

COGMAX

## Minor Internship Report

Ida-Mari Heggelund Svevad, S3983579

[I.h.svevad@student.rug.nl](mailto:I.h.svevad@student.rug.nl), [i.m.h.svevad@umcg.nl](mailto:i.m.h.svevad@umcg.nl)

BSc Liberal arts And Sciences

Specialization: Mind and Behaviour

University of Groningen

UCG3RM01

Organization: UMCG, Cognitive Neuroscience Centre

Study: COGMAX

NeuroImaging Center, Antonius Deusinglaan 2  
9713 AW Groningen

External Supervisor: Nena Lejko

Academic Supervisor: Steven Bergink

INDEX:

1. Benefits of following an internship at the Cognitive Neuroscience Centre
2. Preparation for the internship
3. Expectations prior to internship
4. Internship Supervisor
5. Description of the chosen institution
6. Internship in The Netherlands
7. Description of the undertaking tasks
8. Treating Mild Cognitive Disorder
9. The Experiment
10. Tips for future students
11. Overview of undertaken tasks and activities
12. Learning progress
13. Professional learning goals
14. Primary Goals
15. Secondary Goals
16. Generic Learning Goals
17. Reflection on expectations
18. Supervisor's feedback
19. APPENDIX

### Benefits of following an internship at the Cognitive Neuroscience Centre

Since I was a child, I have never been one to take the easy route. This has been a great motivator for my study choices, and this created the interest in helping people who differ from the norm. I was not certain in which direction within the field of psychology I wished to follow, so I therefore choose to follow classes from the fields of psychology, neuroscience and eventually also biology. As I choose to deepen my insight into the field of neuroscience, and research within the field I became more eager to begin an internship at the UMCG which was my wish for the third year of my bachelor.

My aim to help people who have neurological, biological, or psychological difficulties has driven me throughout my studies and motivated me to take every available opportunity. For this reason, I am keen to embrace the opportunity to participate in different research during my internship period. As a mind and behaviour student at the University College, I have enjoyed the interdisciplinarity aspect of my studies which I feel has broadened my perspective, and I believe this internship will benefit me in a similar way. Therefore, I wish to use this great opportunity of this internship to deepen my knowledge in data collection and analysis, as well as my academic Dutch fluency. My wish is to direct my career towards research and this internship can build on my current knowledge to create a solid ground before I begin my masters. As a future research student and researcher in mind and behaviour, I wish to commit a lifelong learning, which I will embrace.

### Preparation for the internship

My host institution is located in the city of Groningen in the Netherlands. Groningen is the biggest city north in the Netherlands and is regarded as one of the best cities for studying in the Netherlands with over 50,000 students. After living in Groningen for more than two years, I was already familiar with the medical university Medical Centre (UMCG), and its research and education opportunities. UMCG is one of the largest hospitals in the Netherlands, with more than 3,700 students and is amongst the best academic training centres in the Netherlands.

I approached the hospital after reading about the internship in the Ukran. *Studying the effect of transcranial electric current stimulation in people with mild cognitive impairment* was one of the internships on the list, and I was intrigued. To me this is a very interesting study in which I felt like I had something to offer. My previous experience with elderly people suffering with cognitive impairments on different levels has given me several tools that I find useful for experiments like these one. I decided to write my motivation letter, even though the requirements for this internship was to speak fluently Dutch. I thought it was time to leave the comfort zone and go ahead with it.

I was confident that this internship would be a solid step toward achieving my goal of becoming a researcher within the field of neuroscience. This is something that I am incredibly passionate about. I therefore sent the motivation letter, enclosed with my curriculum vitae, and was invited to an interview the next day. During that interview we had a very good conversation leading to the positive news, and I was invited to join the COGMAX team.

Moreover, they shortly informed me about my tasks and responsibilities. Specifically, they stated that I would be conducting the experiments. It was a couple of days with training before the new participant was scheduled. Before my starting day, my supervisor had given me protocol which had to be read and understood before the experiment took place. This was a good way to prepare for such experiment, and they allowed me to try everything during my training before we began with the first session of a new participant. This was a great way for me to learn the routines, as well as getting into explaining our protocol in Dutch for the participant. Information from the protocol is included in the appendix.

### Expectations prior to internship

There were several reasons for why I considered an internship as a part of my bachelor's program. An internship like this one would help me integrate into the work environment of researchers dealing with my field of specialization, while it would give me the opportunity to actively participate in its overall function. Move over, it would provide me with the opportunity to begin recalling the theoretical knowledge that I acquired during my studies at the university, to apply it in practice and to cope with the problems I will be assigned to.

During my bachelor's degree, testing my knowledge has only occurred hypothetically through exercises, topics, and examinations, while with the internship, for the first time, I would be able to face real problems -from the most important issues, such as conducting the experiment, conducting neuropsychological testing, collecting data, and analysing the data. In addition, I expected to acquire skills particularly useful for my subsequent professional career. I would gain experience regarding processes concerning the overall approach, treatment, and social interaction with patients. These are skills that are difficult to acquire only through theoretical knowledge.

