

Appendix

Appendix A: Interview setups

This appendix provides an overview of the questions that were asked in several interviews. Not all interviews are added as some interviews were more casual and did not follow a predetermined semi structured setup.

Int 1: Interviews E-01, E-02, E-03 & E-04 (Semi structured):

1. Explanation of master thesis and the goal of this interview. Ask whether they are okay with me recording the conversation.
 2. Ask them to fill in the informed consent document after guiding them through.
 3. Ask them how long they have for this interview.
 4. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- Could you tell me about your experience with Alzheimer's?
 - I would like to know more about...
 - How you experienced the first signs, diagnosis and treatment. What were the procedures like for you?
 - The impact this all had on you as informal caregiver (time, energy & moneywise)?
 - The impact this all had on the person with dementia or Alzheimer's?
 - How did people around you respond to the situation, and how were you affected by that?
 - Are you afraid of getting dementia/Alzheimer's yourself? Why?
 - After giving another quick recap of my project: Would you screen if this happens on voluntary basis?
 - What aspects are most important in this decision?
 - How would you imagine this to take place?
5. This is the end of this interview. Do you have any further questions or remarks?
 6. Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 2: Interview K-01 (Semi structured):

1. Explanation of master thesis and the goal of this interview. Ask whether they are okay with me recording the conversation.
 - a. Goal a: Sketch the future of combatting Alzheimer's disease
 - b. Goal b: Learn about olfactory loss, the brain and different implications
 - c. Goal c: Discover pitfalls and weak spots
 - d. Goal d: Discover focus points
2. Ask them how long they have for this interview.
3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
 - Could you sketch how you envision the future of combatting Alzheimer's disease?
 - You already mentioned that Olfactory impairment is also a strong sign of Parkinson's disease. Maybe even stronger. Could you explain this? Are there any other implications of olfactory loss that I should consider in this project?
 - I am now going to ask you to burn the project down. Why will this project fail?
 - Medical products are often recommended by experts. What does this project need to earn your endorsement? What would convince you this could change our Alzheimer's battlefield?
4. This is the end of this interview. Do you have any further questions or remarks?

Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 3: Interview K-02 (Semi structured):

1. Explanation of master thesis and the goal of this interview. Ask whether they are okay with me recording the conversation.
 - a. Goal a: Discover the stakes of the hospital in Alzheimer's Disease
 - b. Goal b: Explore the future context of the medical world

- c. Goal c: Discuss my thesis
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- You are Clinical Geriatrician and a member of the board of directors of the Amphia. Could you explain me what this entails?
 - I am trying to get a grip on the Alzheimer's procedures in the Netherlands, from start to end, what can you tell me about them?
 - When and how does the hospital get involved in AD?
 - Is the hospital currently able to diagnose preclinical Alzheimer's? How?
 - What is your future perspective on healthcare? What are the bigger trends?
 - In which context do you see this project have most impact? What will be the role of the hospitals?
 - What is needed for the hospitals to embrace a new concept like mine?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions?
Thank you for your valuable input. Have a nice day.

Int 4: Interview K-04 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: gain insights in the world of nursing homes
 - b. Goal b: explore nursing homes as a stakeholder in the dementia procedures
 - c. Goal c: hear about the impact of dementia from a third party
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- What is your name?
 - Could you explain to me what it is you are doing? What does the job entail?
 - How do you experience working in this field?

- Can you tell me more about the dynamic between patients and their close ones? How does dementia affect each party in your eyes?
 - Could you explain the procedures around dementia homes in the Netherlands?
 - What about availability. Is there an immediate place for everyone? Who gets a place?
 - What do you need to do your job well?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions?
Thank you for your valuable input. Have a nice day.

Int 5: Interview K-05 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: learn about "autonomous ageing"
 - b. Goal b: spar about brain health clinics and requirements for product
 - c. Goal c: spar about current ideas.
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- Could you introduce me to your field of research "autonomous ageing"?
 - Explain and ask about Brain Health Clinics. How do you envision their future?
 - Which are the main medical trends that we see nowadays that I should consider?
 - Introduce idea. Why is this project going to fail?
 - How do you see this in the context of future Brain Health Clinics?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions?
Thank you for your valuable input. Have a nice day.

Int 6: Interview K-06 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: explore the health insurance as a stakeholder
 - b. Goal b: define what is required to get coverage for a medical product
 - c. Goal c: discuss different ways of implementation and their health insurance consequences
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- Could you introduce me to the world of health insurances?
 - What is required of a medical product to be covered by health insurances?
 - How does this process of acquisition go? Do companies apply for coverage of their products?
 - Could having the label “high risk for Alzheimer’s or Parkinson’s” influence the premium people need to pay for their insurance?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 7: Interview K-07 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: Discover how AD originates and develops in the brain
 - b. Goal b: Learn about the initial deterioration of the olfactory brain areas
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- Could you tell me about your PhD research and its focus?
 - What is dementia/Alzheimer’s on a biological basis?
 - Where and how does dementia/Alzheimer’s originate in the brain?
 - How do different variants of dementia differ from one another?
 - Can you explain to me how and why the olfactory bulb in the brain is affected early on?
 - When in the development of Alzheimer’s does this take place?

- Different olfactory tests exist, focusing on identification of odours, the smelling threshold or discrimination between odours. Which of these three would be most preferable for an Alzheimer’s screening test, looking at what happens in the brain?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 8: Interview K-08 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: Learn more about risk factors and biomarkers for AD
 - b. Goal b: Learn how and why sensory parts in the brain are affected by AD
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- You are researching the connection between Alzheimer’s disease and hearing loss. Could you tell me why that is relevant and what you are hoping to achieve?
 - Why, on a biological level, do our senses diminish during Alzheimer’s?
 - What is your take on using diminishing senses as an early biomarker to screen for AD?
 - Different olfactory tests exist, focusing on identification of odours, the smelling threshold or discrimination between odours. Which of these three would be most preferable for an Alzheimer’s screening test, looking at what happens in the brain?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Do you know any researchers or neurologists I should really talk to?
 6. Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 9: Interview K-09 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: learn about the newest advancements in olfactory test technology
 - b. Goal b: take a critical stance towards the ODOFIN Sniffin' Sticks
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- I have recently read a paper about SMELL-RS and was intrigued. Could you explain the current status of the research project?
 - Could you once more explain the critiques you have on current tests like the UPSIT and Sniffin' Sticks? What will this test add for those use-cases?
 - What sort of test will SMELL-RS be? Diffuser? And why did you chose this?
 - In all the research I read, it s described that currently Identification tests are the most used tests. This is impossible with your technique. I am curious to what your envisioned use-cases for SMELL-RS are?
 - What is your long term goal with SMELL-RS?
4. This is the end of this interview. Do you have any further questions or remarks?
 5. Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 10: Interview K-10 (Semi structured):Explanation of master thesis and the goal of this interview.

