

# Preliminary results of the Adult multicentral European HiRes 120 study

B. Kienast, P. Boyle

Advanced Bionics, 76 rue de Battenheim, 68170 Rixheim, France

Over the years, new speech coding strategies have been developed, resulting in a continuous improvement in performance. In 2003, Advanced Bionics released the HiResolution<sup>®</sup> strategy (HiRes<sup>®</sup>), which implemented more spectral channels and provided higher stimulation rates than previous speech coding strategies. Recent research has shown that using current steering to stimulate sites between two physical electrode contacts can benefit subject performance<sup>1</sup>. The 'current steering' technique, something that has been understood for many years<sup>2,3</sup>, is the basis for the newly implemented HiRes Fidelity with 120<sup>TM</sup> Sound Processing (HiRes 120) strategy. This paper reports European data from a multicentre adult HiRes 120 study. The study had four goals: 1) investigate the benefit of HiRes versus HiRes 120 speech coding; 2) determine benefit of the new Harmony<sup>®</sup> sound processor<sup>4</sup> versus subject's own processor; 3) identify

variables to predict benefit of HiRes 120 speech coding; and 4) develop fitting guidelines.

The study was composed of five protocols (see table 1.). Four protocols investigated the benefit of HiRes 120 with subjects that had at least three months of HiRes experience. One protocol option focused on first fitting of HiRes 120 in combination with the Harmony processor. Protocol duration varied from four to eleven months. Subjects were evaluated within various protocol options at different times, having exposure of at least three months to HiRes as well as HiRes 120. Speech perception tests were conducted and in addition, speech quality, music appreciation and processor appreciation questionnaires were delivered. In total 80 subjects have been enrolled at 13 centres across Europe.

Option	1	2	3	4	5
Name of the option	PSP short	Harmony short	Harmony cross-over	First fitting	Custom study
Processor used	PSP	Own processor, Harmony	Own processor, Harmony	Harmony	PSP
subjects	7	24	1	36	12
Duration (months)	4 (5 for BTE user)	4	5	11	5

Table 1: study design overview of the adult HiRes 120 study in Europe

This paper will not report on option four, first fitting with the Harmony in combination with HiRes 120, since insufficient stable longer term data are yet available.

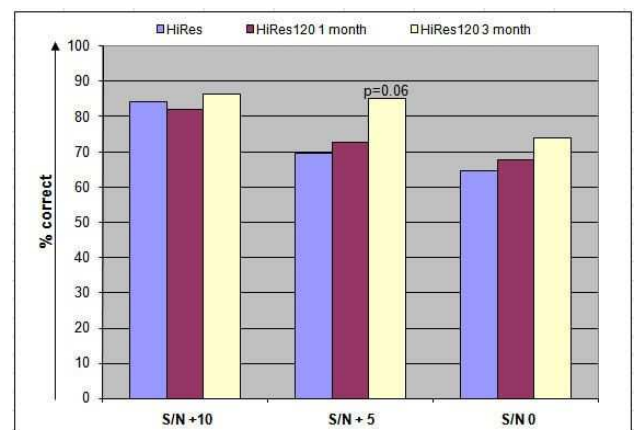
The paper will focus on results from options one and two, which consider subjects with at least nine months of CI experience. A total of 31 subjects were enrolled in these options.

For option one, subjects previously using a BTE processor were switched to a PSP, still using HiRes, before evaluating their baseline. All subjects were then switched to HiRes 120 for 3 months and evaluated after one and three months of HiRes 120 use.

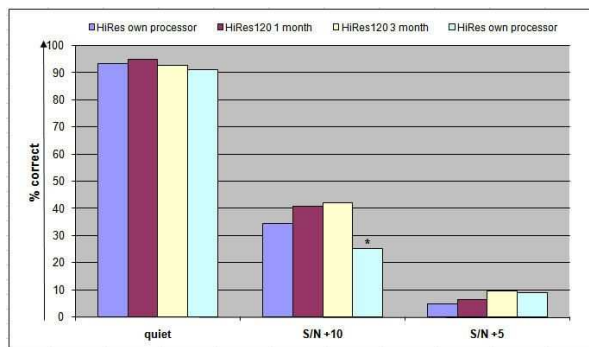
Option two included subjects who used HiRes on a previous generation Advanced Bionics processor (PSP, Auria, BTE I or BTE II). Subjects were upgraded to the Harmony processor and HiRes 120. Option two subjects then experienced HiRes 120 for three months and were evaluated after one and three months. Following three months of HiRes 120 use all subjects were switched back to the initial configuration (own processor and standard HiRes) which they used for a further month.

