The HealthPAC project received its funding from the EU 7th Framework Programme Marie-Curie FP7-PEOPLE-2013-ITN under IDP Grant agreement nr. 604063

Name ESR and number in HP: Sebastian Ausili
Nationality: Argentinean
Research work-package (select): WP3 (HEAR)

Starting date ESR: 01-01-2015
Supervisor and co-supervisor: Prof dr Emmanuel Mylanus, Prof dr. John Van Opstal
Host-institution - Department: Donders Institute - Biophysics

RESEARCH

RESEARCH PROJECTS AND RESULTS FROM **01/01/2014** UNTIL **31/12/2017** ***(use 1-2 pages)***
(for each project give title, its goal(s), the main results and conclusions, with a representative photo/figure which we can use on the Website!
Indicate, where appropriate, Milestone/Deliverable number (see Annex 1 pp 25-26)

Project 1: Sound localization in real-time vocoder simulations with normal-hearing listeners

Bilateral and bimodal cochlear-implant (CI) users are poorer at localizing sounds than normal-hearing listeners. This performance gap is due to the degradation of the binaural and monaural cues for sound localization by an unknown combination of device-related and patient-related issues.

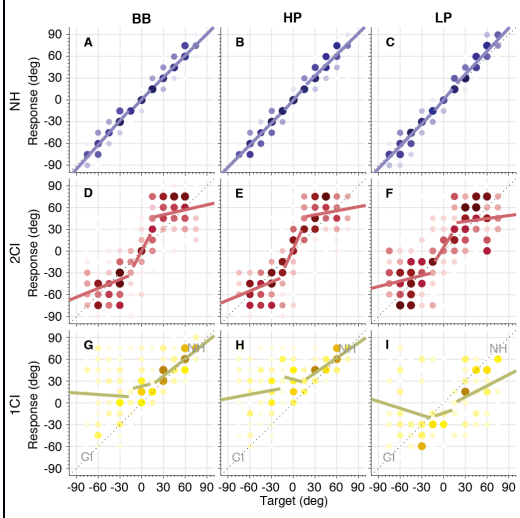

Figure 1. Azimuth sound localization performance the three conditions tested in the study: normal-hearing (NH), bilateral cochlear implant (2CI) and normal-hearing and contralateral cochlear implant (1CI).

The present study aimed to investigate the device-related issues by measuring sound localization performance of 11 normal-hearing subjects, listening to free-field stimuli that were processed bilaterally and unilaterally by a real-time cochlear implant vocoder. The use of a real-time vocoder is a new approach, which enables testing in a free-field environment.

All listeners accurately and precisely localized the sounds according to a linear stimulus-response relationship under normal-hearing listening (Fig. 1A,B,C), both in azimuth and elevation. In contrast, when listening with bilateral real-time vocoders, listeners tended to lateralize sound-source azimuth towards the correct hemi-field (Fig. 1D,E,F). They were unable to determine sound-source elevation. Moreover, when listening with a unilateral vocoder, localization was impoverished on the vocoder side, and typically improved towards the normal-hearing side (Fig. 1H,G,I).

We conclude that perturbation of temporal cues, reduction of level cues, and removal of spectral pinna cues by the vocoder impairs sound localization in the vertical and horizontal plane. Listeners seem to acutely ignore cues that were made unreliable by the vocoder, leading to a reweighting of the available localization cues.

We argue that currently applied device processors may prevent cochlear implant users to (learn to) localize sounds in everyday dynamic environments.

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Project 2: Spatial Hearing MEDEL

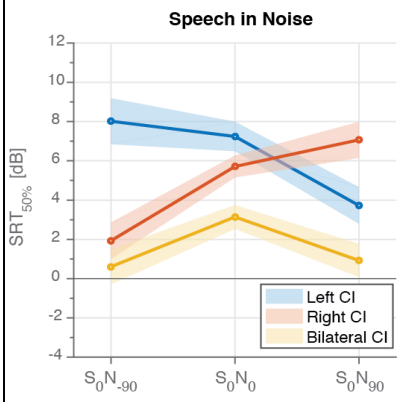

Figure 2. Speech in noise results for patients while using two Cis (Bilateral CI) or one CI (Left CI and Right CI).

A collaboration with a German Clinic (ENT Department from Bohum) result in a project started in the second part of 2016 with a group of 25 bilateral cochlear implanted (BICI) patients. This are all users of a new type of stimulation with potential benefit for bilateral user in their localization and speech in noise situations. In this group a localization test, speech in noise task and a psychoacoustic measurement were tested in order to better understand their binaural perception with two devices. Sound localization results does not deviate from other BICI users (e.g. Fig.3 of Project 3). The benefit in speech in noise with two devices was evident when compared with the unilateral case. Speech in noise was tested fixing the target (speech in front: S_0) with three noise positions (left: N_{-90}, front: N_0 and right: N_{90}). BICI users showed significantly better results (lower Speech Reception Threshold - SRT) when using two CIs than in the unilateral left or right CI condition.

With the data collected we can clearly show the benefits that are obtained in BICIs users as well as the limitations in their perception of binaural cues that impact on their spatial hearing.

