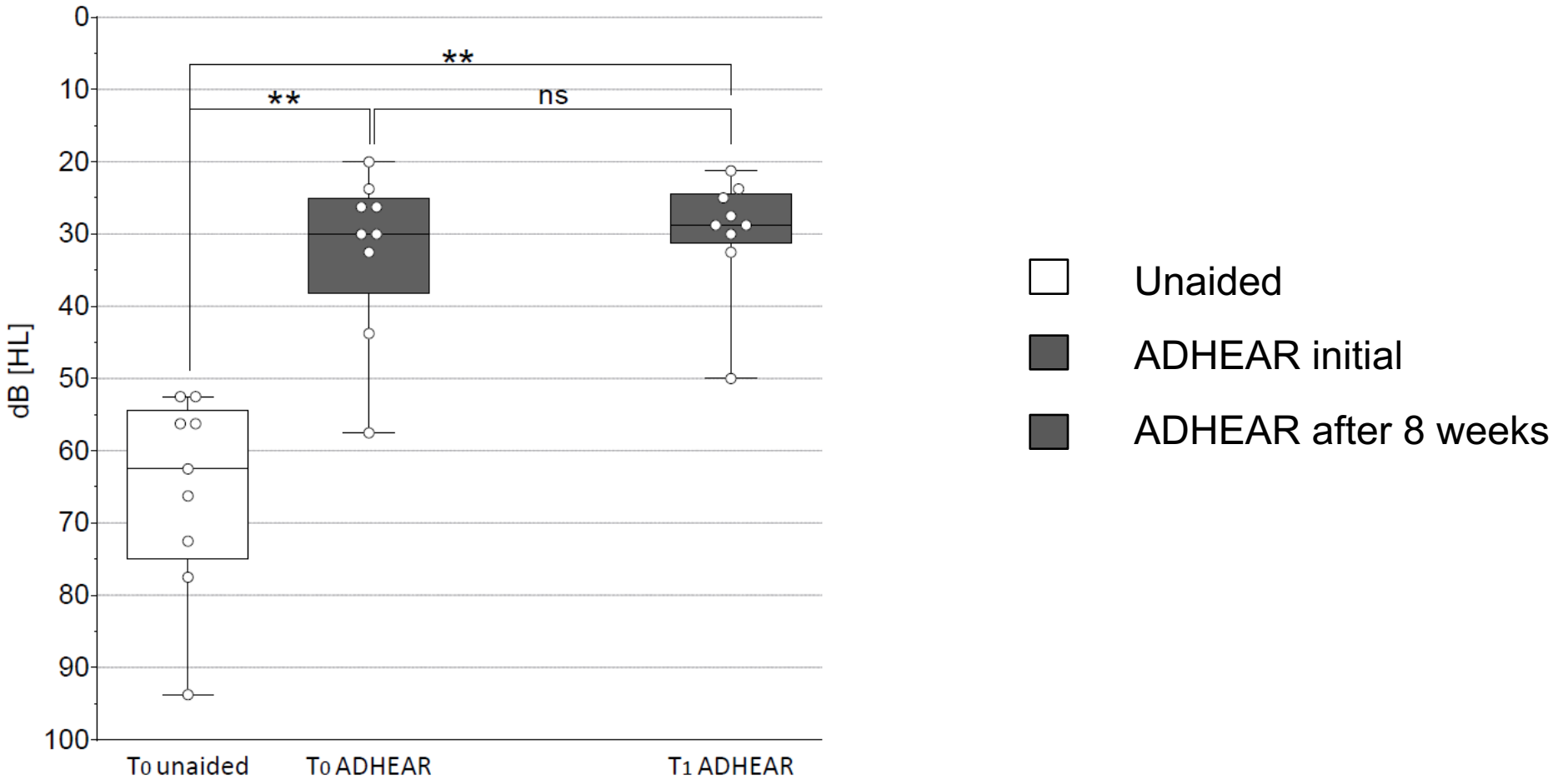
0.25 kHz (n = 7), 0.5 kHz (n = 10), 1 kHz (n = 11), 2 kHz (n = 10), 4 kHz (n = 9), 8 kHz (n = 7)

