Neurology

Research in neurology is mainly focused on the development of implantable hearing devices, the rehabilitation of patients with cochlear implants and tinnitus, and the study of the vestibular functioning in children with developmental delays or hearing loss. We have developed a high expertise in the field of hearing implants and vestibular assessment, particularly in young children. We dispose of a full equipment to assess hearing and vestibular functioning, based on psychophysical and electrophysiological testing.

A new experimental surgery laboratory was developed with the support of Cochlear company. It allows multicentric studies on implantable subcomponents. It also allows surgical training of international otologists to new implantable devices.

A new tablet device is in development to allow the study of visuo-spatial processing in adults and children. It is supported by the foundation Saint-Luc. The research on the visuo-spatial processing development in early deaf children is performed in collaboration with the team of Prof Anne Devolder (IoNS) and Dr Martin Edwards (IoNS, SSH/PSP and IPSY).

LONGITUDINAL EVALUATION OF TEMPORAL FINE STRUCTURE’S CODING BY PATIENTS WITH UNILATERAL COCHLEAR IMPLANT: 2 SUBTESTS FROM A$E AND TEMPORAL FINE STRUCTURE

F. Ngo, J. Wathour, N. Deggouj

A temporal fine structure coding information is mainly mediated by phase locking mechanisms. Temporal fine structure (TFS) disturbances will have a negative impact on speech discrimination in a quiet and noisy environment. Cochlear implanted patients receive limited TFS information and are very disturbed in noisy environment.

The just noticeable difference (JND) of dysharmonic A$E test is frequently presented as a useful test to study the TFS functioning.

A study is going on the JND measures done in cochlear implanted subjects to verify if this measure correlates effectively with their speech perception abilities in a noisy and quiet environment.

VSAD: A NEW BATTERY FOR THE EVALUATION OF VISUO-SPATIAL ABILITIES IN DEAFNESS

E. Lacroix, N. Deggouj, M. G. Edwards

People that are deaf or are hard of hearing particularly rely on visuospatial perceptual and action abilities, not least for communication using sign language. Unfortunately, hearing loss can lead to vestibular function deficits that may impact cognitive and visuospatial behaviors.

With the support of the “Fondation Saint-Luc”, we have the opportunities to start the creation of a new battery of tests for the evaluation of Visuo-Spatial Abilities in Deafness (VSAD). The VSAD will use computerized tests presented on a WACOM tablet, developed with DiagnoseIS software (Metrisquare Company). The main functions that we propose to evaluate with this battery include visual perception, selective visual attention, visuospatial working memory, mental rotation and reproductive abilities (two dimensions). We propose that the use of new computerized technology for the tests will allow greater precision and reduced variance in the different measures, as well as additional dependent variables such as reaction time and response efficiency, not possible in traditional paper and pencil tests. In addition, the simplification of the tasks (recording and automatic correction of the
data), will improve contact between the patient and the practitioner, and provide more time to the practitioner for listening to the patient, and qualitatively understanding the patients various difficulties. The test will also provide economic savings (with time in report writing, and increasing the ability of the clinician to handle more evaluations).

NEW COUPLINGS WITH THE CODACS ACOUSTIC IMPLANT

J-M. Gérard, N. Verhaert (KUL)

Direct transfer function of an acoustic stimulator can be measured using Laser Doppler Vibrometry (LDV) on a third window on the scala tympani (with intact endosteum) created using a robotic drill. We want to investigate the functional results of the Codacs stimulation on the round window (RW), Lateral semicircular canal (LSCC), stapes, footplate and develop the surgical and coupling techniques.

FEEDBACKS IN ACTIVE TBAHA AND CODACS IMPLANTS

J-M. Gérard, N. Verhaert (KUL)

We study the feedback signal picked up by the microphone of the Sound processor on the behind the ear of active implanted device such the tBAHA and Codacs. The active tBAHA measurements consisted of three tested conditions such:

- The transducer at BAHA reference position and touching the strain relief of the BTE cable close to the ear canal.
- The transducer at BAHA reference position without touching the strain relief.
- The transducer is close to the ear.

The two non-compensated stimuli were:
1. Exponential Sine Sweep
2. MaximumLength Sequence

For the Codacs measurements, the stimuli we used were the same as before.