From my internship, I expected to learn more about myself by exposing myself to new disciplines, within the field of my interdisciplinary study. Furthermore, I would want to learn more about myself and my function within the hospital as well as gaining more experience and academic knowledge. I believe it is essential to locate the practice of psychology in a broader context. Therefore, I wished to use this great opportunity of this internship to deepen my knowledge in psychological and neurological assessments. Furthermore, this internship is giving me the opportunity to function clinically by having to follow up patient during their treatment. This is experience I wished to bring with me, as I see the importance of being able to care for patients and function practically when necessary. I considered this direct interaction between me and the patients necessary to better understand the qualifications, duties, and responsibilities in my career field.

Lastly, an internship is a great academic experience, I expected it to confirm the choice of Master that would suit my personality and my interest. I wanted to learn more about my career orientation and the working opportunities offered in the field of neuropsychology. I wanted my internship to guide me through the procedure of conducting research. This internship had given me the different options there is regarding a master choice, which I'm very grateful for.

### Internship Supervisor

My supervisor during the internship was Ms. Nena Lejko, a PhD student working on the COGMAX study mentioned above in the paper.

Ms Lejko was a very good supervisor, that cared about my progress and gave feedback when necessary. She provided me with essential material to read to prepare myself for the experiment, which is explained step by step in the appendix. If necessary, she would explain the overall functions of the neurological testing and explain the data analysis of the results. Her most important task, when it comes to my supervision, was that she overviewed me when I was conducting the experiments in the beginning until I became more secure about my task. I really appreciated that she was available if necessary, and that I could communicate through WhatsApp with the whole COGMAX team if some questions were raised, or practical guidance was needed.

As she was mostly analysing the data, some days we were working in different departments, or we were working from home due to the covid-19 measurements. The pandemic had very unfortunate consequences on the collaboration between me and my supervisor as we needed to work at the home instead of the office, and registration was needed to study in the building. We have followed the national measured and direction of RIM on coronavirus carefully. Fortunately, we have been able to continue with our practical components in this study.

This was quiet unfortunate, as I did not have the possibility to ask questions physically and were bound to communicate through e-mails or by WhatsApp. Furthermore, when problems arose regarding the patient's progress, it had to be logged in a book, and in some cases discussed in the end of the experiments. These problems could for example be, challenges the participant had with understanding the test battery used during tACS or EEG. Another example could be general issues with the computer, the program or the tACS/EEG components.

### Description of the chosen institution

The institution I chose for my internship is a hospital with different departments, including research facilities. It is built and equipped for the proper and safe treatment, monitoring, assessment, and boarding of mild cognitively impaired patients.

The COGMAX study is a scientific study which is aiming at improving the executive functioning in patients suffering from mild cognitive brain stimulation disorders. Cognition is the processing of information by the brain. To give an example, processing information requires memory, language, attention, and the ability to solve problems, which are abilities everyone is using constantly and are named cognitive skills. Someone with a mild cognitive disorder (MCD) has complaints about memory or another cognitive functions. MCD lies between normal aging and dementia. Cognitive functions can also decline with normal aging, but this is even more the case with MCD. Unlike dementia, people within MCD function almost normally in daily life. MCD can progress to dementia, but this is not always the case.

In addition to memory problems, people with MCS often also have other cognitive problems such as difficulty switching between tasks, and difficulty planning and organizing. These are the executive functioning. Problems in these functions have been shown to be predictive of the development of dementia and the degree of independent functioning. It is therefore important for the patient, but also for his/her loved ones, to treat such problems early and thus prevent or delay the development of dementia.

### Internship in The Netherlands

Being a Norwegian citizen living in the Netherlands has been very simple as everyone speaks English and welcomes you no matter what nationality you have. Personally speaking, doing an internship in the Netherlands has been a great experience, and I've been able to practice my Dutch in a working environment. I have learned more about the Dutch language than I did during all the lessons I've had previously. The experiences of the Netherlands have been good, and I enjoy the social life, the culture, and the people very much.

Living in the student city Groningen has been very nice, and I've been lucky finding an apartment to rent as well as getting two dogs in my life. The city has many restaurants, shops, and nightclubs, as well as beautiful nature not far outside the city of Groningen. The public transport from and into the city is very good and can be used for both short and long-distance traveling. Furthermore, in the Netherlands bicycling is a very common thing and everyone owns a bicycle. Groningen is a city with good infrastructure for people biking to school, work or to the market. It is very handy to own a bike in the Netherlands and you can cycle almost everyone within the city as well as on the outside of the city.

### Description of the undertaking tasks

During my internship, I undertook several tasks. I have worked with several patients with mild cognitive impairments, and or patients suffering from mild dementia. I conducted experiments, and took part in both the data collection and analysis. The experimental tests used can be found in Appendix A, as well as the description. Finally, during this internship we sometimes had to travel

home to the participants, and at their house we conducted the same experiments and neurological assessments similar to the CNC, just in their home environment.

### Treating Mild Cognitive Disorder

People suffering from mild cognitive disorder (MCD) have problems with memory, as well as functions such as mental flexibility or the ability to plan and organize, functions called collective executive functioning. In this study, we investigate the effects of tACS (Transcranial Alternating-Current Stimulation) in people with MCD. Previous research has shown that tACS is effective at speeding up information processing in healthy individuals, but this has not yet been studied in people with MCD. If treatment with tACS also proves to be effective in people with MCD, a new treatment may be suggested.

