ANNUAL REPORT OF

AALTO NEUROIMAGING

AALTO UNIVERSITY SCHOOL OF SCIENCE

2016

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Director's executive summary

Aalto NeuroImaging (ANI) has been operational now for four years. In 2016, we have still suffered from the statutory negotiations at Aalto University – the usage of our facilities has dropped down due to the reduced internal usage since we have less post-docs working at the department. In addition, our department has had several professorships in recruitment state and the processes to fill these positions seem to be take excessive time. Hopefully, the recruitments of the new professors at the department will provide more internal usage of our facilities.

One year ago I wished that the new department would make more synergy between the researchers. Our scientific advisory board (SAB) evaluated us in 2016 and provided a very positive feedback regarding our infrastructure. On the other hand, our SAB pointed out the problems with the internal communication and weak leadership at the departmental level. Now we have a new head of the department, Professor Risto Ilmoniemi. However, I'm still waiting for the better communication within the department.

I'm really happy to see that our scientific output is at reasonable level with 29 peer-reviewed publications at excellent scientific quality.

Financially, the year 2016 was negative. AMI Centre was the best part of ANI although all the units, *i.e.*, AMI Centre, MEG Core, and Aalto TMS made negative results. The use of MEG Core was dropped down from 781 hours to 673 hours. Unfortunately, Aalto TMS laboratory has not attracted enough users to cover the costs. Hopefully, the usage of AMI Centre and MEG Core will increase in 2017 to make the both ends of the budget meet.

In 2016, we have applied funding for our 7 T project from the Finnish Research Infrastructures call. Unfortunately, we failed to get the funding. I would very much like to thank Professor Riitta Salmelin and Staff Scientist Toni Auranen for their major contributions to the FIRI2016 application.

Aalto TMS will most likely face its end within this year. We have not been able to find enough users for our excellent navigated TMS system. Anyway, I would like to thank MSc Mikko Nyrhinen for organizing the Aalto TMS laboratory to the top level.

This year we will include the report of the Aalto Behavioral Laboratory (ABL) in our report. We would very much like to include ABL to ANI in 2018 – all the ingredients are ready for the process. I would like to thank MSc Veli-Matti Saarinen for organizing ABL to the top level.

In 2016, ANI received 40% of the budget from Aalto University School of Science. The support was mainly used to reduce the fees of the users from the Aalto University and NEUROIMAGING infrastructure. Hopefully, the financial support will continue in the future since it is crucial to the research and education at the Aalto University. In addition, Aalto Brain Centre (ABC, http://brainscience.aalto.fi), the neuroscience and neurotechnology initiative of the Aalto University, has financially supported ANI measurements in 2016. Special thanks go to Dean Jouko Lampinen and Professor Lauri Parkkonen in making these funding sources available.

New Steering Board to the NEUROIMAGING infrastructure will be announced soon and I would like to thank the present Steering Board for useful comments and suggestions to make the collaboration better between the units.

Finally, I would like to express my gratitude to our staff and users. Your efforts have been very important and valuable both for our infrastructure and neuroscience community.

Magnetically yours,
Veikko Jousmäki

1 Introduction

Aalto NeuroImaging (ANI, http://ani.aalto.fi) research infrastructure was established on January 1st, 2013 at Aalto University School of Science (SCI). ANI research infrastructure houses three functional neuroimaging modalities, navigated and repetitive transcranial magnetic stimulation (nTMS and rTMS) at Aalto TMS laboratory, functional magnetic resonance imaging (fMRI) at Advanced Magnetic Imaging (AMI) Centre, and magnetoencephalography (MEG) at MEG Core. ANI is part of Aalto University School of Science and administrated by Department of Neuroscience and Biomedical Engineering (NBE, http://nbe.aalto.fi). Both AMI Centre and MEG Core are well established and have a long history and tradition starting from the Helsinki University of Technology whereas Aalto TMS was established in 2013. Docent Veikko Jousmäki from the NBE has been the ANI director since February 1st, 2013.

ANI is part of NEUROIMAGING research infrastructure (http://neuroimaging.fi) administrated by Aalto University together with University of Helsinki (UH) and Hospital District of Helsinki and Uusimaa (HUS, Helsingin ja Uudenmaan sairaahoitopiirin kuntayhtymä) in the capital region. NEUROIMAGING established in 2011, is based on agreement between AU, UH, and HUS, and covers, in addition to Aalto TMS, AMI Centre, and MEG Core in the Otaniemi campus, also the BioMag Laboratory (http://www.biomag.hus.fi) located at the Meilahti hospital. The goal of the NEUROIMAGING agreement, in brief, is to enhance joint use and development of the large-scale brain imaging facilities. ANI and NEUROIMAGING, were granted with recognition on "Finland's strategy and roadmap for research infrastructures 2014–2020" (2014) by the Academy of Finland and Ministry of Education and Culture. ANI and NEUROIMAGING are also actively involved in establishing the Finnish Infrastructures for Functional Imaging (FIFI, http://functionalimaging.fi) consortium. FIFI is a national-level large-scale infrastructure providing open access services in functional *in vivo* imaging of humans and animals. FIFI aims to guarantee that cutting-edge imaging technology is widely available for research and development projects both in academia and industry to enhance the science and to exploit the biomedical imaging infrastructures to the fullest. FIFI partners serve more than 700 users annually.

The NEUROIMAGING Steering Board comprised two members from the Aalto University (Dean Risto Nieminen; until May 31st, 2016, Dean Jouko Lampinen; from June 1st, 2016, Academy Professor Riitta Salmelin), two from the UH (Professor Kimmo Alho, Professor Timo Erkinjuntti whose acting deputies have been Professors Teija M. Kujala and Pentti Tienari, respectively), and two from HUS (Chief Medical Officer Markku Mäkijärvi, Chief Physician Erika Kirveskari). The Directors of the units act as experts with the right to speak in Steering Board meetings (ANI: Director Veikko Jousmäki, DrTech Toni Auranen; BioMag: Director Jyrki Mäkelä, DrTech Juha Montonen). The Steering Board had two meetings in 2016; the appointed chairman of the Steering Board for the first three-year period (2014–2016) is Dean Risto Nieminen until his retirement (afterwards Dean Jouko Lampinen) and the secretary in 2016 was DrTech Toni Auranen. Academy Professor Riitta Salmelin has also played a vital role in the FIFI consortium coordination.

Aalto NeuroImaging infrastructure brings new possibilities and openings for the brain research community. Our aim is to maintain and develop the best possible infrastructure for functional brain imaging. All our units have their own transparent budgets and they are providing open-access for brain research community and other users. We have fixed user fees and we meet the requirements set by the Academy of Finland, Tekes – the Finnish Funding Agency for Innovation, and European Research Council. We are strongly supporting neuroscience, one of the research focus areas of the Aalto University, as well as Aalto Brain Centre (established in 2014), Aalto University's initiative in neuroscience and neurotechnology.

In 2016, MSc Veli-Matti Saarinen has launched a new set of research tools within the Aalto Behavioral Laboratory (ABL), which meets the high standards and usage transparency of other ANI units.

ABL annual activities are detailed separately in the end of this report.