- a. Goal a: Understand the olfactory testing industry and current obstacles
 - b. Goal b: Obtain technical information for the requirements of my product
 - c. Goal c: Make a deal about obtaining Sniffin' Sticks for testing prototype
1. Ask them how long they have for this interview.
 2. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- What is the current market for Sniffin' Sticks? Who are your clients and in what industries are they mostly used?

- What are the obstacles you encounter in these markets?
- Why have you decided to create a test that requires healthcare personnel?
- What sets the Sniffin' Sticks apart from other olfactory tests?
- How do you envision the future of the ODOFIN Sniffin' Sticks?
- Explain thesis again. Why will this project fail?
- Technical questions: How do Sniffin' Sticks need to be stored?
 - Horizontal versus vertical position?
 - At what temperature do we store them?
 - When does cross contamination occur?
- Could you send me some Sticks for prototyping?

3. This is the end of this interview. Do you have any further questions or remarks?

Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

Int 11: Interview K-11 (Semi structured):

1. Explanation of master thesis and the goal of this interview.
 - a. Goal a: Get a better grip of all ethical implications of the project
 - b. Goal b: Learn how to best deal with ethical discussions
 2. Ask them how long they have for this interview.
 3. Let them know that during the interview I will be taking notes every now and then. This is not a sign of disinterest, but rather of interest.
- Could you tell me about your job here in the hospital?
 - Is ethics purely about the big discussion or does it have a theoretical part with rules as well?
 - Could you comment on my project from your ethics expertise? What are challenges or things to consider carefully? – discuss.
 - What are ethical concerns you have around Brain Health Clinics?
 - How important are ethics in the hospital context?
 - How is the division of responsibility within ethics? Between designer or doctor and patient?
 - To sum up at the end of this conversation, what are my three main focus points that concern ethics?

4. This is the end of this interview. Do you have any further questions or remarks?

Can I contact you later in case things are unclear or if I have other questions? Thank you for your valuable input. Have a nice day.

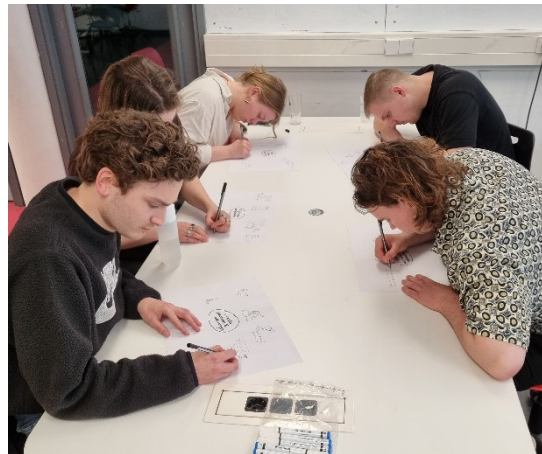
Appendix B: Creative session ideation

The session started with 5 Hoe Kun Je's? (HKJs) [36]. Participants had 1 minute to sketch ideas before giving on and receiving the next sheet.

- HKJ 1:** How could you safeguard the distance between nose and stick?
- HKJ 2:** How could you inform the user that the time to smell has passed and an answer is required?
- HKJ 3:** How could you make the product look professional and trustworthy?
- HKJ 4:** How could you ensure safe and easy (re)placement of sticks in the product?
- HKJ 5:** How could you let the product communicate with the user for guidance during the test?

Following this, participants were asked to **vote with 1 vote per HKJ sheet**. All ideas with at least 1 vote were then cut out and pasted in a **Morphological chart** [36], that was drawn on a big whiteboard.

From this chart, participants were asked to **draw a product** using one idea for each HKJ.



Appendix C: Deep dive into Alzheimer's disease

Alzheimer's and its procedures

People often use dementia and Alzheimer's interchangeably, but they have distinct meanings.

Dementia is an umbrella term for diseases featuring a decline in cognitive abilities that interferes with performing everyday life activities [66]. Alzheimer's Disease (AD) is the most frequently occurring type of dementia. It constitutes to 60-70% of all dementia cases [71].

AD is a neurodegenerative disease, leading to progressive brain deterioration. Symptoms appear 15 to 20 years after the onset of brain damage [9]. During this period, the disease progresses unnoticed.

An overview of the symptoms, procedure and parties involved is provided in Figure 3. The journey map sheds a light on the roles of different stakeholders and possible impact areas for this project. It also helps evaluating the consequences of interventions. Information from several different sources was

combined to ensure the map's complete- and correctness. Interviews with industry experts and relatives of victims provided valuable insight into the stages, procedures and impact. The set-ups of these interviews can be found in Appendix A. Their different experiences and opinions illustrated the discordance within this complex system. Even though the process shown in Figure 3 seems straightforward, reality often is not. The AD journey, like its symptoms, is full of ambiguity and uncertainty.

Notably, Alzheimer's is diagnosed after people visit the general practitioner on their own initiative. This means that Alzheimer's is never detected before clinical symptoms appear. Another conclusion that can be drawn from the journey map is that Alzheimer's journey is a very social one. At each stage, several people are impacted or involved in care-taking.

This project zooms in on the left half of the journey map, on the pre-clinical stage and diagnosis. Two main themes can be seen on this side of the figure: conflict and worry. Denial on both sides (patient and friends & family) may cause friction and grief. This is important to remember when designing for early recognition of the disease.

The impact of Alzheimer's

The influence of dementia and Alzheimer's on society is substantial, affecting both the social fabric and financial landscape. This neurodegenerative disease causes significant costs for patients, informal caregivers, and their loved ones. More detailed information on the impact of Alzheimer's can be found in Figure 4. This figure also contains some personal experiences from interviewed informal caregivers, who lost a relative to dementia.