*significant improvement with ADHEAR compared to unaided situation from 0.5-8 kHz and with bone conduction device on softband (BCDS) from 0.5-4 kHz

significant improvement with ADHEAR compared with BCDS at 1 and 8 kHz

Results

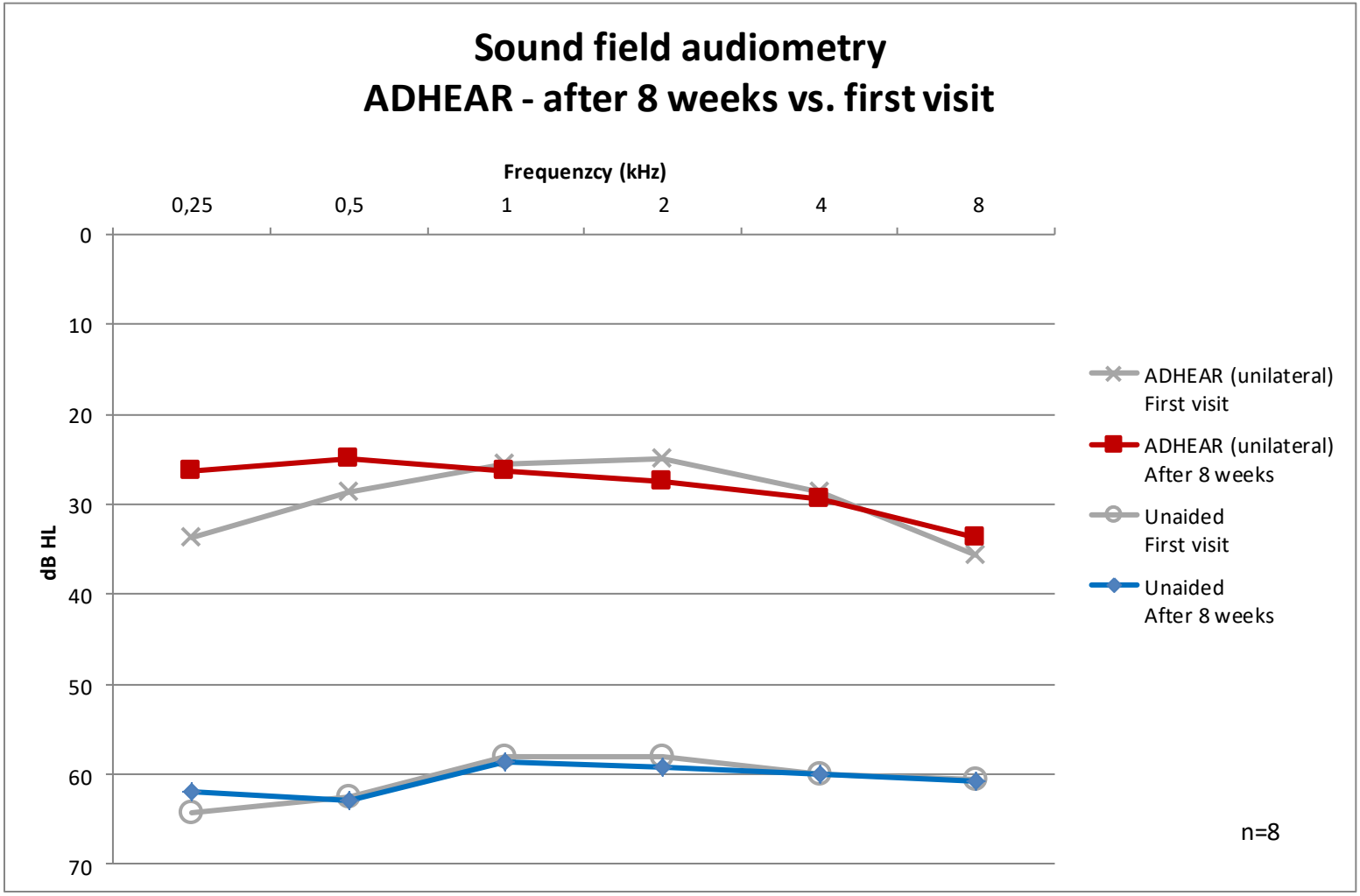
Soundfield audiometry (8 weeks) (Neumann et al., submitted)



Soundfield thresholds averaged over 0.5, 1, 2, and 4 kHz for unaided (white) ans fitted with ADHEAR conditions at initial testing (T0, middle gray box) and 8 weeks later (T1, right gray box) (n = 9): no further improvement