1.1 Aalto TMS

Aalto TMS laboratory (http://tms.aalto.fi) was inaugurated in early 2013. It offers researchers unique possibilities within Finland for multi-modal neuroimaging techniques. The laboratory contains top-of-the-line navigated transcranial magnetic stimulation (nTMS) and electroencephalography (EEG) systems. Aalto TMS operates closely with other ANI units in developing novel equipment setups that aim to enable consecutive and concurrent TMS and functional magnetic resonance imaging (fMRI), for example.

nTMS -system with two stimulation units (Bistim^2 and Super Rapid^2 Plus^1, Magstim Company Ltd., United Kingdom) and various coils makes numerous TMS and rTMS examination setups possible. Bistim^2 consists of two Magstim 200 units with a connection module making possible to deliver paired pulses or one high-energy pulse in to a single stimulation coil. Connection module can also be disconnected making it possible to use two Magstim 200 units as separate stimulation devices. For this purpose the laboratory has two 70 mm figure of eight coils making dual-site stimulations with the system possible. Also the new neuronavigation software (Visor2; ANT Neuro, Enschede, The Netherlands) version has a support for dual coil navigation. Super Rapid^2 Plus^1 consists of three power supply units which enable highpower/frequency stimulations. 70-mm air-cooled figure-of-eight coil makes high power/frequency scenarios possible without having to change the coil during or between sessions. With the two stimulation systems together, it is possible to do even triple-site stimulations in the laboratory.

In addition, the 64-channel EEG-system with 16 EMG channels (NeurOne; Mega Electronics Ltd., Kuopio, Finland), specially designed for co-registration with TMS, can be used to map stimulus event-related responses simultaneously. The laboratory also contains a dedicated system for audio and visual studies with Matlab, E-Prime, and Presentation software available for stimulus delivery.

Aalto TMS has been designed to maximize user and test subject comfort. For example, there are four 42” LCD screens for neuronavigation, ceiling-mounted arm for the navigation camera, salli saddle chair with elbow rest, three coil holders (2x Magstim and a custom build), an adjustable table and chair for visual stimulation system, and a head rest for test subject head support.

1.2 AMI Centre

AMI Centre (http://ami.aalto.fi) houses a research-dedicated, modern 3T Siemens Skyra (Siemens Healthcare, Erlangen, Germany) magnetic resonance imaging (MRI) scanner. For almost fifteen years, several research teams from Aalto University, University of Helsinki (UH), Helsinki and Uusimaa Hospital District (HUS), as well as other academic users and industry have used the facilities of AMI Centre for research and education. Since its inauguration, AMI Centre has operated smoothly with only a few notable interruptions of use, such as a three months downtime in 2011, when the Skyra system was installed to replace our previous 3T MRI scanner (SIGNA^{TM} GE Healthcare Ltd., Wauwatosa, WI, United States) operational since 2002.

The current system houses 48 independent measurement channels and our users have three distinct head coil arrays to choose from according to their needs; 32-channel head coil for excellent signal-to-noise ratio, a slightly more spacious 20-ch head-neck coil to be used with simultaneous EEG recordings, for example, and a custom-made modified version of the 32-channel head coil for excellent visual field of view for the volunteer. Our scanner is equipped with the TimTX TrueShape and syngo ZOOMit –updates enabling the latest possibilities in parallel transmission for MRI and fMRI. We have a Full HD Panasonic 3-DLP projector (PT-DZ110XE) with a custom made lens system for visual stimulation in addition to well-designed stimulus delivery systems and robust eye tracking (EyeLink

1000; SR Research Ltd., Missisauga, Ontario, Canada) as well as simultaneous EEG recording (BrainAmp MR+; Brain Products GmbH, Gilching, Germany) and physiological signal recording/monitoring (BIOPAC Systems, Inc., Goleta, CA, United States) capabilities. We continue to offer exquisite surroundings for fMRI studies and neuroscience research.

1.3 MEG Core

The main research instrument of the MEG Core (http://meg.aalto.fi) is a modern 306-channel neuromagnetometer (Elekta Neuromag^{TM}, Elekta Oy, Helsinki), which was upgraded in 2008. It houses 204 gradiometers and 102 magnetometers with whole-scalp coverage. The device includes 64 EEG channels and 8 additional analog inputs for monitoring purposes. The MEG device is located within a 3-layer magnetically shielded room (MSR; Imedco AG, Hägendorf, Switzerland) that provides >100 dB attenuation of the external magnetic disturbances over a wide bandwidth. MEG Core has extremely low magnetic ambient noise level.

During MEG recordings, stimulators are available, *e.g.*, for auditory (Etymotic Research, Chicago, IL; ADU-2, Unides Design Ay, Helsinki; Sound Shower, Panphonics Oy, Tampere, Finland), tactile (constant current electric stimulator, Medizin Technik Schwind, Germany), pneumatic tactile stimulator (built for the purpose in Germany), vibrotactile stimulator (built in-house), manually-operated brush stimulator (built in-house), visual (Panasonic 7700 DLP projector with a back projection screen), and pain (Neurotest thulium-YAG laser, Baasel Lasertech GmbH, Starnberg, Germany) stimulation. For monitoring purposes, MEG Core has eye tracker (EyeLink 1000; SR Research Ltd., Missisauga, Ontario, Canada), and home-made accelerometer-based monitoring devices. In addition, MEG Core has several home-made response pads and strong knowhow in building and testing MEG compatible stimulators.

2 Location, facilities, and mission

The Aalto NeuroImaging infrastructure facilities are located on the campus of the Aalto University in Otaniemi area. Aalto TMS and AMI Centre are both located in the Magnet Building (Otakaari 5 I, Espoo, Finland), AMI occupying 350 m^2 in floors 1–3 and TMS about 50 m^2 in the fourth floor. MEG Core resides in Nano Building (Puumiehenkuja 2), having 120 m^2 of laboratory space. All the facilities are easily accessed using either public or private transportation in the greater Helsinki area with the expected Western Metro Extension further improving the site access for both researchers and volunteers for studies. All three parts of the ANI infrastructure have a joint online reservation system at http://anitime.aalto.fi. For more detailed information, see http://ani.aalto.fi.

The main research tools at Aalto TMS are two neuronavigated transcranial magnetic stimulation systems (Bistim^2 and Rapid^2, The Magstim Company Ltd., United Kingdom) combined with electroencephalogram mapping (NeurOne, Mega Electronics Ltd., Kuopio, Finland). The laboratory is in very close proximity of our MRI scanner, making it very easy to combine anatomical MR-images to TMS neuronavigation, and to make offline fMRI-TMS studies accessible. Professor Synnöve Carlson is the Scientific Director of the TMS laboratory.

Currently, AMI Centre maintains the 3T MRI scanner (Siemens Skyra, Siemens Healthcare, Erlangen, Germany), develops the related infrastructure, and offers services to research teams at and outside the Aalto University. AMI Centre aims to provide an innovative environment for development and promotion of new imaging techniques in close collaboration with our users. The technical director of AMI Centre is Staff Scientist, DrTech Toni Auranen.

MEG Core offers excellent environment for magnetoencephalographic (MEG) measurements. MEG Core has three strong supports, *i.e.*, a modern MEG device, a variety of stimulators and monitoring

devices, and magnetically quiet laboratory space. The MEG Core with its low-noise, well-equipped environment is currently one of the world's best laboratories to make MEG research. In addition to Aalto NeuroImaging directing duties, Docent Veikko Jousmäki acts also as the MEG Core Director.

3 Achievements

Aalto NeuroImaging serves as an infrastructure that provides top-level brain imaging facilities for multiple research teams, among them many National Centers of Excellence selected by the Academy of Finland. ANI as such, has limited own research program, and thus the scientific achievements and key performance indicators listed below, containing data collected at ANI, reflect the research interests of all the users of the infrastructure in 2016.

Impact factors for the publication series are shown and the classification of the publications is based on the instructions by the Finnish Ministry of Culture and Education, 2010. The indication **TMS**, **AMI**, or **MEG** after the impact factor and classification mark, denote which resource or equipment was used in the work, respectively.