In accordance with what is described by Dasha Kiper in her book 'Travelers to unimaginable lands' [18], interviewees admitted that dementia took a heavy toll on them as informal caregivers, both physically and mentally. The confusion, frustration and conflicts are accompanied by anticipatory grief and constant goodbyes. This was expressed by multiple informal caregivers [*1] [*3] [*4] and is also explained by Sanchez de Boevé in her thesis on anticipatory grief in dementia [29]. It is safe to say that dementia and Alzheimer's turn the lives of those involved upside down.

As can be seen in Figure 4, the impact is widespread and expected to increase further over the years.

Dementia is expected to triple its impact, affecting over 150 million people worldwide by 2050. It has been recognized by the World Health Organization as a global healthcare challenge [71]. In a study by Scheltens et al., Alzheimer's disease (AD) too, is displayed as a swiftly escalating problem, becoming one of the most expensive, lethal, and impactful diseases of this century [31].

There is no cure or effective treatment for the disease, as will later be explained. Fortunately, much attention is spent on alleviating the social consequences. Examples are:

- the before mentioned book and thesis, that explore ways to alleviate the burden on informal caregivers
- 'Alzheimer café's' for patients and caregivers to meet and talk about their experiences

the Tovertafel by Tover, that helps patients find meaning and joy in their lives [64].

Fighting Alzheimer's

No cure or effective treatment is known for AD [40] and a definitive diagnosis can only be made post-mortem. This makes dealing with AD from a medical perspective cumbersome. In the current situation, patients receive a probability diagnosis once they start showing clinical symptoms, such as memory problems or disorientation.

For future treatment to effectively ameliorate symptoms, brain damage should be halted as soon as possible after AD onset in the brain. Preclinical diagnosis is needed to accomplish this.

Current research focuses on risk factors for AD and so-called biomarkers*. The biggest risk factors for AD are **old age**, **genetics** (*APOE* ϵ 4 allele), **cardiovascular risk factors** and an **unhealthy lifestyle** [17] [31].

Established biomarkers for AD pathology are tau and plasma beta amyloid. **Tau** changes in the cerebrospinal fluid (CSF) have been shown to occur ~15 years before the onset of clinical AD. A decline in **A β 42** (beta amyloid) in the CSF can be found up to 20 years before symptoms become apparent [9].

Current detection methods like CSF and brain imaging are expensive and uncomfortable.

They are unsuitable for case-finding or screening at a larger scale according to geriatric and neurological experts [*5] [*9].

New blood test technology is showing a promising prospect, as it allows for detecting extremely small changes in Tau and Amyloid beta levels in the blood. However, this will take many more years to develop and be tested. The medical world needs cost-effective, easy-to-administer tests that can be used for case-finding on a large scale [69].

** Biomarkers are natural features present in the human body by which a biological condition or disease can be identified.*

Appendix D: Deep dive into Parkinson's disease

Parkinson's disease and its procedures

Like Alzheimer's, Parkinson's disease (PD) is a neurodegenerative disease. Symptoms of PD often set in between the age of 50 and 60 [74]. This is on average at least 10 to 20 years earlier than the symptoms of Alzheimer's. Similar to Alzheimer's, people receive a probability diagnosis for PD. This small measure of uncertainty does not influence treatment or procedures however.

The main issue in PD is a dopamine shortage in the substantia nigra, which is vital for the execution of body movements. This shortage is caused by the accumulation of the Lewy body protein, which originates in the olfactory bulb [38].

The symptoms from PD differ from those of AD, apart from a few similarities in later stages. Parkinson's symptoms can be divided in motor and non-motor symptoms:

Motor symptoms:

- bradykinesia, slowness of movements
- rigidity, stiffness of muscles
- rest tremors
- posture and balance issues

- akinesia (difficulty to initiate movements)
- hypokinesia (absence of automatic movements)

non-motor symptoms:

- dysregulation of negative emotions
- physical pain
- behaviour change
- depressive symptoms
- anxiety disorders
- psychotic symptoms
- sleep disorders
- dementia

It is often unclear which of the non-motor symptoms are caused by the disease and which are caused by medication.

Similar to Alzheimer's, Parkinson's has no cure. However, a neurologist can prescribe medication that suppresses symptoms. Levodopa and dopamine agonists reduce tremors and accommodate smoother movements [38] [74]. This difference in treatments options is paramount [*5].

The impact of Parkinson's

These treatment options result in a very different financial landscape, compared to that of AD.

Approximately 44% of the total PD expenses went to care giving, compared to AD's 92.5% (Figure 4). Much more was spent on treatment and aids, compared to AD.

The total costs of PD and other forms of Parkinsonism in the Netherlands were 136.8 million euros. This constitutes 0.14% of the total health costs in the Netherlands that year and 2.7% of the expenses on nervous system and senses [67]. The total costs of Parkinsonism in 2019 of 136.8 million euros is only 1.3% of the 10.3 billion euros of dementia (Figure 4). In 2021, there were approximately 53.000 Parkinsonism patients, with more male than female victims [67]. For dementia, the number of patients in 2021 was 290.000, with more women than men [48]. It appears that treatment options significantly reduce the financial burden of neurodegenerative diseases.

Appendix E: Design details prototype D3

The main report stated:

*“In the before described sitting position, with eyes on the guiding screen, the user is unable to see their hands. A blind feedback mechanism is required. This mechanism should be foolproof; **the given answer should always be the intended answer.**”*

The book Design-relevant characteristics of ageing users [34] was used to determine to following guidelines for the design of a blind feedback mechanism:

- *Subtle hand movements and high sensitivity should be avoided. The mechanism should be robust and ‘clumsy’. Arm movements > hand movements > finger movements.*
- *Buttons on new products should be avoided if people cannot see their hands.*
- *Wrist twisting range is limited and should be avoided if possible.*
- *The mechanism should be suitable for left- and right-handed users.*
- *The arm should be able to rest on the table while giving input.*

- *Haptic feedback should be combined with visual feedback from the screen. Confirmation for answers should always be asked.*

Familiar mechanisms are intuitive. “

With these guidelines in mind, prototypes D1, D2 and D3 were created. This appendix explains the design of Input mechanism prototype D2/D3.