In transcranial alternating current stimulation (tACS), the brain is stimulated in a specific area with a very weak electrical current, while the patient is quietly sitting in a chair. Three electrodes will be placed on the participants' head, glued with paste. tACS is not a painful procedure, has few to no side effects, and is performed while seated. A slight headache is a common side effect after the stimulation.

### The experiment

In this study, we investigate whether brain stimulation with tACS has an effect on improving cognitive skills. Two previous studies with healthy participants show that it is possible to improve executive functioning with tACS after just one session. We think that people with MCD could benefit from this treatment. The two previous studies both used a different stimulation method. We want to test both forms of stimulation for use in people with MCD.

We will examine 90 people with MCD, and the participants will be divided into three groups, each with 30 participants. Two groups receive real stimulation, each group with a different frequency, the other group receives a mock stimulation. We use the group of patients receiving the sham stimulation as a control for the two groups receiving the real stimulation. Each participant will be placed in one of the three groups by drawing lots. Neither the researchers nor the patient will know which group the participant is located in. A researcher who is not involved in the research will allocate a code to each participant by drawing lots. We will only inform the participant which group they belonged to after the experiment has ended. The procedures for the sham stimulation and the real stimulation will be the same, except that in the sham stimulation the equipment does not provide a real stimulation.

### Tips for future students

One of the most important things to consider when applying for an internship where research is conducted in a clinical setting is the language. Many participants, especially the older generation, have little or no education, learning difficulties, and would not be able to speak or communicate in English. Especially when dealing with participants who have MCD or a mild form of dementia, it is quite hard to communicate with the patient, and they often require long pauses, change the subject quickly, or mumble.

Furthermore, there might be internship opportunities at the UMCG offered in English, but there is a big chance that the participants won't be able to speak English and will speak in their native language. This means that if one is considering applying for an internship position in a country such as the Netherlands or another country where English is not the native language and he/she is not fluent in the language of that country, they might not be able to interact directly with the patients. This could affect

the interns' overall job experience and satisfaction and give them the wrong impression of how a job in a clinical setting is.

Another important thing to consider is that demented participants, or participants with other sort of health problems needs special care. Interns might need to face situations with patients collapsing, becoming very ill or needing nurse assistance. It is important for the students to be mentally prepared that they will have to deal with unpleasant situations as well, before applying for such an internship.

#### Overview of undertaken tasks and activities

As already mentioned in the previous section, during my internship I was assigned several tasks. I was conducting the experiments on participants, where we collected data and analysed the data. Moreover, I was communicating directly with the participant in Dutch.

Except for the tasks explained above, I was providing the participants with normal care, such as helping them navigate through the buildings, keeping them hydrated and providing them with lunch, or snacks to keep the blood sugar stable. Some of the participants have diabetes, which has to be monitored since the experiment could take longer than expected, as well as the neuropsychological assessments (NPE) that was conducted after the experiment on day 1 and day 10, and the follow-up.

#### Learning progress

Prior to the internship, I set a few personal learning goals that I wanted to achieve through my internship at the UMCG. These goals, based on the UCG internship manual, and are separated into two categories those being professional skills and generic skills. These goals were set to expend even further my personal development as a person and a student.

In my opinion, I have managed to accomplish all the goals in both categories. Some of the goals, I can proudly say, I have achieved to a great degree, while other goals, unfortunately less. Which of the goals I achieved more or less, was based on my placement in the organization, my tasks and responsibilities, as well as the spare time I had after the session.

#### Professional learning goals

As mentioned above, I set multiple personal goals which I wanted to achieve during my internship at the UMCG. My most important goals in the professional domain were to be able to analyze, identify, resolve, think critically and reflect on the neurological/psychological assessments, as well as the experiments. My secondary goals were to learn more about the neuropsychological tests, and the patient's treatment process. In my opinion, as my ability to understand and work with the participants, conduct the experiment, collect, and analyse the data has been greatly improved since my start date, my primary goals were attained. Unfortunately, I did not analyse enough data to the degree I wished but that was not my responsibility during this internship. Furthermore, I was never fully involved with the neuropsychological assessment. I decided to put it in my goals, because of my interest in the research process and that included analysing the data.

### Primary Goals

Because of the responsibilities I was assigned to during the internship, I had the opportunity to get familiar with different participants and their cognitive challenges. The wide variety of patients helped me notice the heterogeneity problem in such impairments as well as how similar symptoms can have completely different outcomes to different individuals. For example, some of our participants might have worked with numbers their entire life, and as they are doing the digit span task they are being confronted with their impairment and are unable to remember digits the way they did before their diagnosis.

I have learned that patience and being able to contextualise and control a dialogue with the participant are important skills to have as an experimenter, and in clinical settings. This is because many patients suffering from MCD, are in the state where they are realizing that they cannot function as well as they used to. This is because MCD can be a transition between normal aging and dementia, which often is very frightening for the patients. The range symptoms the participants are experiencing are broad, and because I never knew how the new participant would behave it was always important to let the participant speak and follow their conversation. Furthermore, informing the participant frequently about the reason why they are there and how we will proceed during the day is very important. Some of the participants feel very overwhelmed with the test's we are using during the stimulation, causing them to become quiet and very withdrawn. In these situations, I need to help the participant refocus his attention to the specific test he is doing. Other participants remember the preparation and the task very quickly and will not need the extra explanation during the stimulation. Comparing myself to the first time I was preparing the participant, explaining the task, and guiding the participant through test with the stimulation, I have improved my way of approaching the participants and communicating the task. I have become more aware of their symptoms, and how overwhelming these tests can be for them. During my internship, I developed a broader insight and understanding of the patients that suffer from MCD. I became better at reporting in the log book, where I recognize the parts that should be included, how to structure it, and to include my point of view and observation.