3.1 Scientific publications in international journals

PUBLISHED (situation in the beginning of January 2017)

1) Alho J, Green BM, May PJC, Sams M, Tiitinen H, Rauschecker J, and Jääskeläinen IP: **Early-latency categorical speech sound representations in the left inferior frontal gyrus**. *NeuroImage* 2016, 129: 214–223. (IF 5.463, JuFo: 2, A1, **AMI**, **MEG**)

2) Bona S, Cattaneo Z, and Silvanto J: **Investigating the causal role of rOFA in holistic detection of mooney faces and objects: an fMRI-guided TMS study**. *Brain Stimulation* 2016, 9: 594–600. (IF 4.793, JuFo: 2, A1, **AMI**)

3) Bogert B, Numminen-Kontti T, Gold B, Sams M, Numminen J, Burunat I, Lampinen J, and Brattico E: **Hidden sources of joy, fear, and sadness: explicit versus implicit neural processing of musical emotions**. *Neuropsychologia* 2016, 89: 393–402. (IF 2.989, JuFo: 2, A1, **AMI**)

4) Brattico E, Bogert B, Alluri V, Tervaniemi M, Eerola T, and Jacobsen T: **It's sad but I like it: the neural dissociation between musical emotions and liking in experts and laypersons**. *Frontiers in Human Neuroscience* 2016, 9: 676. (IF 3.634, JuFo: 1, A1, **AMI**)

5) Burunat I, Toiviainen P, Alluri V, Bogert B, Ristaniemi T, Sams M, and Brattico E: **The reliability of continuous brain responses during naturalistic listening to music**. *NeuroImage* 2016, 124: 224–231. (IF 5.463, JuFo: 2, A1, **AMI**)

6) de Borst AW, Valente G, Jääskeläinen IP, and Tikka P: **Brain-based decoding of mentally**

imagined film clips and sounds reveals experience-based information patterns in film professionals. *NeuroImage* 2016, 129: 428–438. (IF 5.463, JuFo: 2, A1, **AMI**)

7) Gilani I and Sepponen R: **Quantitative rotating frame relaxometry methods in MRI**. *NMR in Biomedicine* 2016, 29: 841–846. (IF 2.983, JuFo: 2, A1, **AMI**)

8) Glerean E, Pan RK, Salmi J, Kujala R, Lahnakoski J, Roine U, Nummenmaa L, Leppämäki S, Nieminen-von Wendt T, Tani P, Saramäki J, Sams M, and Jääskeläinen IP: **Reorganization of functionally connected brain subnetworks in high-functioning autism**. *Human Brain Mapping* 2016, 37: 1066–1079. (IF 4.962, JuFo: 3, A1, **AMI**)

9) Halme H-L and Parkkonen L: **Comparing features for classification of MEG responses to motor imagery**. *PLoS ONE* 2016, 11: e0168766. (IF 3.057, JuFo: 1, A1, **MEG**)

10) Heinonen J, Numminen J, Hlushchuk Y, Antell H, Taatila V, and Suomala J: **Default mode and executive networks areas: Association with the serial order in divergent thinking**. *PLoS ONE* 2016, DOI: 10.1371/journal.pone.0162234. (IF 3.057, JuFo: 1, A1, **AMI**)

11) Inverso SA, Goh XL, Henriksson L, Vanni S, and James AC: **From evoked potentials to cortical currents: Resolving V1 and V2 components using retinotopy constrained source estimation without fMRI**. *Human Brain Mapping* 2016, 37: 1696–1709. (IF 4.962, JuFo: 3, A1, **AMI**)

12) Jääskeläinen IP, Halme H-L, Agam Y, Glerean E, Lahnakoski JM, Sams M, Tapani K, Ahveninen J, and Manoach DS: **Neural mechanisms supporting evaluation of others' errors in real-life like conditions**. *Scientific Reports* 2016, 6: 18714. (IF 5.228, JuFo: 2, A1, **AMI**)

13) Kaltiainen HL, Helle LM, Renvall HM, and Forss NH: **Slow wave oscillations in awake healthy subjects - methodological and physiological considerations**. *Journal of Clinical Neurophysiology* 2016, 33: 367–372. (IF 1.337, JuFo: 1, A1, **MEG**)

14) Komulainen E, Heikkilä R, Meskanen K, Raij TT, Nummenmaa L, Lahti J, Jylhä P, Melartin T, Harmer CJ, Isometsä E, and Ekelund J: **A single dose of mirtazapine attenuates neural responses to self-referential processing**. *Journal of Psychopharmacology* 2016, 30: 23–32. (IF 3.637, JuFo: 1, A1, **AMI**)

15) Kujala R, Glerean E, Pan, RK, Jääskeläinen IP, Sams M, and Saramäki J: **Graph coarse-graining reveals differences in the module-level structure of functional brain networks**. *European Journal of Neuroscience* 2016, 44: 2673–2684. (IF 2.975, JuFo: 1, A1, **AMI**)

16) Lankinen K, Smeds E, Tikka P, Pihko E, Hari R, and Koskinen M: **Haptic contents of a movie dynamically engage the spectator's sensorimotor cortex**. *Human Brain Mapping* 2016, 37: 4061–4068. (IF 4.962, JuFo: 3, A1, **AMI**, **MEG**)

17) Mandel A, Bourguignon M, Parkkonen L, and Hari R: **Sensorimotor activation related to speaker vs. listener role during natural conversation**. *Neuroscience Letters* 2016, 614: 99–104. (IF 2.107, JuFo: 1, A1, **MEG**)

18) Moisala M, Salmela V, Hietajärvi L, Salo E, Carlson S, Salonen O, Lonka K, Hakkarainen K, Salmela-Aro K, and Alho K: **Media multitasking is associated with distractibility and increased prefrontal activity in adolescents and young adults**. *NeuroImage* 2016, 134: 113–121. (IF 5.463, JuFo: 2, A1, **AMI**)

19) Raij TT, Mäntylä T, Mantere O, Kieseppä T, and Suvisaari J: **Cortical salience network activation precedes the development of delusion severity**. *Psychological Medicine* 2016, 46: 2741–2748. (IF 5.491, JuFo: 2, A1, **AMI**)

20) Ramkumar P, Hansen BC, Pannasch S, and Loschky LC: **Visual information representation and rapid-scene categorization are simultaneous across cortex: An MEG study**. *NeuroImage* 2016, 134: 294–304. (IF 5.463, JuFo: 2, A1, **MEG**)

21) Renvall H, Staeren N, Barz CS, Ley A, and Formisano E: **Attention modulates the auditory cortical processing of spatial and category cues in naturalistic auditory scenes**. *Frontiers in Neuroscience* 2016, 10: 1–10. (IF 3.398, JuFo: 1, A1, **MEG**)

22) Saarimäki H, Gotsopoulos A, Jääskeläinen IP, Lampinen J, Vuilleumier P, Hari R, Sams M, and Nummenmaa L: **Discrete neural signatures of basic emotions**. *Cerebral Cortex* 2016, 26: 2563–2573. (IF 8.285, JuFo: 3, A1, **AMI**)

23) Salmela E, Renvall H, Kujala J, Hakosalo O, Illman M, Vihla M, Leinonen E, Salmelin R, and Kere J: **Evidence for genetic regulation of the human parieto-occipital 10-Hz rhythmic activity**. *European Journal of Neuroscience* 2016, 44: 1963–1971. (IF 2.975, JuFo: 1, A1, **MEG**)

24) Salmela VR, Henriksson L, and Vanni S: **Radial frequency analysis of contour shapes in the visual cortex**. *PLoS Computational Biology* 2016, 12: e1004719. (IF 4.587, JuFo: 2, A1, **AMI**)