Results

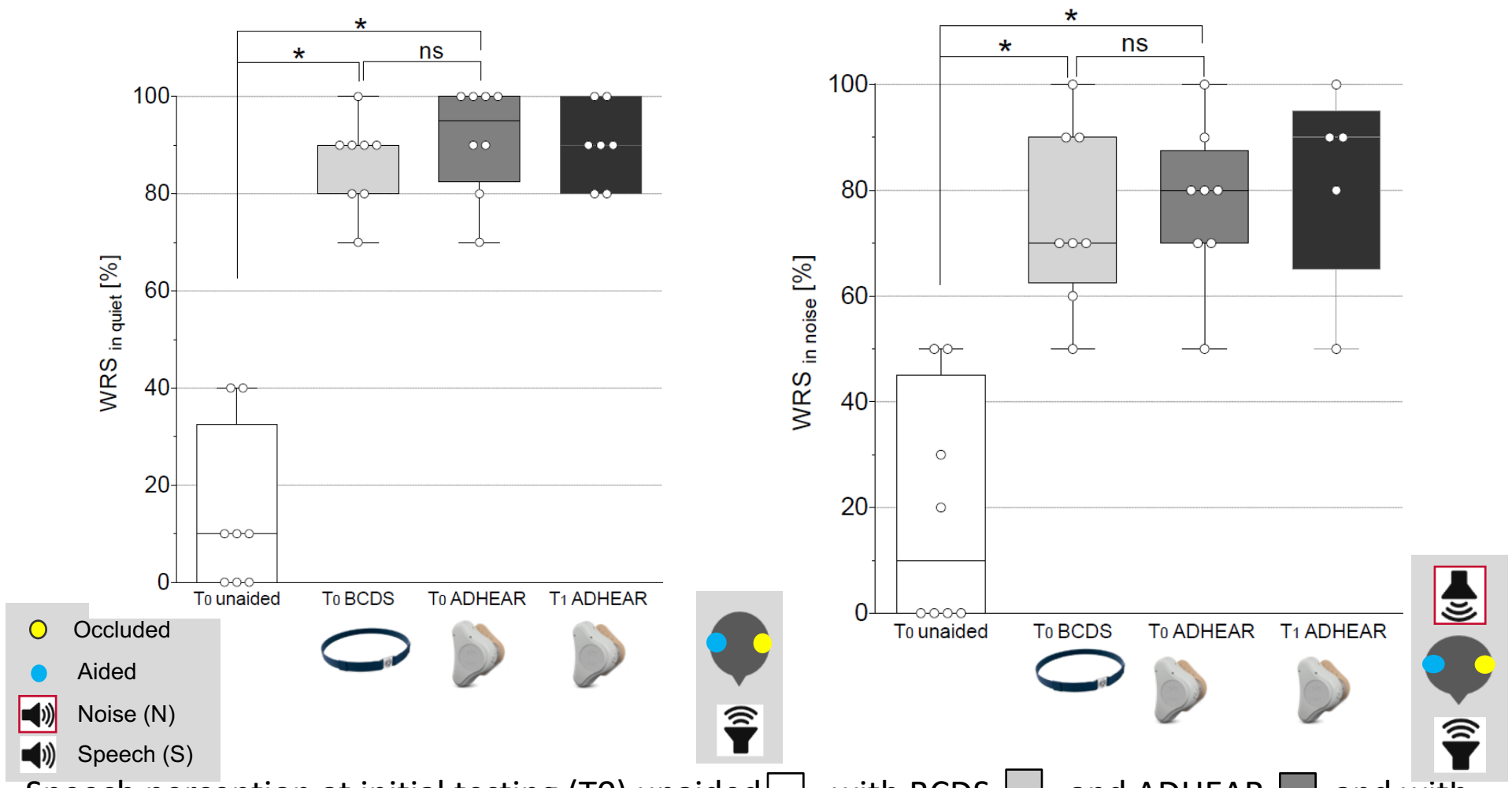
Soundfield audiometry (8 weeks)



Results (Neumann et al., submitted)