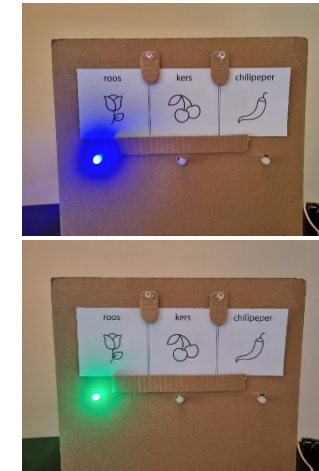
Physical prototype:

Prototype D3 is an input device that allows users to give their answers to the product. It features a slider mechanism with a big knob. The big spherical knob allows people to move the slider with their handpalm.



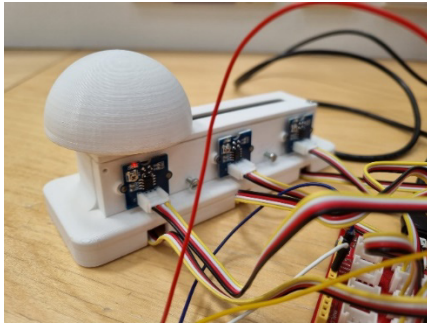
When moving the slider, 3 LEDs indicate the current slider position; left, middle or right. People can press the knob to submit an answer. The LED that was blue from position

indication then turns green to tell the user their answer was submitted successfully.



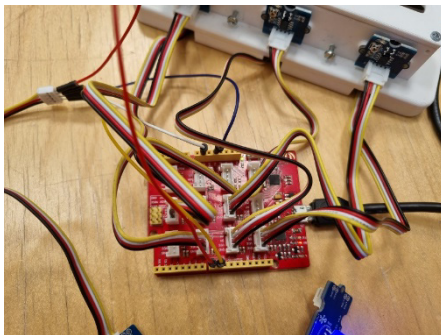
The distance between the three different options was carefully chosen as a trade-off between large (wrist or arm) movements and limited wrist twisting capability of its users. Larger movements are preferred for elderly people over fine movements.

The location of the slider is seen by three infrared reflective sensors, that notice when the slider is in front of them.

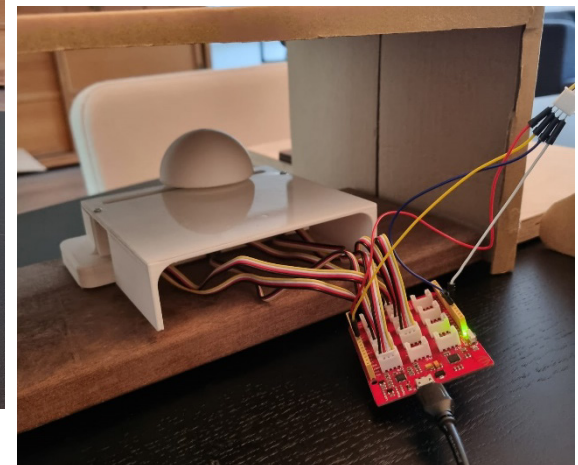
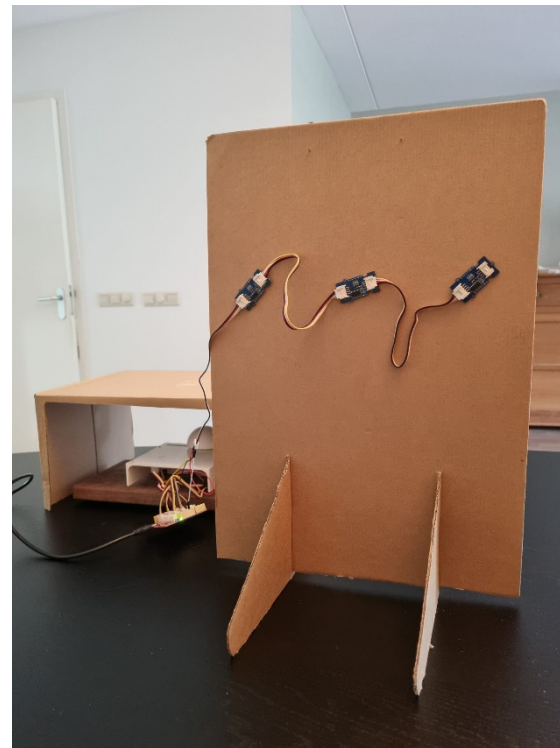
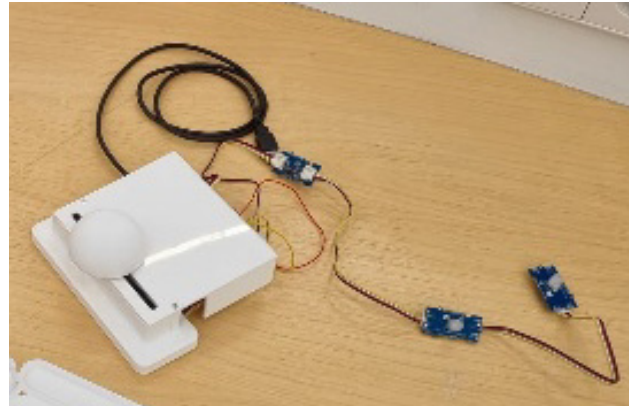