25) Sharifian F, Heikkinen H, Vigário R, and Vanni S: **Contextual modulation is related to**

efficiency in a spiking network model of visual cortex. *Frontiers in Computational Neuroscience* 2016, 9: 155. (IF 2.653, JuFo: 1, A1, **AMI**)

26) Zhou G, Bourguignon M, Parkkonen L, and Hari R: **Neural signatures of hand kinematics in leaders vs. followers: A dual-MEG study**. *NeuroImage* 2016, 125: 731–738. (IF 5.463, JuFo: 2, A1, **MEG**)

IN PRESS (situation in the beginning of January 2017)

1) Hotta J, Saari J, Koskinen M, Hlushchuk Y, Forss N, and Hari R: **Abnormal brain responses to action observation in complex regional pain syndrome**. *The Journal of Pain* 2016, Electronic publication ahead of print. (IF 4.463, JuFo: 1, A1, **AMI**)

2) Hotta J, Zhou G, Harno H, Forss N, and Hari R: **Complex regional pain syndrome: The matter of white matter?** *Brain and Behavior* 2016, Accepted. (IF 2.128, JuFo: 1, A1, **AMI**)

3) Iivanainen J, Stenroos M, and Parkkonen L: **Measuring MEG closer to the brain: performance of on-scalp sensor arrays**. *NeuroImage* 2016, Electronic publication ahead of print. (IF 5.463, JuFo: 2, A1, **AMI**).

4) Moisala M, Salmela V, Hietajärvi L, Carlson S, Vuontela V, Lonka K, Hakkarainen K, Salmela-Aro K, and Alho K: **Gaming is related to enhanced working memory performance and task-related cortical activity**. *Brain Research* 2016, Electronic publication ahead of print. (IF 2.561, JuFo: 1, A1, **AMI**).

5) Nummenmaa L, Oksama L, Glerean E, and Hyönä J: **Cortical circuit for binding object identity and location during multiple-object tracking**. *Cerebral Cortex* 2016, Electronic publication ahead of print. (IF 8.285, JuFo: 3, A1, **AMI**).

6) Rikandi E, Pamilo S, Mäntylä T, Suvisaari J, Kieseppä T, Hari R, Seppä M, and Raij TT: **Precuneus functioning differentiates first-episode psychosis patients during the fantasy movie Alice in Wonderland**. *Psychological Medicine* 2016, Electronic publication ahead of print. (IF 5.491, JuFo: 2, A1, **AMI**)

7) Salmela V, Salo E, Salmi J, and Alho K: **Spatiotemporal dynamics of attention networks revealed by representational similarity analysis of EEG and fMRI**. *Cerebral Cortex* 2016, Electronic publication ahead of print. (IF 8.285, JuFo: 3, A1, **AMI**)

8) Salmi J, Koistinen OP, Glerean E, Jylänki P, Vehtari A, Jääskeläinen IP, Mäkelä S, Nummenmaa L, Nummi-Kuisma K, Nummi I, and Sams M: **Distributed neural signatures of natural audiovisual speech and music in the human auditory cortex**. *NeuroImage* 2016, Electronic publication ahead of print. (IF 5.463, JuFo: 2, A1, **AMI**)

9) Smeds E, Piitulainen H, Bourguignon M, Jousmäki V, and Hari R: **Effect of interstimulus interval on cortical proprioceptive responses to passive finger movements**. *European Journal of Neuroscience* 2016, Electronic publication ahead of print. (IF 2.975, JuFo: 1, A1, **MEG**)

3.2 Other scientific publications and influence in meetings and conferences

BOOK CHAPTERS

1) Carlson S and Vuontela V: **Sellainen mieli, millaiset aivot: miten harjoittelu muovaa aivoja?** (Finnish) In book *Mielen Salat* 2016, 17–26, (ed.) Ylikangas M. Gaudeamus. (A3, **AMI**)

2) Heinonen J: **Conjoint analysis with fMRI: A novel analytical approach to neuromarketing**. In *Handbook of Research on Neuroeconomics and the Decision-Making Process* 2016, 150–165, (eds.) Christiansen B and Lechman E. Advances in Psychology, Mental Health, and Behavioral Studies book series. IGI Global. (A3, **AMI**)

3) Mäntymaa M, Puura K, Aronen E, and Carlson S: **Aivojen kehitys ja varhainen vuorovaikutus**. (Finnish) In book *Lastenpsykiatria ja nuorisopsykiatria* 2016, 23–34, (eds.) Kumpulainen K, Aronen E, Ebeling H, Laukkanen E, Marttunen M, Puura K, and Sourander A. Duodecim. (A3, **AMI**)

ORAL PRESENTATIONS, INVITED TALKS AND POSTERS

Our users reported **approximately 40 oral presentations, invited talks and posters in international and national scientific conferences and meetings** that contain data and/or results based on the fMRI/MRI, MEG or TMS data measured at Aalto NeuroImaging infrastructure. The reader is recommended to take into consideration that the achievements in this category are based solely on notifications from our users and the true number is likely considerably higher, yet very difficult to report accurately. Therefore, they are not listed with detailed information.

3.3 Theses

DOCTORAL THESES

1) Jussi Alho: **Speech motor system mediates phonetic categorization**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2016. Supervisor: Professor Mikko Sams. Advisor: Senior Scientist Iiro

Jääskeläinen. (G5, **AMI**, **MEG**)

2) Silvia Bona: **Investigating the functional roles of occipital face area and lateral occipital cortex with transcranial magnetic stimulation**. Dissertation for the degree of Doctor of Philosophy, University of Helsinki, Faculty of Behavioural Sciences, Institute of Behavioural Sciences, 2016. Supervisors: Docent Juha Silvanto and Professor Teija Kujala. (G5, **AMI**)

3) Anne Mandel: **Brain correlates of social cognition and interaction**. Dissertation for the degree of Doctor of Philosophy, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2016. Supervisor: Professor Riitta Hari. Advisor: Professor Lauri Parkkonen. (G5, **MEG**)

4) Arno Solin: **Stochastic differential equation methods for spatio-temporal gaussian process regression**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering and Department of Cumpter Science, 2016. Supervisor: Professor Jouko Lampinen. Advisor: Professor Simo Särkkä. (G5, **AMI**)

5) Andrey Zhdanov: **Capturing complex behavior in brain imaging: strategies and instrumentation**. Dissertation for the degree of Doctor of Science in Technology, Aalto University School of Science, Department of Neuroscience and Biomedical Engineering, 2016. Supervisor: Professor Lauri Parkkonen. Advisor: Docent Jyrki Mäkelä. (G5, **MEG**)

MASTERS THESES

1) Katri Mikkola: **Attentional-networks in adult ADHD: an fMRI study**. Master's thesis for the degree of Master of Science, University of Helsinki, Faculty of Behavioural Sciences, Institute of Behavioural Sciences. Supervisor: Juha Salmi. (G2, **AMI**)

2) Kati Penttinen: **Tracking connections between striatum, and frontal and motor cortices using diffusion tensor imaging and tractography**. Master's thesis for the degree of Master of Science (Technology), Aalto University School of Electrical Engineering, 2016. Supervisor and Advisor: Professor Synnöve Carlson. (G2, **AMI**)

3.4 Promoting public awareness

The reader is recommended to take into consideration that the achievements in this category are based on selected notifications from our users and from the information that ANI personnel have received from other sources. The true number of events **promoting public awareness** may thus be considerably higher.