### Secondary Goals

Other personal goals that I set before the internship was to learn more about working independent during situations where I had the responsibilities. From the beginning I knew I would not be fluently in speaking Dutch, but I had the expectations that I would be using the language more independently. As of many new interns you will rely more on the knowledgeable person in your group, and as we were a group of two people I could often remain in the shadow. Fortunately for me, my colleague finished her internship before me, which gave me the opportunity to "take her place" and embrace myself. We did one training with the new interns together, and then I had to take the role and gain the expertise of the practical work such as the EEG and tACS we conduct. Learning how to 'train' other interns has been very giving to me as I was using speaking Dutch, which is not my native language, and I became more confident on myself.

When using two computers, and several connections to different outputs, complications can often occur. In these situations, there is not much one can do, except trying to observe what has happened and which options is there to solve the problem. In such situations, the first task should be to make sure the participant is feeling comfortable. Because of my previous experience from a nursing home, I personally feel like I'm able to provide well for the participants, but the circumstances are a little different. I'm doing the care in a foreign language, and this has been very giving to me and I feel like my nursing abilities has grown more during my internship. I'm able to explain what has been going wrong, and which options we have for solving the problem. In the meanwhile, we take a cup of coffee together and I get to learn more about the participant.



### Generic learn goals

My goals in the generic skills category were to work effectively and contribute to the organization, as well as being flexible and take initiatives under different work circumstances. I was gaining more patience, I learned to better communicate, and improved my problem-solving skills which are three essential generic skills. Furthermore, I learned to operate and communicate as a professional, and work both autonomously and collaboratively. According to my co-workers and my supervisor, my employment and tasks was necessary to conduct the experiments, and I will be extending my contract and combine working with my thesis and helping with the participants during my last semester at UCG, which was highly appreciated.

Secondly, by being in charge of the testing on participants with MCD you have to read your participants and observe their behaviour to be able to predict how they will respond. To motivate the participants to go through with the experiment, I had to use encouragement techniques and positive feedback during small talk, as well as humour. For example, a participant was very upset and frustrated about the 2LDT test. He would express himself by being loud and aggregated, so to keep him motivated, humour was one of the techniques that worked well on him. The feedback he gave to me, and my co-worker was that because of us he enjoyed coming to do these tests, even though he did not enjoy the test itself. Moreover, good collaboration and co-operation with my co-workers was important to provide for the participant in the best way. It is important that the co-workers display a positive attitude towards each other and respecting each other's differences in working styles. This helped me sustain good relationships with all employees throughout the internship. I have only received positive feedback about my behaviour and attitude, and there was no conflict with anyone in the hospital.

Lastly, learning to work collaboratively and independently was another important goal. In general, during my internship, I spent most of my day working collaboratively and autonomously. As I previously mentioned, working collaboratively was a big part of my internship because I was co-operating with different people on a weekly basis. Independent tasks, some of which being preparing for the EEG and tACS, picking up the participant from the waiting room, and having a conversation with the participant throughout the session. Other tasks such as cleaning up, and having a conversation regarding the next appointment, or assuring that the participant gets safely home are essential as well. The participant can sometimes mix up the appointments, or forget that they have an appointment, so then it is our responsibility to reach out to the participant to check that everything is fine and remind them of their appointment. By conducting both collaborative and autonomous tasks I developed my listening, communication, and adaptability skills. Furthermore, my confidence, dependability, self-motivation, and planning skills has improved.

### Reflection on expectations

My experience having an internship at the CNC exceeded my expectations. I have not only had the opportunity to work on so essential research, but also meet and collaborate with some remarkable people. Through the internship, I made connections, learned professional communication, got familiar with the EEG and tACS methods, gained knowledge, independence, and this opens doors for future employment and study opportunities in which I am grateful. My supervisor was always available in the building or approachable for any questions that came up. I felt like I could always ask for advice regarding both future studies and my bachelor thesis which are both personal matters. Most of the times I have had to take the initiative myself, and this has given me a feeling of being trustworthy, and dependable.

From the beginning, I was treated with respect, and I felt welcomed by the co-workers. My supervisor was around in the beginning to make sure everything was going well, and she was approachable. Throughout my internship, I had to put previous theoretical knowledge into practice and learn how to

use it effectively to successfully complete my tasks. Especially when conducting EEG, a good theoretical foundation was necessary. In addition, being responsible for patients with MCI increased my knowledge of psychological testing both on a theoretical and practical level. I learned about the 2LDT, VRTT, Digit span task, n-back task, which are all test batteries, and I learned how to use EEG and tACS as a measuring instrument. Due to the pandemic and shortage of time, I was not able to learn how to read through the results, but as I will be here to an extended period, I hope will learn this all well.