(a) *Speech in quiet*

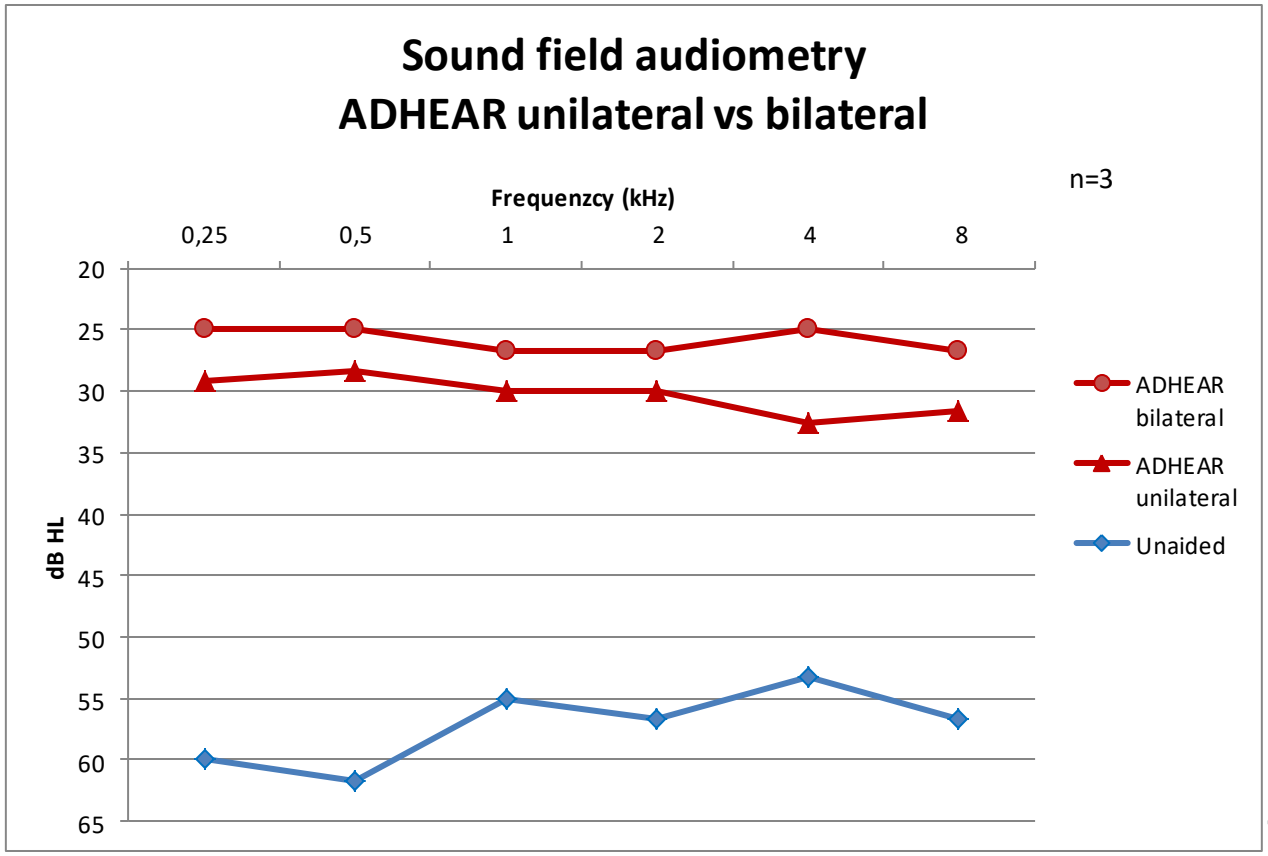
(b) *Speech in noise*

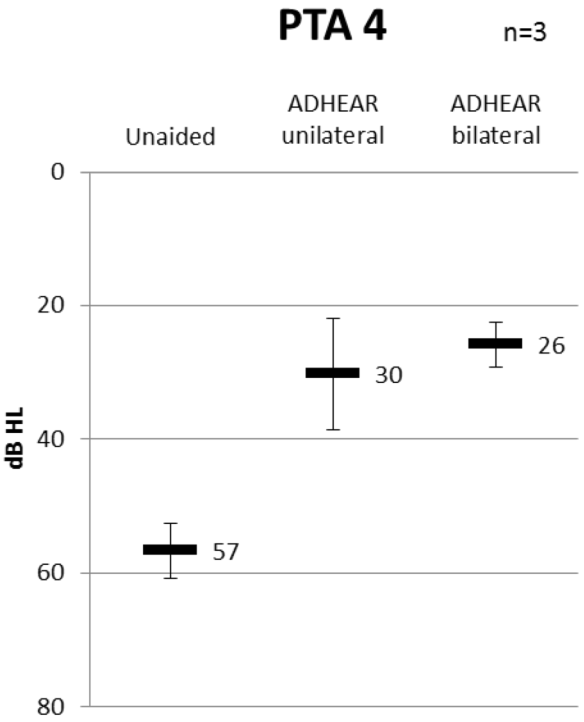


Speech perception at initial testing (T0) unaided □, with BCDS ▒, and ADHEAR ▓ and with ADHEAR after 8 weeks (T1) ■ for (a) speech in quiet (n = 8 at T0, n = 7 at T1) and (b) speech in noise (n = 8 at T0, n = 5 at T1): significant improvement compared with unaided situation