Hari R: Interview for Denmark radio about 2-person neuroscience, 16 March 2016. (**AMI**, **MEG**)

Hultén A: Interview for Radio Vega, 15 March 2016. (**AMI**, **MEG**)

Nummenmaa L and Lähteenmäki M: Interview for TV, *Eläinpeloista* (Finnish), Prisma Studiossa, Yle Teema, 31 March 2016. (**AMI**)

3.5 Scientific awards and positions of trust

Senior Scientist **Veikko Jousmäki** continued the part-time position as a visiting professor (3-year period starting from Oct 1, 2015) at the Department of Clinical Neuroscience, Karolinska Institutet, Stockholm, Sweden. He was also attributed to a part-time honorary visiting professor position (from March 2016) at the Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore.

University of Helsinki recognized exceptional doctoral dissertations annually. In April 2016, **Elyana Saad**'s thesis from 2015, *Interaction between visual perception and mental representations of imagery and memory in the early visual areas*, containing data from Aalto TMS was awarded 5000 euros.

3.6 Summary of achievements

This table depicts a summary of the highlights of the achievements presented in this chapter and from previous years since Aalto NeuroImaging started to operate in 2013.

	Refereed papers*	In-press papers*	PhD theses	MSc theses
ANI total 2016	**29**	**9**	**5**	**2**
TMS used in	*0*	*0*	*0*	*0*
AMI used in	*22*	*8*	*3*	*2*
MEG used in	*9*	*1*	*3*	*0*
ANI total 2015	**46**	**10**	**5**	**4**
TMS used in	*2*	*0*	*1*	*0*
AMI used in	*28*	*7*	*4*	*2*
MEG used in	*21*	*3*	*1*	*2*
ANI total 2014	**33**	**7**	**4**	**1**
TMS used in	*0*	*1*	*0*	*0*
AMI used in	*26*	*4*	*4*	*1*
MEG used in	*13*	*2*	*0*	*0*
ANI total 2013	**32**	**13**	**5**	**4**
TMS used in	*0*	*0*	*0*	*1*
AMI used in	*25*	*11*	*5*	*2*
MEG used in	*11*	*4*	*0*	*1*

* Including refereed conference proceedings papers and book chapters

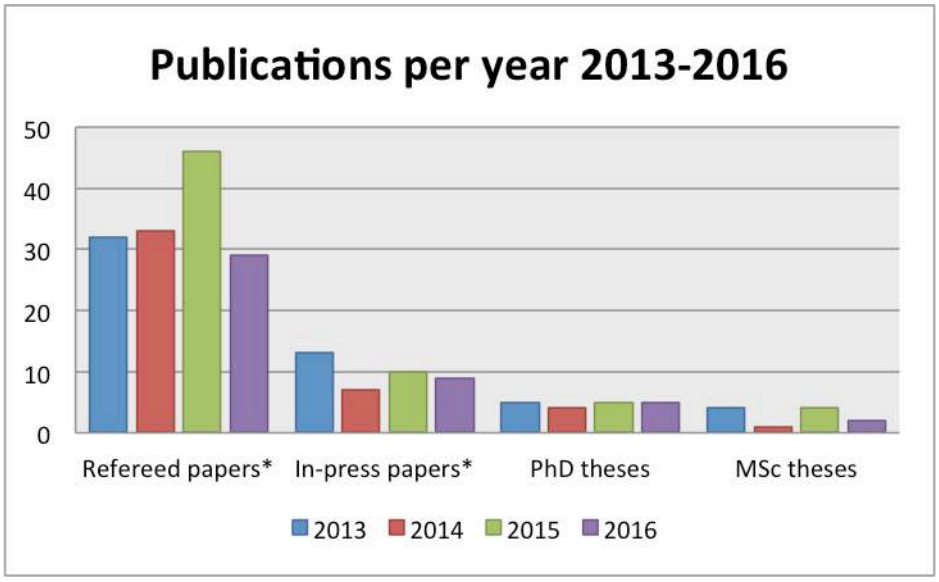

Figure 1 Total number of published achievements (2013–2016) where data gathered at the Aalto NeuroImaging –infrastructure were used.

4 Technical development

While keeping the infrastructure operational and of the highest quality for our users, ANI infrastructure personnel is also actively involved in many technological and methodological development projects that may not result in publications, but stand out as improved services and possibilities for the users to benefit from the infrastructure. Below, some important projects and advances made in 2016 are described. Many of these projects are done in direct collaboration with our users and, therefore, they often interact with academically funded research projects resulting in achievements listed in the previous chapter.

AALTO TMS

Improving of Aalto TMS laboratory's facilities continued in the year 2016. The testing of the concurrent TMS–fMRI system and considerations regarding the safety issues of acoustic noise pressure while operating a TMS coil in the presence of strong external magnetic field (3T MRI) continued. In addition, Aalto TMS was reorganized in order to make all the instruments more accessible. A graphical user interface for the system enabling the use of Magstim stimulators via a computer was built. In 2017, Aalto TMS will aim to attract new external users as well as to take part in novel scientific projects within the department. Users' training will also be held to train and attract new users.

AMI CENTRE

We have been very pleased with the Siemens Skyra scanner since its installation at the end of 2011. In 2016, no major updates to the scanner itself or scanner software were made. The scanner has operated in the software level VD13C. As mentioned in the previous chapter, AMI Centre is involved in building a concurrent TMS–fMRI measurement setup with Aalto TMS. Unfortunately, to fully exploit the capabilities of such setup, a specifically designed head coil is needed. Consecutive TMS and fMRI can be made, but so far our users have not launched projects exploiting this possibility.

AMI Centre was actively involved in organizing a symposium "Ultra-High Field MRI: Transition to Human 7T in Finland" in the fall of 2015 together with ABC, NBE and Finnish Infrastructures for Functional Imaging (FIFI) consortium. Stemming from this, we made grand effort in 2016 together with Academy Professor Riitta Salmelin in order to secure funding for the first 7 T MRI scanner in Finland from the Academy of Finland 2016 funding call for Research Infrastructures. To our disappointment, funding was not received. Despite the setback we continue striving towards this goal together with our national partners in the future.

As previously, measurements of combined EEG–fMRI, eye-tracking, and acquisition of galvanic skin response and other physiological signals, such as respiration, plethysmography, ECG, and EMG, have been routinely performed throughout the year in AMI Centre. Some smaller upgrades took place during 2016 regarding the stimulus delivery computer and improving the usability of the eye tracking system. Our staff constantly follows the current trends in fMRI stimulation/response systems and attended several roadshows of different manufactures as well. All our devices (both custom-made and commercial ones) are available to all users of AMI Centre.

The project of improving the quality assurance (QA) procedures of AMI Centre has continued in 2016, and the implemented methods are taken into use in the early 2017. In addition, there are definitive plans of bringing the newest advancements with the functional magnetic resonance Inverse Imaging (InI) into full use at AMI Centre in collaboration with Professor Fa-Hsuan Lin from the National Taiwan

University and NBE, Aalto University School of Science. Further on in 2017, we continue improving our stimulus systems to meet the demands from our users. We are actively finding sources for funding the 128-channel RF-receiver expansion for Siemens Skyra and a new 64-channel head/neck coil for advanced fMRI purposes. Funding is also needed for the latest software update for the Skyra, the E11C which would provide some intriguing possibilities, such as the simultaneous multi-slice (SMS) EPI acquisition. This may prove to be an extremely vital update for our users.

MEG CORE

MEG Core has made small upgrades related to the Elekta software and further developed stimulators using pneumatic artificial muscles (PAMs) for several research projects. In addition, we have trained new Elekta MEG users at MEG Core.