Data was collected until the end of 2017 and a manuscript is being written.

Project 3: Spatial Hearing in Bilateral Cochlear Implant Users of the Oticon Neuro System

In this particular research four patients were studied during one year. These patients are users of a new cochlear implant system with new features from Oticon Medical (Denmark). Some of these new features were tested in relation to spatial hearing: localization abilities and speech in noise performance pre-and post-implantation. Three main research questions were approached: a) their sound localization performance; b) if there is any improvement over time and; c) their speech in noise performance. A benefit of the bilateral implantation was shown in our results in speech in noise and sound localization when comparing to unilateral cochlear implant users. Still, there is a big performance gap in sound localization between the patients and normal-hearing (Fig. 3).

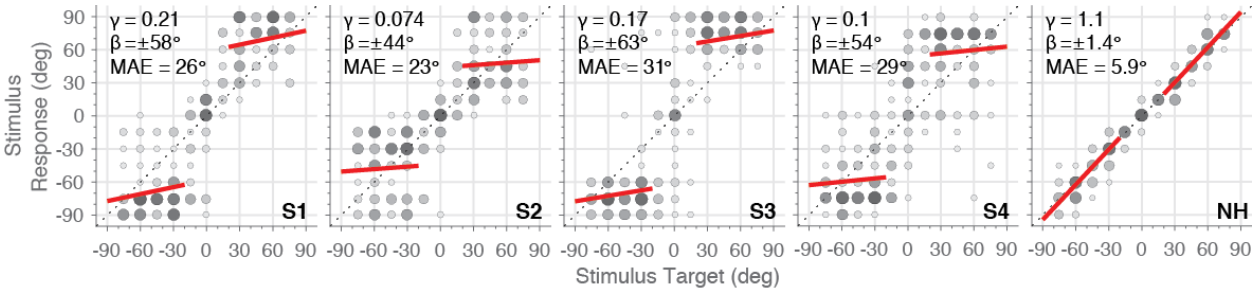

Figure 3. Sound localization performance of bilateral cochlear implanted patients (S1, S2, S3, S4) and a normal-hearing (NH) example as control.

This data was collected and a manuscript is being written and going to be submitted in the first months of 2018. The results inspired to continue a next investigation oriented to bilateral cochlear implantation and bimodal stimulation (cochlear implant and hearing aid in the contralateral ear). A new PhD student will follow more patients with this type of stimulation in another follow up study.

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Project 4: Sound localization in Bilateral, Unilateral and Unilateral-acute cochlear implant users. Which cues are they using?

There is increasing evidence of benefits on bilateral implantation over unilateral implantation in sound localization. Still, many of these studies compare the bilateral fitting with the unilateral by switching off one of the two devices in the same subject. This approach creates an (unilateral) acute listening condition which is not the one the subjects are used to and probably yielding a bigger performance gap. Experienced unilateral CI users might learn in their everyday life environments, how to exploit potential acoustics cues to locate sounds around them. If long-term unilateral CI users are well studied, the real benefit between bilateral and unilateral implantation might be better quantified and understood.

The present study aimed to determine: 1) how the sound localization performance and error vary across bilateral, unilateral and unilateral-acute CI listeners and; 2) which sound localization cues are available and are used in each of this groups.

BICI patients have lower RMS error in sound localization than the unilateral case, demonstrating the benefit of having two implants (Fig. 4). The unilateral cases do not perform the same, where the experience users showed less errors compared to the acute ones.

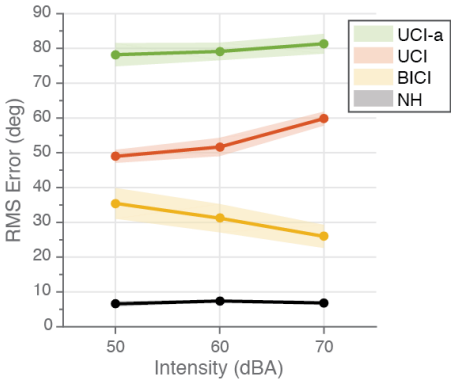

Figure 4. Sound localization RMS Error for bilateral CI users (BICI), unilateral CI users (UCI), acute unilateral CI users (UCI-a) and normal-hearing (NH).

OUTREACH ACTIVITIES

OUTREACH ACTIVITIES FROM 01/01/2014 UNTIL 31/12/2017

(mention your public presentations on open days, participation in general public events, press, etc. etc.: when, what and where).

Your publications: those that have been submitted/published (provide all bibliographic details), and those that you are currently finishing: give title, and foreseen journal, if possible)

Are there any patents? New foreground? Applications for the general public/society?