Results

Soundfiled audiometry – bilateral fitting





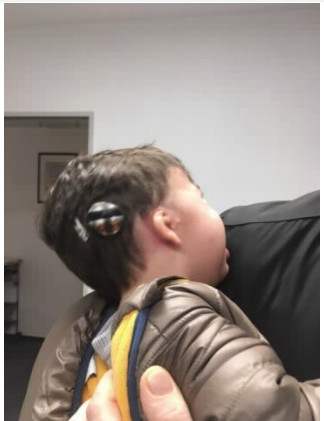
ADHEAR Questionnaire

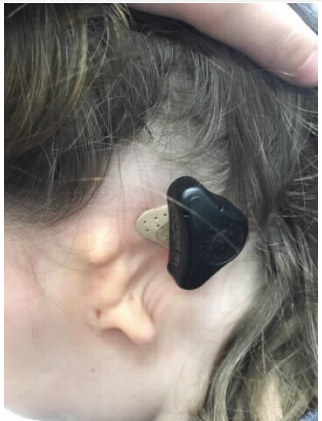
n=8

	Reply	100%			
How often on average did you change the ADHEAR band aid adapter?	□ Less than once a week □ Once a week □ Twie a week □ Every second day □ Every day	Every day 38%	Every second day 25%	Twice a week 25%	Once a week 12.5%
How many hours per day did your child wear the ADHEAR?	___ hours per day	1-4 hours per day 25%	5-7 hours per day 12.5%	>8 hours per day 62.5%	
Was the ADHEAR system a useful hearing aid for your child?*	□ Very useful □ Useful □ Partially useful □ Not useful	Not useful 12.5%	Useful 25%	Very useful 62.5%	
Did you face skin problems of your child where the ADHEAR band-aid adapter was fixed?*	□ No, never □ Yes, a little □ Yes, somewhat disturbing □ Yes, very awful	Yes, a little 50%	No, never 50%		
Did the people in your sourrounding notice that your child wears a hearing aid?	□ Nearly never □ Rarely □ Most of the time	Most of the time 25%	Rarely 50%	Nearly never 25%	
How would your child evaluate the sound quality of the ADHEAR?*	□ Very good □ Good □ Sufficient □ Poor □ Very poor	No reply 12.5%	Sufficient 12.5%	Good 25%	Very good 50%
How do you evaluate the esthetics of the ADHEAR band-aid adapter and the audio processor?*	□ Very good □ Good □ Sufficient □ Poor □ Very poor	No reply 12,5%	Poor 12.5%	Sufficient 12.5%	Good 25%	Very good 37.5%
Did your child speak more clearly while wearing the ADHEAR?	□ Yes, __ □ No, __	No reply 25%	No 12.5%	Yes 62.5%	

Discussion

Advantages	Disadvantages	Problem solution
Benefit for listening	Occasionally poor adhesion of the band-aid, in particular for children <1 year (handling, activity, specifics of skin of children, sweating, manipulation, curvature of mastoid)	Optimization of band-aids: • Skin preparation • Fixing band-aid for a while without sound processor • Variations of band-aids • Blow-dry of band-aids
Good alternative for a soft-/headband-integrated BCHA	Few cases of skin reactions	Skin barrier creme (Cavilon)
No pressure, children forget about wearing a device	Feedback noise	Feedback suppression by software
No or only little stigmatization	Wearing comfort (hats, leaning against car seats etc.)	Special hats with capsule?





Conclusion

- After finishing the study, 7 of 11 children (1drop-out) keep on wearing ADHEAR
- Comparable or better audiological results than with conventional, softband-integrated BCDs
- New transmission concept of vibrations via a band-aid – avoiding pressure on the head – in connection with the ADHEAR audio processor functions
- For children with conductive hearing loss due to ear atresia or middle ear malformations, frequently draining ears or otherwise upleasent occlusion or stigmatization effects of BCDS the ADHEAR seems to be a very good alternative.
- Useful for bridging a longer period until ear surgery (Vibrant Soundbridge, Bonebridge, BAHA)

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