In 2017, we will start our plans for upgrading our MEG system. Our MEG system will have its 20th anniversary in 2018 and the new MEG system will provide zero boil-off rate to reduce helium costs, better dynamic range to facilitate measurement with more artefacts, niobium-shielded MEG sensors to provide easier tuning and maintenance, and more additional channels to facilitate more complicated experimental settings. The next FIRI call is expected in early 2018 and we aim to get the most of the funding for the upgrade from the FIRI call.

5 Equipment use and infrastructure funding

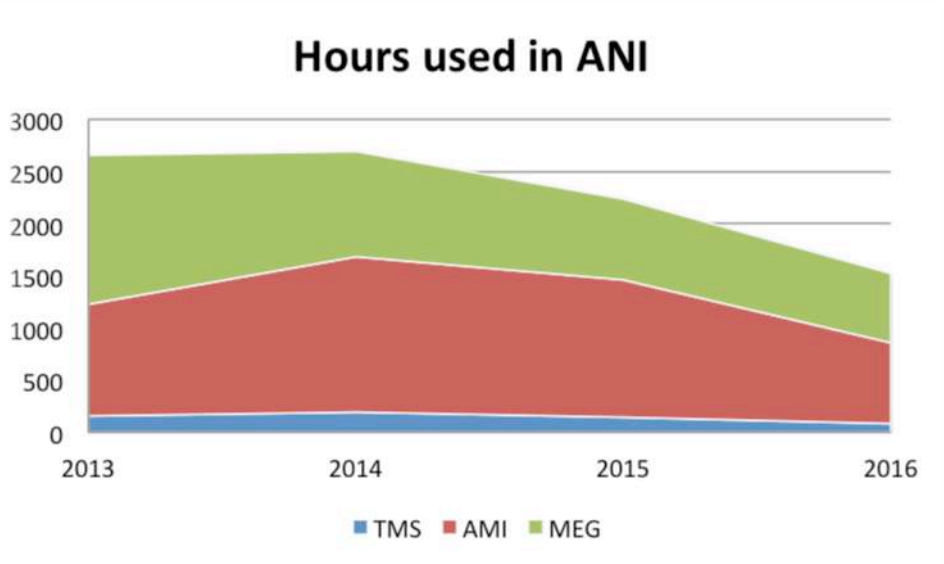

Figure 2 Total number of used hours of the Aalto NeuroImaging –infrastructure during 2013–2016. The numbers do not include service hours, but they include non-invoiced hours for scientific internal development, teaching purposes and similar use.

AALTO TMS

Total number of invoiced hours in 2016 was 34. A total of 18 hours was used to user and safety courses. A total of 31 hours was used to demonstrate the laboratory to various interested parties. In addition, a total of approximately 50 hours were used to technical development and service. In the fourth year of operation, the total number of invoiced hours in Aalto TMS was unfortunately well below the expected, inflicting the need of decisions to be made about the future of Aalto TMS during 2017.

	AALTO TMS (hours used)				**2016**
	2013	*2014*	*2015*	**2016**	**%**
Users					
NBE (previously BRU)	*118.5*	*98*	-	-	-
ABC	-	-	*31.5*	32	38.6
UH	-	*22.5*	*23*	2	2.4
Training	*11*	*42*	*54.5*	18	21.7
Demos, Workshops, Visitors	*28*	*5*	*29*	31	37.3
Free pilots	-	*22.5*	-	-	-
All users total	***157.5***	***190***	***138***	**83**	**100.0**
Service and technical development	*100*	*50*	*100*	50	

AMI CENTRE

In 2016, the total number of used hours (not including maintenance and free pilot hours) reached only 769 hours (out of which almost 80% during prime time). The biggest single users were University of Helsinki users (several groups from many departments added up to more than half of the total). From Aalto University, the biggest users were the groups supported by the Aalto Brain Centre (~12%) and Department of Neuroscience and Biomedical Engineering (~9%). We were happy to see the share of outside users increasing up to 75% of the total.

The drop in Aalto internal use is partly explained by the move of Professor Lauri Nummenmaa, a heavy user of AMI Centre's fMRI, to Turku PET Centre in the summer. We have estimated that had his group continued measurements at AMI, we would have almost reached the 1000 paid hours mark, designating a budget balance. Radiographer assistance is still very much needed and extremely important part of our operation as many groups measure only during prime time (Mon–Fri, 9–16) when this service is available. We are looking forward to boosting the usage back to the level of the previous years after the pending professor recruitments at Aalto.

	AMI CENTRE (hours used)													**2016**
	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	**2016**	**%**
Aalto users														
NBE (BECS)	*173*	*168*	*194.5*	*98*	*85*	*84*	*108*	*194*	*50*	*231*	*365.75*	*285*	67.5	8.8
NBE (BRU)	*286*	*529*	*479.5*	*622*	*339*	*253*	*227*	*335*	*286*	*185*	*178.25*			
ABC	-	-	-	-	-	-	-	-	-	-	-	*163.5*	97	12.6
aivoAALTO	-	-	-	-	-	*28*	*252*	*115*	*177*	*201*	*125.5*	-	-	-
AMI Centre[1]	*230*	*151*	*154*	*85*	*27*	*46*	*56*	*47*	*92*	*39*	*71.5*	*97.5*	20	2.6
NeuroCine	-	-	-	-	-	-	-	-	-	-	*10*	*31*	4	0.5
Others[*]	-	*16*	-	-	-	-	*7*	*53*	*30*	*3*	-	-	3	0.4
Aalto total	***689***	***864***	***828***	***805***	***451***	***411***	***650***	***744***	***635***	***659***	***751***	***591.5***	**191.5**	**24.9**
Outside users														
UH	*115*	*76*	*81.5*	*126*	*126*	*172*	*268*	*131*	*339*	*286*	*526.5*	*501.5*	413	53.7
HUS	*37*	*19*	*18*	*10*	*10*	*4*	*4*	*5*	*82*	*60*	*43*	*109.5*	77	10.0
Other academic[#]	*283*	*35*	*27.5*	*7*	*24*	*91*	*10*	*63*	*57*	*61*	*174.5*	*116.5*	87.5	11.4
Others (industry etc.)	*2*	*9*	*50*	*20*	*40*	*47*	*35*	*16*	*3*	-	-	-	-	-
Outside total	***437***	***139***	***177***	***163***	***200***	***314***	***317***	***215***	***481***	***407***	***744***	***727.5***	**577.5**	**75.1**
All users total	***1126***	***1003***	***1005***	***968***	***651***	***725***	***967***	***959***	***1116***	***1066***	***1495***	**1319**	**769**	**100.0**
Radiographer	-	-	-	*577*	*410*	*508*	*663*	*553*	*641*	*647*	*744.5*	*819.5*	*553.5*	
Radiogr. %	-	-	-	*60%*	*63%*	*70%*	*69%*	*58%*	*57%*	*61%*	*50%*	*62%*	*72%*	
Service[1, 2]	-	-	-	*214*	*234*	*218*	*212*	*735*[3]	*180*	*185*	*195*	*228*	*175.5*	
Free pilots[1]	-	-	-	-	-	-	*5*	*13*	*6*	*5*	*10.5*	*25*	*26*	
Cancellations[4]	-	-	-	*~30*	*~20*	*~5*	*~5*	*32*	*55*	*65*	*180.5*	*127.5*	*77*	

[1] Not invoiced: 1. AMI Centre's technical development projects 2. Service times 3. Complimentary phantom pilots
[2] Includes: GE/Siemens maintenance (prime time only), AMI maintenance, trainings, visits
[3] Including the 3-month downtime for Scanner change (approx. 575 prime time hours)
[4] Late cancellations (not invoiced), 2016 reasons: 1. Subject cancelled (more than 70%; sickness, no-show, other) 2. Other reasons
[*] In 2016: Applied Electronics Laboratory
[#] In 2016: THL, University of Jyväskylä

MEG CORE

The usage of MEG Core was slightly reduced in 2016. This drop in usage is partly explained by recent downshift and retirement of two professors in the MEG field. Furthermore, new professor slots at NBE, stemming from these personnel changes, have not yet been filled by the end of 2016. It will take some time and fresh recruitments before the usage gets back to the level of prior years.