In addition, being an intern had a positive influence on my personality. When working with participants suffering from any form of pathology, I've become more patient and understanding as well as a better listener. Furthermore, I have learned that communication and engaging in conversations with the participant can be challenging, but I enjoy it. I discovered that talking to the patients gave me a feeling of fulfilment while making me a more empathetic individual. I cannot describe the amount of joy I was feeling when my co-worker and I was helping a participant finish the experiment, which he found very challenging. This was a man who worked with number his entire life, and at this point he is unable to remember a couple of digits. To him, this is very confronting and since the participant is coming every day for 10 days, he has a rough time making it through. This is a situation in which the experimenter must provide for the participant with the care and support he needs. Instead of asking him "how did it go", you rephrase it in to, "we are finished now, and you did great". He would often give me a smile, which confirms that the way you either ask a question or provide information can have a large impact on the participant and the way he feels about the experiment.

Finally, being an intern has helped me discover how much I Enjoy working with people. I am positive that working either in a clinical setting, or experimental will be a part of my future career. The career I want to have in the future is helping patients in either way.

### Supervisor's feedback

In general, the final feedback from my supervisor was positive. She seemed satisfied with my overall performance, in the completion of the assigned tasks, and with my character and availability. She stated that my interpersonal and communicating skills, as well as my motivation were good. As mentioned earlier in this report, my practical skills were good, but I did have a lack of trust in myself when all my colleges finished their internship. As I were the only intern left with experience, we had to train four new interns. This was a very overwhelming time for me since the new intern's relied on me in the similar way I relied on my previous colleges. This does not at all mean that I have little confidence in my practical skills or that I did not develop my skills as expected by the supervisor. This was personally very overwhelming for me, and I felt like I had little follow-up with my insecurity regarding training new interns, as it were expected that I took the lead. Normally, an intern should not be responsible for teaching new interns, which was the part I did not expect I would be responsible off during this internship. However, I have grown immensely by doing this training and due to little observation from the supervisor, she has not seen my improvement the last three weeks.

According to my supervisor, I showed great initiative, while I was fulfilling my tasks with good speed and accuracy. My communication and co-operation with her and the other employees were sufficient with no conflict or antagonism of any kind, a fact that can be confirmed by other co-workers as well. Finally, according to my supervision, my placement benefited the institution as I was carrying many important tasks (e.g., EEG and tACS). She referred to me as a natural in communicating with participants, and I did this in a foreign language which was very challenging to me. Furthermore, I were always flexible and available when needed and communicated the time I would be unavailable in time.

**APPENDIX****DESCRIPTION:**

The protocol lasts 12 days

Day 1: MRI, Practice Two Letter Delay Task (2LDT), EEG, Vienna Reaction Time Task (VRTT), tACS with 2LDT (approximately 3h 30 min without break and walking between locations).

| Location              | Radiology department, UMCG | Walking and break | Antonius Deusinglaan 2, NIRS lab -115 |     |      |      |
|-----------------------|----------------------------|-------------------|---------------------------------------|-----|------|------|
| Measurement           | MRI                        |                   | 2LDT practice                         | EEG | VRTT | tACS |
| Duration (in minutes) |                            |                   | up to 20                              | 30  | 20   | 25   |
| Preparation           | 30                         |                   |                                       | 20  | 2 18 | 7 18 |
| Measurement           | 60                         |                   | 10                                    |     |      |      |

Day 2-9: tACS with 2LDT/ digit span (25 minutes)

Day 10: tACS with 2LDT, EEG, VRTT, neuropsychological evaluation (NPE), MRI (approximately 4h without break and waiting)

| Location              | Antonius Deusinglaan 2, NIRS lab -115 |     |      |     | Walking and break | Radiology department, UMCG |
|-----------------------|---------------------------------------|-----|------|-----|-------------------|----------------------------|
| Measurement           | tACS                                  | EEG | VRTT | NPE |                   | MRI                        |
| Duration (in minutes) | 25                                    | 30  | 20   | 75  |                   | 90                         |
| Preparation           | 7                                     | 20  | 2    |     |                   | 30                         |
| Measurement           | 18                                    | 10  | 18   |     | 60                |                            |

Day 11: 1 month follow-up NPE, EEG, VRTT (2h 30min)

Day 12: 1 year follow-up NPE, EEG, VRTT (2h 30min)

Duration of measurements:

NPE – 75 minutes

MRI – 90 minutes (up to 30 for preparation, 60 scan time)

EEG – 30 minutes (20 preparation, 10 recording)

VRTT – 20 minutes

tACS – 25 minutes (7 preparation, 18 stimulation)

Example of a day 1:

The participant will meet us at the radiology department for their MRI scan. The participant will enter through the changing room where they will be given MRI-compatible clothing.

Practicing the n-back task

The participant will be taken to an area where they can practice the n-back task. This version is times exactly as the real practice version.

Explanation of the task: “In this task, you are going to see a series of letters. You will be asked to keep track of the letters and press a button when you see a letter that you have already seen before. There are two versions of the task -1 back and 2-back. In the 1-back version, you have to press the button when you see a letter that is the same as the letter you saw right before (refer to the example on the instruction screen). In the 2-back version, press the button if the letter on the screen is the same as the one two letters before (refer to the example on the instruction screen). The two versions will be presented in several blocks in random order, but there will always be a short instruction before each block so you will know what to do. Give answers by pressing the left bottom corner of the touchpad.”