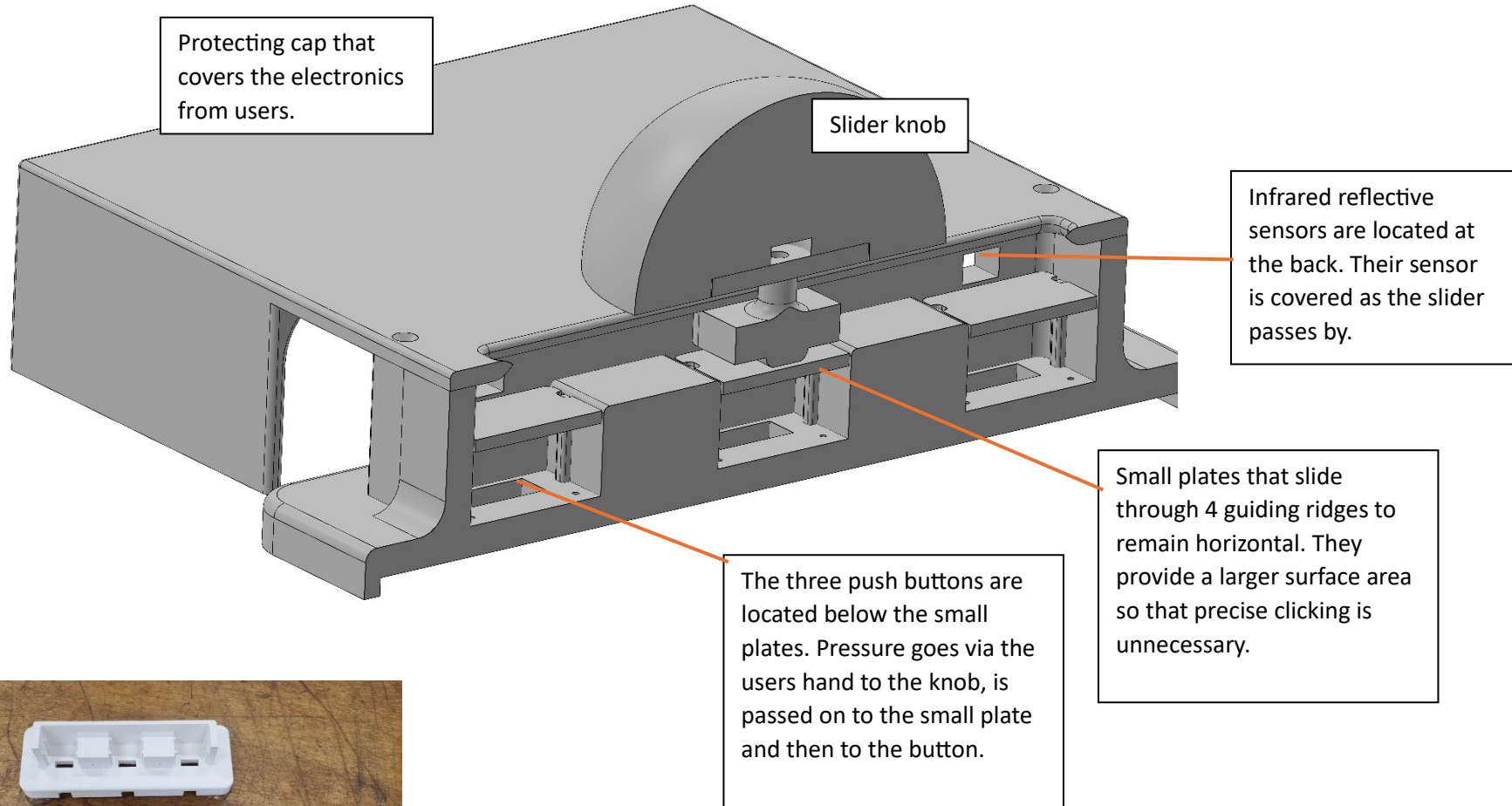
Three buttons below the knob can be pressed to submit the answers. All of this information is communicated by three LEDs in front of the user. This is shown on the next page.

All sensors and actuators are connected to a Seeeduino board.



The final device in its test setup are shown on the right. The following page explains where components are with a section view.





Appendix F: User interaction test

This appendix describes the goals, setup, procedures and results of the user interaction test, that was conducted to find the most suitable input device in the designed context.

Research questions

Main question:

How do a standard HP computer mouse and prototype D v2a compare in terms of **usability** for selection tasks in a simulation of the to be developed olfactory test?

Usability = the extent to which a product can be used by **specified users** to achieve **specified goals** with effectiveness, efficiency and satisfaction in a **specified context** of use.

Users = Adult people between 18 and 90 years of age, who are able to use at least 1 hand at table height while sitting at the table.

Goal = Communicating the by the user intended answer, out of 3 options, to the product.

Context = The user is doing a simulation of tasks for the developed olfactory test while sitting at a table with the input mechanism on the table. The user's head rests on a chin and forehead support in a chin-head rest. While performing the selection tasks, the user is unable to see their hands. This is further explained in research setup.

Prototype D v2a is explained in Chapter 4.2.7 of the main report.

Sub questions:

- How do users experience the physical (dis)comfort of providing input?
- How much explanation do users need to understand how they should use the input mechanism?
- To what extent do users experience uncertainty?
- How much mental effort does the participant perceive while performing answer selection tasks?

Hypotheses

- A. It is expected that elderly people prefer prototype D v2a over the computer mouse in terms of usability for selection tasks.

Reasons for this hypothesis are the limited and guided movement possibilities of the prototype D v2a, its ergonomic spherical knob and its full hand press to submit answers.

- B. Younger people on the other hand, are expected to prefer the computer mouse for its familiarity. However, they are expected to do equally well with prototype D v2a and immediately understand its full working principle.

Method

This research is of qualitative nature. A total number of 7 participants conducted the experiment and were asked questions about their experience and preference after. The research was conducted at different locations, in people's own kitchen or living rooms. This will be further explained in Research setup. The total duration of each experiment was 20 minutes. The table below provides participant demographics. A mixture of male/female, different age groups and different educational levels was sought for more representative insights. This will be discussed further in Discussion.

Participant no.	M/F	Age	Occupation	Educational level
1	M	86	Retired	HBO
2	F	86	Retired	MBO
3	F	86	Retired	MBO
4	M	52	Working	MBO
5	F	57	Working	HBO
6	F	20	Student	WO
7	F	23	Student	WO

Research procedure

Participants were visited for this experiment, which happened at their home. The setup was prepared and participants were asked to take a seat at the table. The following list describes the research procedure:

1. The participant is asked to watch a **pre-made video**. This video described the goal of the research, explained the setup and procedure, provided several disclaimers* and asked participants to sign the Informed Consent (IC) sheet in front of them. The information on the IC was shared in the video.

* (1) You will be filmed for data analysis purposes only. (2) The ODOFIN Sniffin' Sticks, that are used, are CE certified and for medical use. They are carefully tested and safe. (3) This is not a smell test. The original test was carefully modified and no longer provides any meaningful outcome. (4) You may stop at any moment during this research if you are feeling unwell or uncomfortable.

2. The test with the first setup is conducted. The participant gets to **see the first input device**, before this is

covered and hidden from sight by a box.

3. The participant is asked to put their head in the head-chin rest. They are **presented 5 Sniffin' Sticks**. After each stick, they are asked to select what they smelled out of three choices with the **input device**.
4. After the 5th stick and answer, the following **questions** are asked:
 - a. How did it go for you?
 - b. When did you discover how to use the device?
 - c. Do you feel like the device enabled you to provide the answers that you wanted to give?
5. Steps 2, 3 and 4 are repeated for the **second setup** with reversed stick order.
6. **Comparative questions** between the two setups are asked and discussed with the participant.
7. The participant is thanked for their participation.