The total use of MEG Core was 673 hours (service hours excluded). Department of Neuroscience and Biomedical Engineering (NBE), Aalto Brain Centre (ABC) supported researchers and Elekta training were the main users of the facility.

	MEG Core (hours used)				**2016**
	2013	*2014*	*2015*	**2016**	**%**
Users					
NBE	*950*	*488.5*	*468*	101	15.0
ABC	-	-	*24.5*	55.5	8.2
HUS collaboration	*265*	*24.5*	*12*	-	-
Outside visitors	*19*	*18*	*27.5*	6	0.9
Elekta (intro training)	*64*	*188.5*	-	73.5	10.9
Elekta (service training)	*135*	*29.5*	*125*	237	35.2
Elekta (testing)	*n/a*	*n/a*	*n/a*	40.5	6.0
Courses	-	*4*	*5*	17	2.5
Visitors	-	*54*	*46*	29.5	4.4
Method development (free)	*n/a*	*n/a*	*n/a*	55	8.2
Free pilots	-	*200*	*73.5*	58	8.6
All users total	***1433***	***1006***	***781.5***	**673**	**100.0**
Service (helium refills)	*156*	*207*	*158*	191	

INCOME AND OPERATING COSTS 2016

In 2016, the total income of Aalto NeuroImaging (725 k€) was below to the estimated budget. The income came from user fees (297 k€) and basic funding (427 k€). The total expenses were 904 k€ (expenses in MEG Core were 325 k€, AMI Centre 467 k€, and Aalto TMS 112 k€) signifying that the budget was 180 k€ on the negative side.

AMI Centre, performing best of the three separate units, needed 56% of its budget from ANI basic funding (planned 40%), MEG Core needed more support (approximately 73%) whereas Aalto TMS was fully supported (approximately 97 %) by ANI basic funding. Adding to the cumulative surplus/deficit from the previous years, the cumulative sum is currently -348 k€.

6 Safety, teaching, seminars, visitors, and travel

AALTO TMS

Aalto TMS Laboratory's own safety and user course which is a prerequisite for all TMS measurements at Aalto TMS was organized 2 times during 2016 and was attended by a total of 7 participants (2 foreigners).

Aalto TMS was part of the organizers of the 4th Science Factory: TMS–EEG summer school 2016 held on 8th–13th of September. This included 2 hands-on TMS–EEG demonstration at Aalto TMS which was attended by 12 people (9 foreigners). The most of the event was organized in Solvalla, Espoo, in which the research engineer, MSc Mikko Nyrhinen, also attended.

Tapiola upper secondary school psychology students (19 people) visited Aalto TMS and AMI Centre on 17th of March. Optician students from Metropolia University of Applied Sciences visited Aalto TMS, AMI Centre, MEG Core, and ABL on two occasions: 18th of May and 14th of December. The visits were attended by 26 and 22 persons, respectively. On 18th of May the Summer School of Behavioral Operational Research, Mind and Brain Day, visited Aalto NeuroImaging. Also, Helsinki Normaalilyseo visited Aalto TMS and AMI Centre with 11 attendees. In addition, Scientific Advisory Board of School of Science with Arto Nurmikko and Martin Ingvar visited Aalto TMS and AMI Centre.

Aalto TMS housed a demonstration of navigated TMS on 26th of October for the course "TRANSMED: Imaging in Science and Medicine" organized by University of Helsinki. The demonstration was attended by 7 students. Two professor candidates for Department of Neuroscience and Biomedical Engineering visited Aalto NeuroImaging on 10th of November.

Research engineer, MSc Mikko Nyrhinen, also visited Clinical neurophysiology department of Uppsala University hospital, NatMEG research laboratory at Karolinska Institutet, and Psychiatry clinic at Karolinska University Hospital Brainsway where we became acquainted with Brainsway deep TMS therapy device. The trip was organized by Physicist division of Finnish Society of Clinical Neurophysiology.

AMI CENTRE

AMI Centre organizes its own MRI safety course, which is a prerequisite for all MRI scanner users at AMI. It was organized 4 times during 2016 and a total of 32 individuals (7 foreigners) passed it (altogether 519 people have passed it since 2002).

The knowhow of our experts in fMRI/MRI is delivered to our user groups by arranging demonstrations of new equipment and magnet use. These sessions are organized several times a year and they are often based on user's requests and tailored to their specific.

AMI personnel hosted numerous formal and informal visits by groups or individuals of students, researchers, science reporters, and television crews. The visitors included, but not limited to, groups from Aalto University, University of Helsinki, Metropolia University of Applied Sciences, high school student groups and both Finnish and international media representatives. In addition, the Scientific Advisory Board of Aalto University School of Science visited AMI Centre in the fall 2016.

During 2016, the AMI Centre's internal safety committee (whose members were Toni Auranen, Veikko Jousmäki, Tuomas Tolvanen, and Raimo Sepponen) had email exchanges and informal discussions in which safety issues and procedures of testing new devices for the MRI environment were evaluated. Additional scientific talks related to AMI activities were included in the laboratory seminars of the Department of Neuroscience and Biomedical Engineering (NBE) and Aalto Brain Centre (ABC).

MEG CORE

In 2016, MEG Core contributed to Elekta Neuromag Triux introductory MEG courses in May and September. Typically, the Introductory Course lasts for 5 days and including both lectures and hands-on data acquisition and analysis sessions. These courses were carried out in collaboration with Elekta Oy. In addition, the Elekta Service Training was organized at MEG Core in October.

MEG Core personnel also host formal and informal visits by groups or individuals of students, researchers, science reporters, and television crews throughout the year.

7 Aalto NeuroImaging personnel

7.1 Aalto TMS, AMI Centre, MEG Core

DIRECTORS

Veikko Jousmäki, ANI & MEG Director, PhD, Visiting Professor, Senior Scientist (**MEG**)

Synnöve Carlson, TMS Scientific Director, MD, PhD, Professor of Practice (**TMS**)

Toni Auranen, AMI Technical Director, DrTech, Staff Scientist (**AMI**)

OTHER PERSONNEL

Mia Illman, MEG Technologist (**MEG**)

Helge Kainulainen, Technician (**MEG**)

Marita Kattelus, Radiographer (**AMI**)

Mikko Nyrhinen, Laboratory Engineer, MSc (**TMS**)

Petteri Räisänen, System Administration/Technical Support (~1 day per week for **ANI**)

Veli-Matti Saarinen, Laboratory Engineer, MSc (~0.5 months for **ANI** / the rest for **ABL**)

Ronny Schreiber, System Administration/Technical Support (~1 day per week for **ANI**)

Tuomas Tolvanen, Laboratory Engineer, MSc (**AMI**)

7.2 Users and collaborators of ANI (n = 208)

The persons listed below are either, *authors* in scientific publications and theses where Aalto NeuroImaging is indicated in the byline or where data measured at any part of ANI (Aalto **TMS**, **AMI** Centre, **MEG** Core) were used in 2016 (previous years in parentheses), and/or they are members of research teams collecting data or carrying out research on data collected at ANI; the latter names have been collected from the active research permissions as well as project information and user notifications delivered to ANI in 2016. Also the employees of ANI who are performing measurements are listed here.