Graph 1. shows the results of five subjects from option one with the Italian PPV test (test created by Elena Amigoni / Milan, Italy) . An improvement over

time with HiRes 120 can be seen, the improvement approaching significance for the +5 dB SNR condition. Mean HiRes scores across the different noise conditions shows a greater drop than do the HiRes 120 scores at three months. This implies that HiRes 120 is more stable than HiRes for listening in noise.



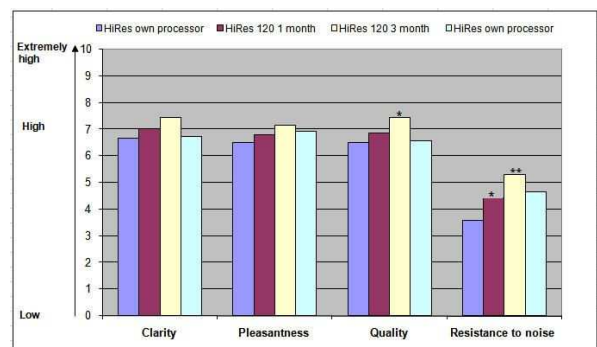
Graph 1: Italian PPV sentence test, Option 1, PSP short, n=5



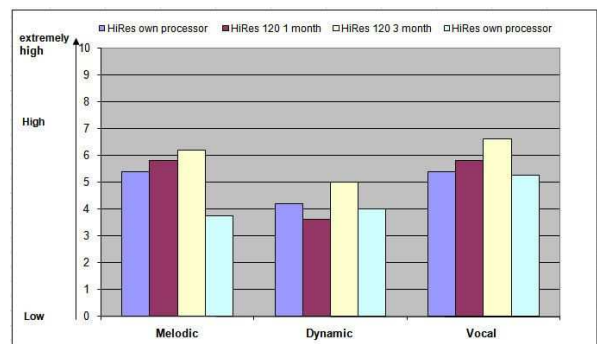
Graph 2: HSM sentence test, Option 2, Harmony short, n=8

For option two German HSM sentence<sup>5</sup> data are shown. The results from option two are basically what a centre might see when upgrading subjects to the Harmony processor and HiRes 120. In graph two a ceiling effect is seen in quiet and a floor effect is present at +5dB Signal to Noise Ratio (SNR). This indicates that more sensitive tests, such as the ABC sentence test<sup>6</sup>, are required to be able to show performance differences. At +10dB SNR an improvement for HiRes 120 over time can be seen. A significant drop (paired two-tailed Student t-test  $p<0.05$ ) was seen when subjects were switched back to HiRes and their own processor for one month following their three months of HiRes 120 and Harmony use. The fact that group mean HiRes score was less than baseline for these experienced users indicates that HiRes 120 is quite different from HiRes and a considerable time period is required to adjust to either strategy.

Objective data do not necessarily fall inline with subjective data therefore, all subjects were asked to complete Speech Quality Questionnaires. Results detailing clarity, pleasantness, overall speech quality and the extent of background noise interfere are shown in graph 3. Higher scores indicate better performance. An improvement for HiRes 120 over time can be seen for all displayed categories. Improvements after three months of HiRes 120 use are significant for the overall quality of speech (paired two-tailed Student t-test  $p<0.05$ ) and highly significant for the judgement of background noise interference with speech (paired two-tailed Student t-test  $p<0.01$ ). Clarity, pleasantness and overall quality of speech were rated with over 7/10 responses; representing 'clear', 'pleasant' and 'high quality' respectively.