Research setup

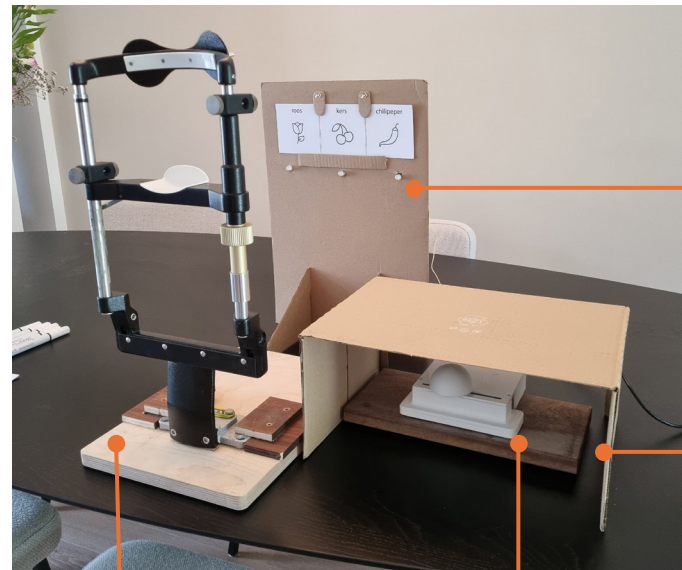
For this research, two different setups were used. Setup A tests prototype D v2a. Setup B tests the computer mouse. Participants with an uneven number start their experiment with prototype D v2a. Participants with an even number start their experiment with the computer mouse setup. Sniffin' Sticks were presented by the researcher by hand.

Effort was done to make the two setups as similar as possible, in order to avoid influencing differences between the two.

Setup A

The annotated figure shows setup A and its different components. The table below provides insight about the specific Sniffin' Sticks used and the choice options provided. The test is in Dutch. The correct answer is in bold. This is partially based on guidelines of Burghart Messtechnik.

Choice options in setup A are presented on paper sheets with words and simple images. The LEDs below the sheet turn blue on hovering (position indication) and green when clicked.



Guiding board with the different choice-options and feedback through blue and green lights

Cover box to hide the input device from sight during the test

Chin-head rest for participants to rest and position their head

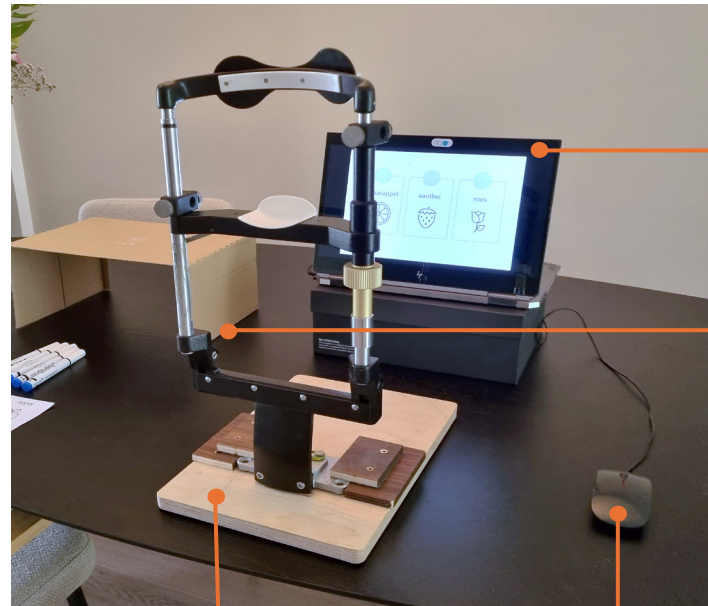
Prototype D v2a for participants to provide their answers to questions of the olfactory test simulation. D v2a is further explained in Chapter 4.2.7.

Stick no. (in order of presentation)	Answer option 1	Answer option 2	Answer option 3
1	sinaasappel	aardbei	ananas
5	pinda	banaan	kokosnoot
6	limoen	appel	perzik
11	meloen	sinaasappel	appel
14	roos	kers	chilipeper

Setup B

The annotated figure shows setup B and its different components. The table below provides insight about the specific Sniffin' Sticks used and the choice options provided. The test is in Dutch. The correct answer is in bold. This is partially based on guidelines of Burghart Messtechnik.

Choice options in setup B are presented via an automatic Figma prototype, that guides the user through the test. This prototype uses circles that turn blue on hovering and green on clicking, similar to prototype D v2a. Similar words and images are used as in setup A.



Guiding screen with the different choice-options and feedback through blue and green lights

Cover box to hide the input device from sight during the test

Chin-head rest for participants to rest and position their head

Computer mouse for participants to provide their answers to questions of the olfactory test simulation

Stick no. (in order of presentation)	Answer option 1	Answer option 2	Answer option 3
14	sinaasappel	aardbei	roos
11	appel	banaan	kokosnoot
6	meloen	limoen	ananas
5	pinda	perzik	banaan
1	sinaasappel	aardbei	kers

Results

The table below provides an overview of all research findings.

<i>Participants no.</i>	<i>A: Previous exp. slider input mechanism - Prototype D v2a</i>	<i>Setup A: self-reported ease of use</i>	<i>Setup A: observed ease of use</i>	<i>B: Previous exp. computer mouse?</i>	<i>Setup B: self-reported ease of use</i>	<i>Setup B: observed ease of use</i>	<i>Self-reported preference</i>	<i>Reason</i>
1 (start setup A)	No	Answering was relatively easy. Doubted only answers, not answer input.	Did not realise pressing to answer was an option. Thought sliding and remaining on a blue light was enough. Grip and movements smoothly as intended.	Yes	Answering was very easy. I am used to working with a computer mouse.	Answering was no problem at all. Clicking did happen automatically this time.	Preferred the computer mouse	He is used to working with a computer mouse. It requires no additional thinking.
2 (start setup B)	No	Answering was okay after figuring out how the sliding worked. Doubted answers, but always reached the wanted input.	Did not realise pressing to answer was an option. Grip and movements doubtful and slow.	No	Had to get used to the computer mouse in the beginning. Later on this became easier. Feels comfortable to her hands.	Was not aware of how a mouse really worked and initially used right button to click. Also moving the mouse to intended place was difficult at first, better later.	Preferred the computer mouse	The slider is even less familiar than the mouse. She also thinks the mouse was easier to move as it required less specific movements.
3 (start setup A)	No	Answering was very easy. After trying once you cannot go wrong anymore. Doubted only answers, not answer input.	Did not realise pressing to answer was an option. Grip and movements smoothly as intended after trying.	No	Like the slider, it is very doable as soon as you know how it works.	Struggled in the beginning with clicking the mouse. Also took longer than expected to submit answers.	Preferred prototype D v2a	Felt nice to the hand and the few options make it easy to select one. Felt like she could not go wrong.