A sensor or microphone is a crucial component of a fully implantable hearing system. A sensor coupled to the middle ear ossicles benefits from the natural directivity and amplification of the pinna, ear canal and ossicles. To ensure optimal performance, a mobile middle ear is essential since the sensitivity of the sensor is proportional to the movement of the ossicles. However, the sensor inherently affects the mobility of the chain. A correct impedance matching is therefore vital. In this study, a middle ear sensor and its influence on the mobility of the ossicular chain is modeled. The model is validated using fresh frozen cadaver heads and is used to optimize the design parameters of the sensor.
The main focus of our research group is human chemosensation (taste, olfaction and trigeminal chemosensory function). Since 2004 we have developed a high expertise in the field of human chemosensation, particularly olfaction, and an increasing number of patients with olfactory dysfunction are referred to our department. Since 2004 we have evaluated almost 1000 patients complaining of olfactory dysfunction. We dispose of a full equipment to assess human chemosensory function, based on psychophysical and electrophysiological testing. Of note, we are the only hospital in Belgium having an olfactometer. This device is mandatory to deliver chemosensory stimuli in a controlled manner, a prerequisite for the recording of chemosensory (olfactory and trigeminal) event-related potentials. Our current researches involve: (1) the assessment of olfactory bulb volume as a prognosis factor, (2) the development of new psychophysical methods to assess olfactory and trigeminal function, (3) the development of new electrophysiological methods to assess olfactory and trigeminal function, and (4) the evaluation of the usefulness of olfactory testing for the early diagnosis of Alzheimer’s disease. Researches are performed in collaboration with Prof André Mouraux (COSY pole) and Prof Adrian Ivanoiu (NEUR pole) of the IoNS, and with international collaborators (Prof Thomas Hummel, Dresden, Germany).

PROGNOSTIC VALUE OF THE OLFACTORY BULB VOLUME MEASUREMENT FOR RECOVERY IN POSTINFECTIONOUS AND POSTTRAUMATIC OLFACTORY LOSS

Ph. Rombaux, C. Huart C., N. Deggouj, T. Duprez, T. Hummel

Olfactory dysfunction is thought to affect up to 20% of the general population and severely impact quality of life. Because treatments are lacking, scientific community agree that a complete clinical work up procedure is necessary to assess olfactory function and propose a prognosis of recovery to patients. Several prognostic factors influencing the recovery from olfactory dysfunction have been described. The olfactory bulb is a highly plastic structure whose volume reflects olfactory function. The aim of this study was to investigate whether olfactory bulb volume could be used as a new predictor of olfactory recovery in postinfectious and posttraumatic olfactory loss.

A cohort of patients with postinfectious and posttraumatic olfactory loss was investigated. Assessment of olfactory function was performed using psychophysical olfactory tests, at the time of the diagnosis (t1) and 15 months later (t2). All patients were examined on magnetic resonance imaging, and the olfactory bulbs volume was assessed using planimetric contouring at the time of the diagnosis (t1).

Our results showed a significant correlation between changes in olfactory functions and initial measurement of the total olfactory bulb volume; with larger volumes relating to higher improvement of olfactory function. Finally, we found that none of the patients with a total olfactory bulb volume of 40 mm3 or less exhibited recovery of olfactory function.

Our conclusion was that olfactory bulb volume seems to be a predictor of olfactory recovery in patients with postinfectious and posttraumatic olfactory loss.

Currently, we are continuously collecting MRI data from patients in order to better understand the morphological variations of olfactory-related brain structures in the context of olfactory deprivation and/or recovery.

These studies could significantly improve our understanding of the plasticity of the human olfactory system.
DEVELOPMENT OF A NEW PSYCHOPHYSICAL METHOD TO ASSESS THE OLFACTORY AND TRIGEMINAL COMPONENTS OF CHEMOSENSORY PERCEPTION.

C. Huart, Ph. Rombaux, A. Mouraux

We developed a new psychophysical approach to specifically assess the trigeminal contribution to chemosensory perception. Our test shares similarities with the well-known and validated Sniffin' Sticks Test to assess the olfactory function. Instead of using sticks impregnated with substances that preferentially activate olfactory afferents, we have used a number of substances previously shown to preferentially activate trigeminal afferents (menthol, allyl isothiosulfate, ethanol, propanol, eucalyptol and camphor). The psychophysical test comprises the following four steps: (1) estimation of the detection threshold; (2) assessment of the discrimination performance; (3) evaluation of the ability to identify different types of trigeminal chemosensory stimuli; (4) assessment of the ability to localize lateralized trigeminal chemosensory stimuli. At present, the experimental setup is finalized (conception and development of the trigeminal felt tip pens, etc.) and we have started to collect normative data by testing a population of healthy normosmic subjects. Furthermore, we have started to test patients presenting with smell disorders in order to validate its clinical usefulness.