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ASARA Conference - Argentina

During my first visit to Argentina, my home country, a small conference was organized by the Argentinean Audiological Association (ASARA – Asociación Argentina de Audiología). There I presented some results from my PhD and discussed the possible future of cochlear implant technologies.
http://www.asara.org.ar/article.php?q=0000000076

Universidad Nacional de Tres de Febrero (UNTREF)

To maintain the contact and help my previous University back in Argentina (UNTREF), I supervised two master students for their degree in Acoustics. One thesis was particularly oriented in the design and elaboration of a low-cost head tracker. After its construction, it was validated and used for sound localization testing. The student tested normal-hearing as well as cochlear implant users. The thesis was finished and defended and the student already got the master degree in Acoustics. The second student tested 20 BICI patients with psychophysical experiments. Patients CI settings were changed in order to look for improvement in their binaural cues perception. Thesis finalized and will be defended in the first semester of 2018.

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TRAINING ACTIVITIES

TRAINING ACTIVITIES FROM 01/01/2014 UNTIL 31/12/2017

describe your courses (received and given), (summer)schools, and your Secondments: when, what, and where

Neurobiophysics

During the past three years, my teaching assistant activities were related to Neurobiofysica lectures guided by Prof. John van Opstal at the Science Faculty at Radboud University.

Business school

This business school was organized by Health Pac, Radboud University and TU Eindhoven and was done in April and May of 2017. Startups, business developers and senior industry managers shared their knowledge on business modeling and marketing and act as coaches when teams work on their project.

Summer School in Computational Sensory-Motor Neuroscience (CoSMo 2015)

Health PAC organized a Summer School in Computational Sensory-Motor Neuroscience. It was focused on computational techniques integrating the multi-disciplinary nature of sensory-motor neuroscience through combined empirical-theoretical teaching modules. The summer school took place June-July 2015.

Secondment in Oticon Medical

The main reason of this secondment was to learn and optimize a new Research Platform from Oticon that I wanted to use in my PhD experiments. This platform is intended to control the cochlear implant settings of the patients in real time and can link/synchronize both devices in a bilateral fitting. During the first period of the secondment, I've receive training in the software and programming capacities of the device. Also, since I was incorporated as part of the R&D group in this project, I have access to the details of the hardware and learnt the limitations of it as well. Later on, I oriented my time to code and prepare the necessary software for my particular research. After the secondment I went back to Nijmegen with the device to finalize the experiments there.
This took place August and September of 2016, in the Implant factory of Oticon Medical (Sophia Antipolis, France).

Nijmegen-Canada Exchange Program

I received funding for a collaboration proposal between Donders Institute and the Western University in London (Canada). This was a call for proposals and mine was favorable reviewed for founding including a visit to the Principal Investigator of Canada related in the study. We conducted a collaborative research about improving a bilateral cochlear implant model based on the data I've been collected at Donders Institute. This was carried out in September 2017.

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CONFERENCES

CONFERENCES, WORKSHOPS FROM 01/01/2014 UNTIL 31/12/2017
(mention which conferences and workshops you have attended: when and where)

Auditory Model Workshop

This workshop offered a forum to discuss the future of auditory models for improved understanding of the normal and hearing-impaired human auditory system. Combining overview talks with latest model advances, the workshop emphasized on the strengths and limitations of existing model approaches in answering key questions of auditory processing. This was done in Oldenburg (Germany), June 2015.

International Symposium of Hearing 2015

This Symposium was organized right after the Auditory Model Workshop in Oldenburg (June 2015). The 17th International Symposium of Hearing (ISH) was organized by members of Department of Otorhinolaryngology of the University of Groningen / University Medical Center Groningen.

Association for Research in Otolaryngology (ARO)

In this Association for Research in Otolaryngology - 39th Annual MidWinter Meeting, we presented our preliminary data in bilateral cochlear implant patient and a case study with electro-acoustic stimulation (EAS).
The title of the poster was: "Spatial Hearing by EAS-CI and Bilateral CI users" and the conference was in in United States, San Diego (February 2016).

14th International Conference on Cochlear Implants

The International conferences on Cochlear Implants and other Implantable Auditory Technologies is one of the most world-wide known in the field of cochlear implants for ENT surgeons, audiologist and researchers. This conference took place in Toronto (Canada) during May of 2016. We participated there we part of the ENT department from Radboudumc. There I presented a poster with the title: "Spatial Hearing by Bilateral Neuro System CI users".

Conference on Implantable Auditory Prosthesis

CIAP provides a unique forum for the presentation and discussion of fundamental scientific research from a diversity of basic science disciplines, as well as input from clinicians, engineers, and technical staff. The close interaction among leading scientific researchers from around the world facilitates the exchange of up-to-the-minute research results. I participated in this meeting on July 2017 and we presented two posters:

- "Spatial Hearing by Bilateral CI users with Fine-Structure Processing"
- "Sound Localization with Real Time Vocoder simulation in normal-hearing"

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FUTURE CAREER PLANS

Describe your future career plan(s), after the end of the project. Note: the PhD is obtained *after* HP (31/12/2017!), so it's part of the future career plan.
What are your career plans after obtaining your PhD?

Initially, during 2018, I will finish and submit the manuscript that are the 4 Projects already described in the "Research" section of this report. We plan to submit the manuscripts in peer-review journals before summer 2018. After that, I will write the necessary introduction and overall conclusion to submit the thesis and present myself as a candidate for PhD degree at Radboud University.

During this process, I will be looking for post-doc possibilities aligned to the line of research I'm actually conducting.