<i>Participants no.</i>	<i>A: Previous exp. slider input mechanism</i>	<i>Setup A: self-reported ease of use</i>	<i>Setup A: observed ease of use</i>	<i>B: Previous exp. computer mouse?</i>	<i>Setup B: self-reported ease of use</i>	<i>Setup B: observed ease of use</i>	<i>Self-reported preference</i>	<i>Reason</i>
4 (start setup B)	No	Hard to recognise some of the odours. Using the device was very easy and comfortable.	Did not realise pressing to answer was an option. Grip and movements smoothly as intended, but slowly.	Yes	I am used to working with a mouse. This was very familiar.	The experiment was over within a minute because everything went quick and smoothly.	Preferred the computer mouse	Mouse is ideal. I would not need any changes to a normal computer mouse.
5 (start setup A)	No	Answering went very well. The device feels nice and its use is clear. It did feel a bit rough to slide.	Used the device exactly as intended, pressed when submitting answers.	Yes	I am used to working with a mouse. I was doubting on where to press on the screen though. I did not have that issue with the slider.	Participant was clearly used to working with a computer mouse. Test went well.	Preferred the computer mouse	The mouse felt smoother and is more familiar.
6 (start setup B)	No	Answering was very easy. The slider works well and nothing can really go wrong.	Did not realise pressing to answer was an option. Grip and movements smoothly as intended.	Yes	I am used to working with a mouse. This was very familiar.	Participant was clearly used to working with a computer mouse. Test went well.	Preferred the computer mouse	The mouse is more familiar. I automatically click when submitting answers. That is what I always do.
7 (start setup A)	No	Answering was very easy. Did mention that it was good to see the device before working with it. Also said that if she had known about having to confirm, pressing would be the logical thing. Liked the spherical shape in her hand.	Did not realise pressing to answer was an option. Grip and movements smoothly as intended.	Yes	I am used to working with a mouse. This was very familiar.	Participant was clearly used to working with a computer mouse. Test went well.	Preferred the computer mouse	Although the mouse requires no thinking due to its familiarity, I liked the shape of the other device. I am wondering if I had pressed that device if it had been combined with a computer screen as well.

Discussion

Only one participant preferred prototype D v2a over the computer mouse. Prototype D v2a was developed as an alternative to the computer mouse according to design guidelines for elderly people. As only one out of the three elderly people preferred this over the computer mouse, hypothesis A was dismissed.

Familiarity seems to be a key-aspect of usability. It was provided as the main argument by all six participants that preferred the computer mouse over prototype D v2a. Therefore, hypothesis B was partly approved.

Although familiarity was expected to be of great influence, it came as a surprise that its impact on usability was more substantial than other factors such as simplicity and guidance, even for participant 2, with no prior computer mouse experience.

Both devices allowed all users to communicate 5 out of 5 answers as they intended. No mistakes were made. However, only 1 out of 7 participants clicked on the knob of prototype D v2a to submit the answer. All others simply slid the knob towards the answer, saw the light turn blue and thought this would be

enough. No differences were found for the even and uneven orders of setup A and B.

Participant 7 noted that clicking to submit an answer with a computer mouse is logical, as this is required for almost every computer program. She also noted that the computer screen may have played a role here, as opposed to the cardboard board with LEDs.

It is worth mentioning that by the time this product enters the market, most elderly people will have experience with a computer mouse, even if this is not the case at this moment.

Conclusions

Although both devices worked without error, this comparative research has a clear winner. The computer mouse was preferred by 6 out of the 7 participants and seems the most promising blind input mechanism for *Knowse*.

The most determining factors for better usability were familiarity and prior knowledge.

The computer mouse will be used for further development of the product.

Limitations

Several limitations of this research were identified and are listed here. These should be considered when reviewing the results.

- A professional product was tested against a self-made prototype. This may have consequences for overall smoothness and usability, which may influence experience.
- Setup A made use of a cardboard board and LEDs, whereas setup B used an automatic Figma prototype on the computer. Although the interfaces were similar, familiarity with computers and clicking to answer may have given the mouse an unfair advantage.
- The relatively short research experiment gives people only little time to get used to the devices. It works well to test initial reactions, but does not account for use with more practise or familiarity, which may influence results.

Appendix G: Project brief



IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

Family name		IDE master(s)	IPD ☐	Dfi ☐	SPD ☐
Initials		2 nd non-IDE master			
Given name		Individual programme (date of approval)			
Student number		Medisign	☐		
		HPM	☐		

SUPERVISORY TEAM

Fill in the required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair		dept./section		! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why. ! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter. ! 2nd mentor only applies when a client is involved.
mentor		dept./section		
2 nd mentor				
client:				
city:		country:		
optional comments				

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Name

Date

Signature



CHECK ON STUDY PROGRESS

To be filled in by SSC E&SA (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total EC
Of which, taking conditional requirements into account, can be part of the exam programme EC

☐	YES	all 1 st year master courses passed
☐	NO	missing 1 st year courses

Comments:

Sign for approval (SSC E&SA)

Name

Date

Signature

SSC E&SA

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team comply with regulations?

YES	☐	Supervisory Team approved
NO	☐	Supervisory Team not approved

Comments:

Based on study progress, students is ...