- When the participant understands the instruction, let them practice the task. Stay with them and assist if needed by pointing out target letters.
- Make sure the participant goes through all 4 practice blocks, even if they feel it is not necessary.

Prepare glasses (if needed)

Glasses may have metal elements that are not MRI-compatible. If the participant needs glasses, plastic frames and lenses are available to assemble an MRI-compatible pair.

Entering the scanner room:

- Follow the lead of the scan operator. Do not go in or send the participant in without their approval. Do not enter the room yourself.
- The scan operator will instruct the participant and tell them that we can communicate through an intercom during the scan.
- Make sure the participant is holding the correct response box and knows the right button. This is very important as only responses from the correct button will be recorded! Have the participant press the button while Notepad is open on the stimulus computer to make sure they have the correct one.

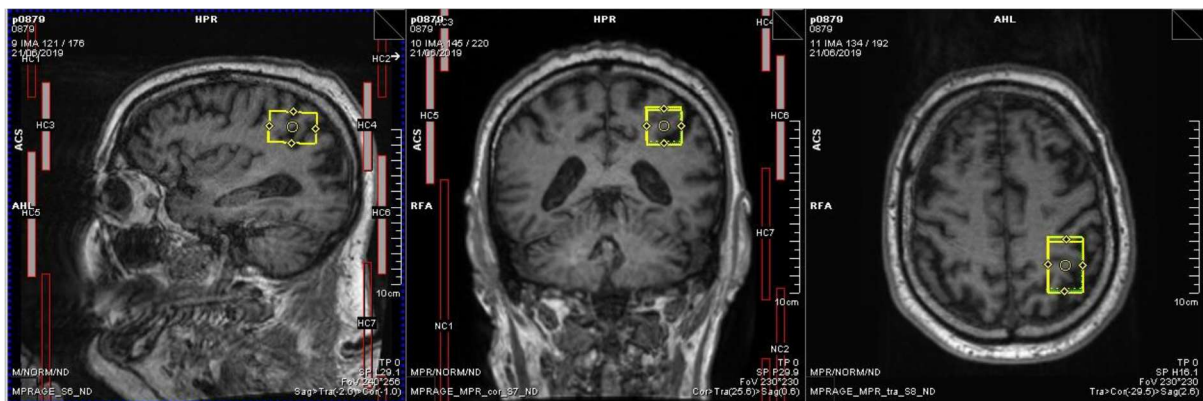
During the scan:

MRI protocol:

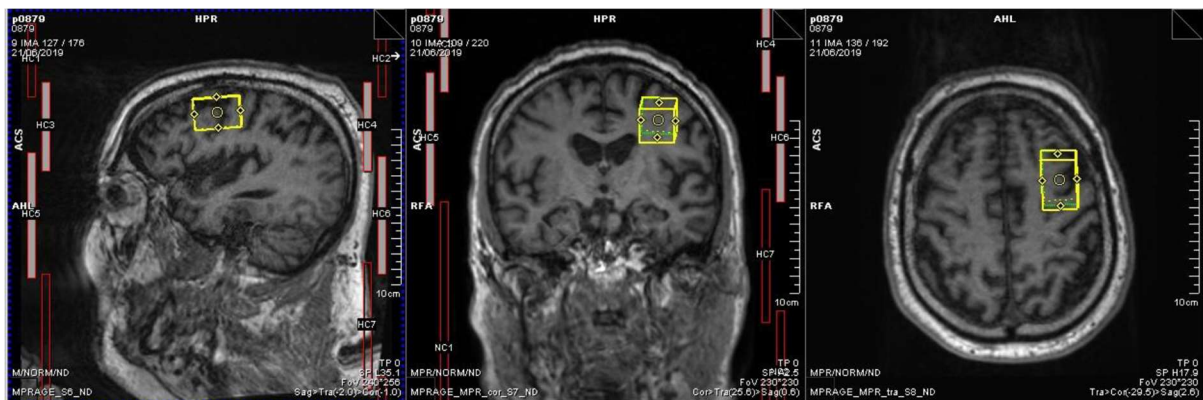
- Anatomical scan (9 minutes)
- Resting state (the participant is asked to keep their **eyes closed**; 8 minutes)
- MRS-dorso parietal (dor\_par; 6 minutes)
- MRS – parietal (par;6 minutes)
- N-back task (8 minutes)
- DWI (13 minutes)

For MRS, a **2x3x2 voxel** needs to be placed on areas corresponding to electrodes P3 and F3. This will be done by the scan operator. In case of uncertainty, images of where the voxel should go are added below in Figure 1.

When it is time for the n-back task, press run scenario and let the participant perform the task. For the first block of each condition, look at the response box and the task to make sure the participant is performing it correctly. When the scan is finished, finish and close the n-back task.



**Figure 1: Dorso-parietal voxel replacement for MRS**



**Figure 2: Parietal voxel placement for MRS**

After the MRI:

The participant will be brought to another building where EEG will be recorded and tACS treatment will be conducted.