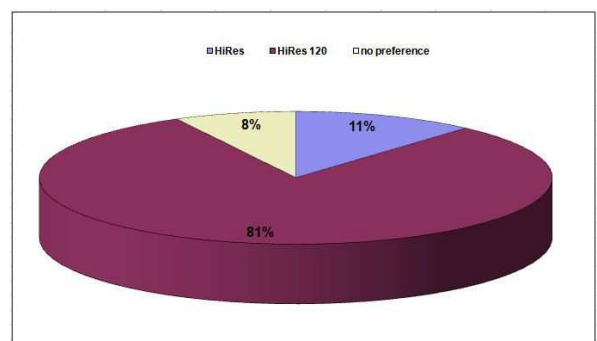


Graph 3: Speech Quality over time, Option 2, Harmony short, n=14



Graph 4: Pleasantness of music over time, Option 2, n=4

Evaluation music appreciation was also part of option two. To reflect the great variety of music, three different musical pieces were selected (representing melodic, dynamic and vocal music). To ensure that all subjects based their judgements of the same music the three pieces were recorded and provided to the participating centres. The same music questionnaires were used for all three pieces. All subjects were exposed to a least the dynamic piece. Only four subjects evaluated all three pieces as the testing procedure in total is very tiring. Graph four displays the results for the pleasantness of music. When listening to music using HiRes 120 an increase in pleasantness was reported for all three pieces. The vocal music piece was judged most pleasant overall.



Graph 5: Preference between standard HiRes and HiRes 120, n=26

Preference for processing strategy was determined via questionnaire and the results are summarised in graph five, showing that 80% of the subjects preferred HiRes 120 over Hires. Some 12% preferred HiRes while 8% did not state a preference.

In summary, it may be said that the clarity, pleasantness and overall quality of HiRes 120 after three months of use is rated at better than 7/10, representing 'clear', 'pleasant' and 'high quality' respectively. Benefits with HiRes 120 have also been recorded using measures of speech perception. Especially encouraging are the improvements when listening in competing noise. The 80% preference rate for HiRes 120 over HiRes underpins these findings, suggesting that still more sensitive speech perception measures are required to truly assess everyday life use.

## References

- Donaldson G.S., Kreft H.A., Litvak L. (2005); *Place-pitch discrimination of single- versus dual-electrode stimuli by cochlear implant users*; Journal of the Acoustical Society of America: 118(2), 623-626.
- Townshend B., Cotter N., van Compernelle D. White R.L. (1987); *Pitch perception by cochlear implant subjects*; Journal of the Acoustical Society of America: 82,106-115
- Wilson B.S., Lawson D.T., Zerbi M., Finley CC. (1994); *Recent developments with the CIS strategies*; In I. Hochmair-Desoyer and E. Hochmair E (Eds): *Advances in Cochlear Implants. Proceedings of the Third International Cochlear Implant Conference, Innsbruck, Austria, April, 1993* (pp. 103-112). Vienna, Austria: Datenkonvertierung, Reproduktion und Druck.
- Gault A., Frohne-Buechner C., Goldring J., Arnold A., Miller D., (2006); *Concept and technical features of a new HiRes Auria+ Processor: A paediatric friendly behind-the-ear Processor*; IX<sup>th</sup> International Cochlear Implant Conference Vienna, June, 14th - 16<sup>th</sup> 2006, Poster
- Hochmair-Desoyer I, Schulz E, Moser L, Schmidt M (1997); The HSM sentence test as a tool for evaluating the speech understanding in noise of cochlear implant users, *Am J Otol*:18 (6suppl);83
- Khajehnouri Y., Lenarz Th., Büchner A., *Input Dynamic Range testing*; 2007 Conference on Implantable Auditory Prostheses, Lake Tahoe, USA, July 15-20 2007

## Participating centres

**France:** Hôpital Avicenne, Paris / Beaujon Clichy / Hospital Edouard Herriot, Lyon / St. Antoine, Paris  
**Germany:** Klinikum d J W Goethe Universität Frankfurt / Medizinische Hochschule Hannover / Universitätsklinikum Freiburg / Universitätsklinikum Kiel  
**Italy:** University of Rome 'La Sapienza'  
**Spain:** Hospital Clínico Universitario, Valencia  
**Sweden:** Karolinska University Hospital Huddinge  
**United Kingdom:** Birmingham Adult Cochlear Implant Programme / RNTNE Hospital / South of England Cochlear Implant Centre