☐	ALLOWED to start the graduation project
☐	NOT allowed to start the graduation project

Comments:

Sign for approval (BoEx)

Name

Date

Signature

BoEx



Personal Project Brief – IDE Master Graduation Project

Name student

Student number

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title

An olfactory screening product for preclinical Alzheimer's Disease

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Dementia is marked by the World Health Organisation as a global healthcare challenge. The disease is expected to triple its number of victims by 2050 to a staggering amount of over 150 million people worldwide. Alzheimer's Disease (AD) is the leading cause of dementia and constitutes to 60-70% of all cases (**World Health Organisation, 2023**). Besides its impact on people's lives, AD patient care is associated with high costs. Unfortunately, we have no cure for AD. As a neurodegenerative disease, AD can onset >15 years before the first symptoms appear (**Dubois et al., 2016**). By then, most irreversible brain damage has been inflicted, rendering treatment to delay or ameliorate symptoms less- or ineffective. Tests to diagnose early-stage preclinical AD exist. For example, Cerebro Spinal Fluid, PET or (f)MRI scanning and genetic risk profiling. However, all of these are expensive and inconvenient, and will therefore not be used without clear incentive. The medical world needs a cost-effective, patient-friendly way of discovering preclinical AD. In recent years researchers have concluded that diminishing Olfaction Indication (OI) is an early sign of AD (**Marie-Élyse Lafaille-Magnan et al., 2017**). The opportunity of screening for OI diminishment will benefit multiple parties. Product users (patients) and medical staff are among the main stakeholders. The context of use will largely depend on their interests. The user stands to gain the most from early diagnosis, but has to be willing to conduct preventative periodical testing. Medical staff, on the other hand, should be enabled, not thwarted. A good solution allows them to help patients better, without excessive additional workload. Existing olfactory tests have not systematically been used for this purpose in practice, but do provide a basis to start from.

This project is self-initiated and does not have any external project stakeholders. I would like to continue this project after graduation in the form of a startup company, if the opportunity presents itself. That makes me an important stakeholder. My main interests are staying motivated and proving on the feasibility, viability and desirability of the solution. The uncertainties accompanying medical innovation limit these goals. My TU Delft supervisors could also be regarded as stakeholders, as the project will be guided and graded by them. I will focus on clear communication, regular updates and providing a fun, interesting project for them as well.

→ space available for images / figures on next page

introduction (continued): space for images

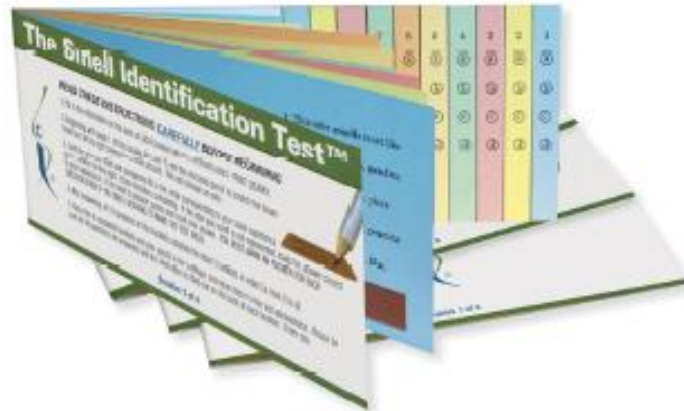


image / figure 1 UPSIT Smell Identification Test (Sensonics International [1], 2024)



image / figure 2 Self-Administered Computerized Olfactory Testing System (SCOTS) (Sensonics International [2], 2024)

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

The medical field lacks a cost-effective, patient-friendly way of screening for preclinical AD. The potential added value of early diagnosis and treatment has a significant impact on prolonging life quality and reducing health costs. Numerous olfactory tests exist, but none of these were specifically designed to notice the progression of neurodegenerative diseases. For example, most existing tests provide an 'absolute score', whereas individual 'relative scores' are preferred to track disease development. **The challenge is not to create a clinical test from scratch, but rather to transform existing olfactory tests into a solution that suits the described problem in its context.** The following questions describe sub-problems that constitute to the main problem.

- **Who** are the main stakeholders and **what do they need** to embrace and adopt a solution to this problem in their lives?
- **Why** are current olfactory and AD tests are not widely used for screening and **what** makes them unsuitable?

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a product to facilitate olfactory testing for preclinical self-screening for Alzheimer's Disease

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

My research phase will consist of **literature review**, **interviews** with experts and disassembling and **investigating currently available products** used for scent diffusion and medical self-testing. Additionally, a **Journey Map**, a **Stakeholder analysis**, a **Function tree** and looking from different **Thinking Lenses** will help me in setting up a preliminary **List of Requirements**. This list will be used as reference throughout the design project. **Design sketching**, **lo-fi and hi-fi prototyping** and continuous **evaluation with peers and medical experts** will finally result in a **functional model** and an **operational model** (no 19 and 20. Loughborough ID cards). A **bill of materials**, **System tree**, **technical drawings** and a **qualitative LCA** will be presented and CAD renders will provide a **digital appearance model** (no 21 Loughborough ID cards).

My **final deliverables** are the functional model, digital appearance model and operational model of a product that can be used for olfactory screening. I intend to build a startup after my thesis. The first two models are required for pitching and have higher priority as this helps securing funding for further development. Clinical testing is not included in this thesis. Nor are the **Ethical concerns** of labelling people as 'at risk of AD'. **Feasibility**, **desirability** and **viability** will be determining factors throughout my thesis project. Further focus will be on usability for stakeholders and the sensory perception of smell.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting, mid-term evaluation meeting, green light meeting and graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	29 Jan 2024
Mid-term evaluation	22 Mar 2024
Green light meeting	31 May 2024
Graduation ceremony	1 Jul 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	☐
For how many project weeks	
Number of project days per week	

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.

(200 words max)

For me, IDE combines many things that intrigue and enthuse me. I attempted to integrate them in my thesis project. Human psychology, technical problem solving and the startup attitude of networking and thinking in business cases therefore all have their place. My interest in the human brain, sensory perception and Alzheimer's Disease was sparked during my psychology minor in the Bachelor's. The other two developed over my years as IDE student.

During this thesis I aim for 5 learning goals:

1. Becoming an expert on designing for the medical world; by learning more about **(neuro)psychology**, errorproofing for testing **[Design with Intent toolkit]** and **medical regulations**.
2. Updating skills with various tools like **SolidWorks** and **Keyshot**, **DINED**, **CES EduPack** and the **Adobe Programmes**.
3. Building on my **startup attitude**; by being proactive, reaching out to new people, 'going out of the building' and maintaining a high project pace.
5. Improving my **(hi-fi) prototyping** ability and acquiring new skills like machining, complex printing or vacuum forming materials.
5. Becoming more versed in **electronic prototyping** and programming (if required by the project).