Preparation for EEG and tACS: equipment pictures below



Figure 3: EEG (LEFT) and TACS (RIGHT) equipment

1. Fit the EEG cap
2. Mark positions P3, Cz and F3 with red pencil
3. Let participant practice the 2LDT
4. Record EEG while the participant performs the vigilance task
5. Dry participants hair with a towel
6. Check that the P3, Cz and F3 marks are on
7. Let participant perform the VRTT
8. Place tACS electrodes and check impedance
9. Turn tACS on
10. Let participant perform the 2LDT.

Skin scrubbing and placing ground and reference electrodes:

Scrub the skin on the **sternum** and on each **mastoid** (A1 and A2; pictured right) with skin prep gel and clean it with alcohol wipes. Also scrub and clean the skin on the **forehead** (electrode positions Fpz, Fp1, Fp2). Place the electrodes in the optode holder and attach them to the sternum and the mastoids using adhesive stickers.

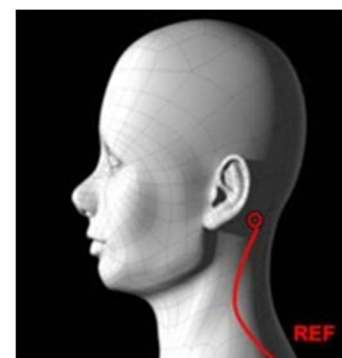


Figure 4: Positioning of the reference electrodes (Fpz, Fp1, and Fp2).

Measuring of the head and positioning of the cap:

Measure the circumference of the head and select the right cap size. When the circumference is between cap sizes, use the smaller cap for a tight fit. Place the cap and ask the participant to firmly hold it in place. Measure the distance between the left and right preauricular point/tragus, and between the nasion and the inion (from the dip above the nose to the back of the head). Position the cap so that the central optode holder (Cz) is exactly in the middle. The front of the cap should be at 10% of the nasion-inion distance measured from the nasion.

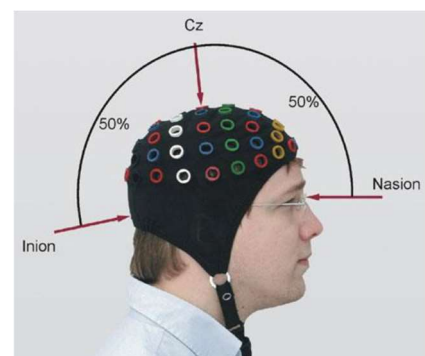
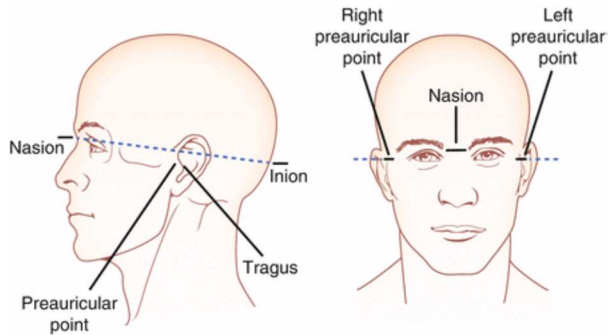


Figure 5: Correct positioning of the EEG cap.

1. Place the cap and check the position visually
2. Make sure the front of the cap starts at about 10% of the nasion-inion measurement
3. The central optode holder (marked Cz) should be exactly at the centre of the nasion-inion and tragus-tragus measurement.

Using the red pencil, mark positions F3, P3, and Cz. Before doing do, draw a dot on your hand to demonstrate to the participant that the markings are easily removable.



**Figure 6: Location of nasion, inion, tragus, and preauricular points.**

Connecting the trigger box:

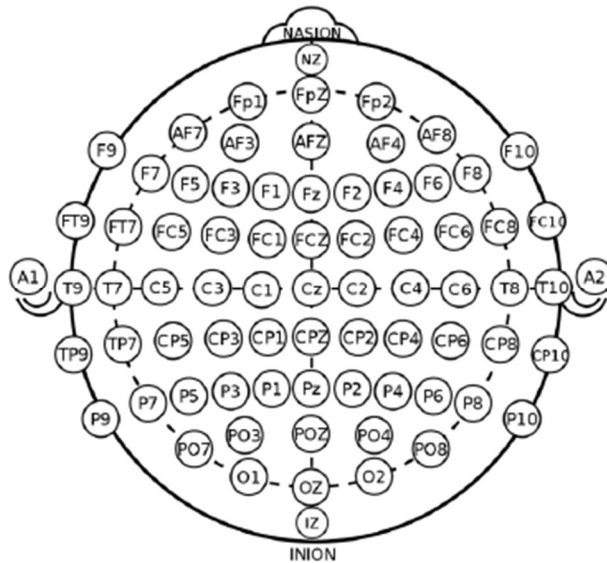
Connect the trigger box (pictured right) to the laptop with the vigilance task via a USB cable and test the connection according to the instructions give by the COGMAX protocol.