The total number of users and collaborators of the Aalto NeuroImaging infrastructure in 2016 (2015, 2014, 2013) adds up to 208 (212, 214, 220) individual researchers [48 (43, 61, 65) foreigners, 139 (155, 126, 112) individual authors] with AMI Centre affiliating to 180 (172, 174, 189), MEG Core to 57 (67, 76, 51), and Aalto TMS to 4 (12, 10, 5) of them. Out of the total, 98 (113, 112, 113) were affiliated with Aalto University, 64 (52, 45, 51) with University of Helsinki and 26 (20, 20, 10) with HUS / HUCH, some with double or triple affiliations.

Abbreviations: *AU = Aalto University*
UH = University of Helsinki
HUS = Hospital District of Helsinki and Uusimaa
HUCH = Helsinki University Central Hospital

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8 APPENDIX: Aalto Behavioral Laboratory (ABL)

8.1 Introduction

Aalto Behavioral Laboratory (ABL) was established on summer 2015 on the old premises of Behavioral Imaging Laboratory (BIL). For a year and a half ABL has been constantly improved to its current state, while the laboratory has been in full operation.

Laboratory is meant for behavioral measurements; it offers two measurement rooms and versatile devices for subject monitoring, such as EEG, eye tracking, thermal imaging, EMG, EDA, ECG, and accelerometry. Electroencephalography (EEG) measurements are conducted in electrically shielded room where the equipment consists of Brain Products devices, including a 32-ch BrainAmp amplifiers and actiCAP EEG-caps. For eye tracking there are a remote EyeLink 1000 plus (SR-Research Ltd.) eye tracker with a chin rest, which enables recording eye movements up to 2000Hz; and two head mounted Eye Tracking Glasses (SensoMotoric Instruments GmbH) which are for remote measurements. For autonomic responses laboratory has a data logger (ME6000, Mega Electronics Ltd) which can record signals like EMG, EDA and ECG.

For subject monitoring purposes surveillance cameras and voice intercom system are installed in the rooms. The laboratory has systems for visual and audio stimuli, including headphones, earphones, speakers and display monitors. Our stimulus system also includes a thermal stimulator (MSA Thermotest, Somedic SenseLab AB).

8.2 Location, facilities, organization, and mission

ABL offers variety of different stimulus and monitoring devices for versatile experimental setups for one or more subjects at a time. It is located in the 4th floor of the Magnet Building, in the immediate proximity of both AMI Centre and Aalto TMS.

During 2016, ABL was operating under NBE and is supported in part by ANI personnel. Tentative plans exist to include ABL as part of the Aalto NeuroImaging infrastructure in 2017. Research Engineer, MSc Veli-Matti Saarinen, has been managing the laboratory with the guidance of Aalto NeuroImaging director Veikko Jousmäki. Until the end of 2016 the measuring has been free of charge, but hourly fees are introduced in the beginning of 2017.

8.3 Achievements

MASTERS THESES

1) Maria Rytioja: **The effects of transcranial direct current stimulation on oscillatory brain activity.** Thesis for the degree of Master of Science (Technology), Aalto University School of Electrical Engineering, 2016. Supervisor: Professor Lauri Parkkonen. Advisors: Tuomas Neuvonen and Jani Virtanen. (G2, **ABL**)

8.4 Technical development

During late 2015 and in 2016, the laboratory has been developed continuously to serve our users with easy measurements. An electrically shielded room (built in 2002) has now been equipped to improve the room's performance and usability. Mains electricity was installed inside the shielded room including several power sockets and power supply for the door mechanics. The main power supply was connected

through RFI suppression filter (EMPF – 2016, Filtro Oy, Orimattila, Finland), which locates just outside the room. An isolation transformer (KKS-500, Muuntosähkö Oy – Trafox, Helsinki, Finland) was installed to isolate the room's power devices from the power source. Cable feedthroughs were handled with optic fibers to avoid noise signals entering the room. Lens filters were applied on optic illuminators, which were room's lighting source, to get rid of the infrared light that was distracting the eye trackers inside the room. An emergency handle was added to the room side of the door.

Remote Eye Link 1000 plus eye tracker (SR Research Ltd, Missisauga, Ontario, Canada) and EEG-devices (Brain Products GmbH, Gilching, Germany) were installed into the shielded room.

Stimulus system was built to the room, which included stimulus PC, stimulus monitor (XL2420Z, BenQ Corporation, Taipei, Taiwan), external soundcard (Fireface UCX, RME GmbH, Haimhausen, Germany), earphones (ER-2, Etymotic Research Inc., Elk Grove Village, USA), headphones (HD600, Sennheiser electronic GmbH, Wedemark, Germany), panel speakers (Sound Shower, Panphonics Oy, Tampere, Finland) and triggering system for the data synchronization. Aluminum bar profile system was mounted to the ceilings of the rooms, which makes attachment of different devices easy

Voice communication system with the subjects (Indoor Touch, 2N 2N Telekomunikace a.s., Prague, Czech Repulic) was installed; also surveillance cameras (Stingray, Allied Vision Technologies GmbH, Stadtroda, Germany) for monitoring purposes. In addition, ANItime (http://anitime.aalto.fi), Aalto NeuroImaging reservation calendar system, was taken into use at ABL. With ANItime, you can reserve both rooms and loanable devices separately.

8.5 Equipment use and infrastructure funding

In 2016, there were 453 hours of measurements in the ABL, including both rooms and all loanable devices. The biggest single user was NBE/Aalto (283.5 hours). During 2016, all measurements were free of charge. Assistance was in extremely important role in the shielded room measurements, where assistance was needed in 51% of measurements, mainly in EEG and eye tracking related experiments.

	ABL (hours used)					**2016**
	AC	DC	ETG1	ETG2	IR	**Total** (in %)
Users						
NBE/Aalto	140	143.5	-	-	-	**283.5** (62.6)
Others (Aalto)	-	55.5	-	-	-	**55.5** (12.3)
Åbo Akademi	38	-	-	-	-	**38** (8.4)
Piloting	1	27	24	24	-	**76** (16.8)
All users total	179	226	24	24	0	**453** (100)
Service	*51*	*101*	*31*	*31*	*31*	*245*

AC = normal room
DC = shielded room
ETG1 = Eye Tracking Glasses 1
ETG2 = Eye Tracking Glasses 2
IR = Thermal Camera

8.6 Safety, teaching, seminars, visitors, and travel

There were several informal visits for students and research groups in ABL; content was varying from visitor tours to hands-on training sessions.

ABL organized 3 day event "ABL – Open House" on 25-27.5., which was part of Aalto Festival

2016. Talk “Aalto TMS and Aalto Behavioral Laboratory” was held in Aalto Brain Centre (ABC) Seminar on 1.2. by Mikko Nyrhinen and Veli-Matti Saarinen. A workshop titled “EEG-workshop EGI” was organized on 1.9. by ANI in co-operation with ABC.

Master thesis demonstration by Viktor Klüber (TU Ilmenau, Germany) about “SSVEP-BCI” with EEG device was held in ABL on 2.12. A student group on project course “DOM-E5034 - Dynamic Visualization 2”, lectured by University Lecturer Markku Reunanen (Aalto University), was measuring EEG and eye movements in ABL in their project.

8.7 Users and collaborators of ABL (n = 24)

The persons listed below are either, authors in scientific publications and theses where Aalto Behavioral Laboratory is indicated in the byline or where data measured at ABL were used in 2016 and/or they are members of research teams collecting data or carrying out research on data collected at ABL in 2016. Also the employees of ABL and ANI who are performing measurements are listed here.

The total number of users and collaborators of the Aalto Behavioral Laboratory in 2016 is 24.

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