

CRITICALLY APPRAISED TOPIC #2

DIGITAL SIGNAL PROCESSING

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PICO

- **PICO Question:**
- *In adults with sensorineural hearing loss is there more improvement in speech intelligibility, as measured by the (WIN, HINT, QSIN), when using digital signal hearing aids when compared to analog conditions?*

- **Details of Evidence Request:**

- **Patients:** Adults with mild to moderate SNHL
- **Intervention:** Digital Signal Processing (DSP) Hearing Aids
- **Comparison:** Non-DSP/analog hearing aids
- **Outcomes:** Performance on speech recognition task

Background

- Digital signal processing in hearing instruments may alleviate some of the adverse effects of hearing problems.
 - Reduce feedback
 - Reduce noise, for improved intelligibility
 - Automatic adjustments according to environment
- **1991**: first BTE HA using DSP for feedback reduction was introduced
- **1996**: first entirely digital HAs, in which DSP was used, became commercially available.

Search Terms

Field of Focus	Search Term
Disease-related	Hearing loss, sensorineural hearing loss
Intervention-related	Hearing aids, analog, digital signal processing, digital hearing aids
Outcomes-related	Speech recognition performance, satisfaction

Resources Searched

- **Resources Searched (Sept – Oct 2008)**
- Searched the following databases and Internet websites:
 - Academic search premier
 - Wilson omnifile full text mega edition
 - General OneFile
 - CQ researcher
 - Pubmed*
 - Google Scholar*



**USF Libraries
MetaSearch
Engine**

* Most relevant hits

Hits

	ASP	WO	GO	Pub Med	Google
digital signal processing hearing aids	37	10	826	344	thousands
digital signal processing analog speech recognition	0	5	1033	12	thousands
Digital signal processing speech recognition	50	28	2616	180	thousands
Digital signal processing speech recognition hearing aids	7	0	175	67	thousands

Reference list review: 4 hits

Inclusion Criteria

- Primary studies comparing digital signal processing hearing aids with analog hearing aids particularly using speech recognition as an outcome measure
- Males &/or Females
- Adult &/or Elderly

Exclusion Criteria

- ❑ Children and adolescents
- ❑ Trade Journals

Search Strategy Results

Search strategy resulted in **three** articles for review:

- Bille, M., Jensen, A., Kjoerbol, E., Vesterager, V., Sibelle, P., Nielsen, H. (1999) Clinical Study of a digital versus an analogue hearing aid. *Scandinavian Audiology*, 28:127–35.
- Magni, C., Freiburger, F., Tonn, K. (2005) Evaluation of satisfaction measures of analog and digital hearing aid users. *Brazilian Journal of Otorhinolaryngology*, 71: 650-7.
- Wood, S., Lutman, M. (2004) Relative benefits of linear analogue and advanced digital hearing aids. *International Journal of Audiology*, 43, 144-155.

Search Strategy Results

First Author and Year of Publication	Location	Comparison	Control Patients	N	Outcomes
Billie, 1999	Denmark	Digital vs. Analog	N/A	25	Speech rec in noise, preference, satisfaction, self-assessment
Magni, 2005	Brazil	Digital vs. Analog	N/A	40	Self-assessment IOI-HA
Wood, 2004	UK	Digital vs. Analog	NA	100	Speech rec in noise, self-rated benefit APHAB, GHABP, QoL, preference

Bille et al (1999)

□ PURPOSE

- This study compares a DSP HA with a modern analogue HA with programmable fitting
 - ▣ Identical in appearance
 - ▣ Test subjects were blinded
 - To avoid the bias tending to favor the “new and modern” instrument

Bille et al (1999)

- PARTICIPANTS
- 25 experienced HA users with SNHL
 - ▣ 9 males, 16 females
 - ▣ Median age 72
 - ▣ 16 binaural fit, 9 monaural
- Test subjects acted as their own controls
- 6-9 weeks of acclimatization

Bille et al (1999)



- OUTCOME MEASURES
- Improvements in speech recognition score in noise with HAs
- Overall preference for HA
- Overall satisfaction
- Self-assessment questionnaire

Bille et al (1999)

□ RESULTS

- **No significant** difference were found in **speech recognition score in noise**
- **Overall preference:**
 - 11 subjects preferred digital HA
 - 10 subjects preferred analogue HA
 - 4 subjects had no preference
- **Overall satisfaction**
 - 8 subjects – digital HA
 - 7 subjects – analogue HA
 - 10 subjects – rated both equal
- Acceptability of **noise from traffic** was the only outcome parameter which gave a significant difference between the HAs in favor of the **digital HA**.

Bille et al (1999)

Situation	Digital hearing aid (<i>n</i> = 25) %	Analogue hearing aid (<i>n</i> = 25) %	Use of hearing aid	Digital hearing aid (<i>n</i> = 25) %	Analogue hearing aid (<i>n</i> = 25) %
At home on ordinary days	96	96	> 8 h every day	80	84
Listening to TV/radio	100	96	4–8 h every day	20	16
In the street	92	92	Not in use every day	0	0
In company with a few others	100	100			
When telephoning	44	40			
At parties	84	92			
At the theatre	28	20			
Taking lessons	32	32			
At outdoor activities	88	88			
At work	24	24			

*No significant differences

Magni et al (2005)

□ PURPOSE

- To investigate satisfaction of analog and digital hearing aid users

□ PARTICIPANTS

- 20 analog hearing aid users (Group I)
- 20 digital hearing aid users (Group II)