**Figure 7: Trigger box.**

Connecting the EEG:

Place electrodes in positions **Fpz, Fp1, Fp2, F7, F8, F4, Fz, T7, T8, C3, C4, Pz, P4, P7, P8, O1, O2, and Oz.** according to the 10-20 system (pictures below)



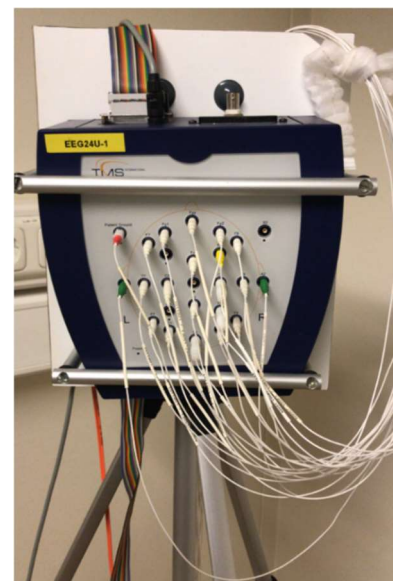
**Figure 8: Electrode placement according to the 10-20 system.**

Connect each electrode to the amplifier, starting with the ground and reference electrodes.

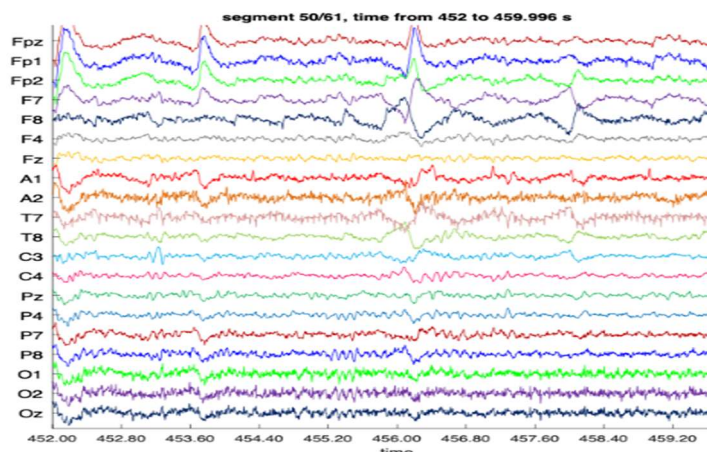
**IMPORTANT STEPS:**

1. Turn amplifier on
2. Open the design and acquisition servers. Check if the correct recording scenario is open.
3. Connect the server to the amplifier. → this will open up a new window with boxes showing impedance per electrode.
4. **Fill the ground and the reference electrode first.**

Before starting, demonstrate to the participant that the needle is blunt by brushing it against the skin on their hand. When you are finished, make sure to tie the wires into a “ponytail” at the back, similar to in Figure 8.



**Figure 9: Amplifier**



**Figure 10: illustration of EEG recording of positions, Fpz, Fp1, Fp2, F7, F8, F4, Fz, A1, A2, T7, T8, C3, C4, Pz, P7, P8, O1, O2, Oz.**



Practice 2LDT:

Take care that the participant practices the 2LDT informally for up to 10 minutes.

Explanation of the task: “In this task, you are going to see two letters one after another. Afterwards, you will see a number, either number 1 or number 2. The number denotes the order of the letters you saw earlier – number 1 refers to the first letter, and number 2 refers to the second. The number you will see will tell you which letter you have to remember, either the first or the second. You will then see a letter again. If this letter is the same as the one you were asked to remember, press button A. If it is not, press S. In the first version of the task, letters are always going to be T and L. In the second version, letters will be either T, L or C.”

The Participant practice the 2 letter version, and the 3 letter version.

EEG recording:

Start the vigilance task, and measure EEG until the task is over.

Explanation of the vigilance task: “In this task, you are going to see a cross in the middle of the screen. This cross will eventually turn. When the cross turn, press button 1 on the keyboard.

After EEG recording:

Check the markings on positions P3, Cz and F3. Remove the cap and clean the gel off the participants hair.

VRTT:

Explanation of the task: “In this task, you are provided with a response panel with several colourful buttons. The button we will be using in this test is the golden button on the bottom, and the black square button. You should hold one finger on the golden button at all time. On the computer there will be a black circle that will turn yellow, as this happens you should click on the black square button and put your finger directly back on the golden button.

Part two of the test includes a sound, and the instructions on the computer will inform you when and when not to click on the black square button.



**Figure 11: Response panel (Schuhfried dongle)**

tACS preparation and execution:

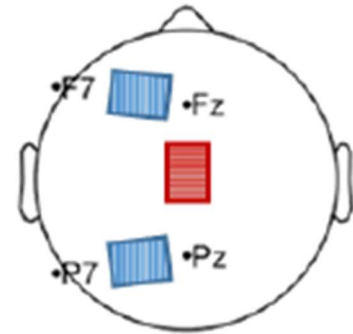
Fit the electrodes on top of the markings in position F3, P3 (blue, active electrodes) and Cz (red, return electrode; pictures right) using the Ten20 paste.

Turn the tACS device on, select the correct setting and press OK. Enter participant's code.

On days 1, 3, 5, 7, and 10, participants do the 2LDT.

On days 2, 4, 6, 8, and 9, participants do the digit span task.

For this task, difficulty is set based on each participant's individual digit span so that everyone begins the task with a series that is  $n - 2$  items long,  $n$  being their individual capacity. We know their forward and backward digit span because they have already done this task during the NPE.



**Figure 12: Positioning of active (blue) and return (red) electrodes.**