TIME-FREQUENCY ANALYSIS TO STUDY OLFACTORY FUNCTION AND DYSFUNCTION

C. Huart, Ph. Rombaux, A. Mouraux

We developed a new psychophysical approach to specifically assess the trigeminal contribution to chemosensory perception. Our test shares similarities with the well-known and validated Sniffin' Sticks Test to assess the olfactory function. Instead of using sticks impregnated with substances that preferentially activate olfactory afferents, we have used a number of substances previously shown to preferentially activate trigeminal afferents (menthol, allyl isothiosulfate, ethanol, propanol, eucalyptol and camphor). The psychophysical test comprises the following four steps: (1) estimation of the detection threshold to trigeminal; (2) assessment of the discrimination performance; (3) evaluation of the ability to identify different types of trigeminal chemosensory stimuli; (4) assessment of the ability to localize lateralized trigeminal chemosensory stimuli. At present, the experimental setup is finalized (conception and development of the trigeminal felt tip pens, etc.) and we have started to collect normative data by testing a population of healthy normosmic subjects. Furthermore, we have started to test patients presenting with smell disorders in order to validate its clinical usefulness.
Fig. 1: Time-frequency representation of the non phase locked EEG responses to olfactory and trigeminal stimulation (CWT-SINGLE) in the normosmic, hyposmic and anosmic groups of patients.

Non phase-locked EEG responses were identified by performing across-trial averaging in the time-frequency domain, enhancing both phase-locked and non phase-locked EEG responses. Signal amplitude (group-level average, olfactory stimulation: electrode Fz vs. A1A2; trigeminal stimulation: electrode Cz vs. A1A2) is expressed as a percentage increase or decrease relative to baseline (-0.4 to -0.1s) (ER%). After olfactory stimulation, normosmic patients exhibit a clear and long-lasting increase of signal amplitude at low frequencies, referred to as OLF-TF1. In hyposmic patients, the magnitude of OLF-TF1 is reduced. In anosmic patients, this increase cannot be identified. Also note that trigeminal stimulation does not only elicit a phase-locked EEG response (TRI-TF1) but also induces a long-lasting desynchronization of the alpha-band EEG rhythms (8-12Hz) and a non phase-locked increase in EEG signal amplitude peaking approximately 350 ms after stimulus onset and centered around 10-15Hz.
**Fig. 2: Receiver Operating Characteristic (ROC) analysis.** ROC curves were computed to estimate the discrimination performance of each of the different measures of the EEG response to olfactory stimulation identified using across-trial averaging in the time-domain (OLF-N1 and OLF-P2) and across-trial averaging in the time-frequency domain (OLF-TF1). The shaded areas represent the 95% confidence interval of the obtained curves.

**Fig. 3: Correlation between psychophysical olfactory performances (TDI score) and the magnitude of the OLF-TF1 response to olfactory stimulation identified in the CWT-SINGLE transform.** Note the significant positive correlation between the TDI score and the OLF-TF1 magnitude ($r=0.64$, $p=0.0001$).
EVALUATION OF NORMAL OLFACTORY FUNCTION IN A POPULATION OF SOUTH-KIVU (CONGO) AND IMPACT OF ENDEMIC DISEASES ON OLFACTORY FUNCTION

P. Balungwe, C. Huart, Ph. Rombaux

The aim of this work is to evaluate olfactory function in different populations of adult living in South-Kivu (Democratic Republic of Congo). First, (1) we will evaluate in healthy subjects if psychophysical testsings of olfactory performances used in Europe are culturally adapted to Congolese population. Based on the results of this first study, (2) we will adapt the test to the Congolese population. Then, (3) we will assess olfactory function in different group of patients suffering from olfactory disorders in order to evaluate whether the frequency of these disorders are similar to those observed in Europe. Finally, (4) we will study olfactory function of patients suffering from diseases endemic to this region of the world (i.e. HIV, malaria, tuberculosis).

MRI AND SMELL

C. Huart, A. Mouraux, Th. Duprez, Ph. Rombaux

The aim of this study is to assess the usefulness of structural MRI in patients suffering from smell disorders. Attention is paid to morphological variations observed in patients with acquired or congenital anosmia, as well as to the pronostic value of MRI. Using MRI, we aim to evaluate the correlation between olfactory function and the trophicity of brain structures known to be associated with olfactory perception in controls and patients with olfactory disorders, as well as the correlation between olfactory function and trophicity of brain structures known to be associated with Alzheimer’s disease pathology. This study is expected to bring new insights on the understanding of the olfactory system and its interaction with cognition.

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