Magni et al (2005)

□ RESULTS

□ IOI-HA

- Group II used the hearing aid longer every day than than Group I
- Group II had fewer difficulties in some situations over Group I
- Both groups reported satisfaction with their hearing aids

Magni et al (2005)

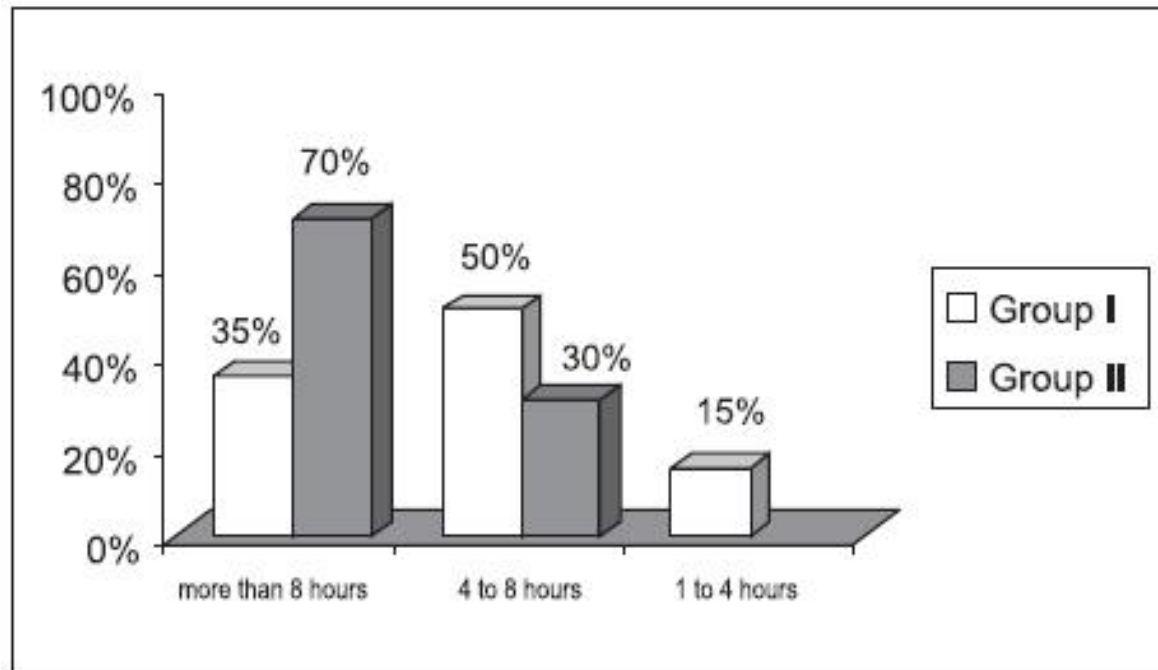


Figure 1. Distribution of the percentage of analog (Group I) and digital (Group II) hearing aid users concerning hours of daily use.

*On average Group II wore HA longer each day

Wood et al (2004)

□ PURPOSE

- To investigate speech recognition performance and self-reported benefit from linear analogue and advanced (digital) hearing aids in 100 first-time users with mild to moderate SNHL fitted monaurally with a BTE in a single-blind randomized crossover trial.

Wood et al (2004)

- METHODS
- Subjects used each aid for 5 weeks
- Aided speech recognition performance was measured at speech levels of 65 and 75 dB at a SNR of +2 for closed sets of single words.
- APHAB & GHABP
- QoL, HA use, and preferences were also assessed

Wood et al (2004)

□ RESULTS

- **Speech rec scores** with the **digital** aids were significantly **better** at 75 dB than with analog aids
- **Self-reported benefit** (APHAB & GHABP) and improvement in QoL were *generally not significantly different*
- Aversiveness measured with the APHAB was significantly lower with digital aids, and satisfaction measured with the GHABP was greater.
- **Digital aids were preferred** significantly over analog aids: 61 preferred digital, 26 analog.
- Overall, this study shows advantages for digital aids over linear analog aids in both objective and subjective outcomes although the average differences are **not large**.

Wood et al (2004)

Table 9. Preferences in different listening situations (D=digital)

<i>Situation</i>	<i>Preference</i>			<i>Significant preference</i>
	<i>NHS</i>	<i>Digital</i>	<i>None</i>	
Speech in quiet	17	32	51	D
Speech at a distance	22	42	36	D
Speech in a background of street/traffic noise	27	42	31	–
Speech in a background of other talkers	22	44	34	D
Listening to music	12	34	54	D
Overall sound quality	21	50	29	D
Acceptability of high levels of background noise	27	47	26	D
Acceptability of own voice	19	32	49	–
Performance in a changing communicative environment	23	34	43	–

Discussion

- Bille et al (1999) – no significant differences
- Magni et al (2005) – digital
- Wood et al (2004) – digital

Conclusion

- Overall the use of digital hearing aids over analog hearing aids do improve speech intelligibility (in noise) when compared to analog hearing aids, but the improvement is small.
- Digital hearing aids are to a certain extent successful at reducing background noise (DNR, d-mics, etc) which makes the signal more audible.

References

- Bille, M., Jensen, A., Kjoerbol, E., Vesterager, V., Sibelle, P., Nielsen, H. (1999) Clinical Study of a digital versus an analogue hearing aid. *Scandinavian Audiology*, 28:127–35.
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