SUPPLEMENTAL MATERIAL

Contents

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Supplemental Table 1. Interview Guide

Notes for the interviewer:

- The first input to give to the interviewees is always an open question. In this guide, open questions are designated with numbers. The NR (No Reaction) notes are meant to help the interviewer to guide the counterpart in the process of starting or further elaborating her ideas.
- Be aware of individual differences and pay attention to the verbal and non-verbal components of the communication in your interaction with the interviewee. Sometimes, interviewees might need time to think about a question and organise their ideas, and sometimes, a question should be reformulated more than once. At times, a question might also be skipped.
- Review this guide before every interview: being familiar with the questions to be presented to the participants will give you confidence but also leave some attentional resources available to recognise when and how to ask for further details.

Introduction *(Estimated time: 3 minutes)*

a. Short introduction of the interviewer

b. Short introduction of the project and explanation of the purpose of the interview:

"The Luxembourg Institute of Health (LIH) dedicates an important part of its research to exploring possible new paths for the development of technologies that contribute to the well-being of the population.
The following interview is part of an effort to involve people in the design process of health-management resources to be made available for them. We believe that taking into consideration the interests, needs, and wishes of intended users of the technology we try to develop, might add to it tremendous value in terms of usability and improve the chances of being incorporated into their everyday lives and so, to serve its final purpose: to help people maintaining or improving their quality of life".

c. Verbal consent for recording the interview:

- Remind participants about the "Information Sheet" and the previously mentioned fact that the sessions will be recorded for research purposes.

- Re-confirm their agreement with the terms of the research and ask once again for their verbal consent. If necessary, clarify doubts concerning how their data would be processed and stored.

Start recording!

Part 1: *Persona-scenario exercises* *(Estimated time: 30 minutes)*

I would like to ask if you have already heard about vocal biomarkers.

Notice: Encourage interviewees to speak their minds and do not rush to give them "the right answer" or correct them". If they have a partial idea of what it means, then integrate their ideas in the definition you will offer them (e.g.: "Exactly. Diabetes distress refers, as you said, to all those emotional reactions that emerge when dealing with diabetes...like the frustration of having to check your blood sugar levels constantly..."). Here, there is a simple definition to use as a basis or to be read to participants having no previous knowledge:

"Vocal biomarkers is a technique to analyse sounds, most of them imperceptible to humans, as people speak. Vocal biomarkers are an easy and comfortable method to detect diseases or symptoms. We can say that vocal biomarkers are medical signs coming from the voice. They can serve to alert people about signs of illnesses, to diagnose, and as for monitoring".

Can you get an idea about what vocal biomarkers are, or would you like me to explain it again or more in detail?

Now, I would like to know if you have some ideas about what diabetes distress is.

"Diabetes distress is a range of emotional responses to living with and managing diabetes. Symptoms can include feeling overwhelmed by the activities related to managing diabetes; fear and worries about complications and/or them progressing or having a severe low; feeling defeated, discouraged, and maybe burned out when you are not meeting your blood sugar goals despite your best efforts. It is a normal reaction to living with diabetes, and it can affect the person with a diabetes diagnosis and family members as parents and partners".

I suggest you keep these concepts and ideas in mind for the next activity.

I would like to hear your opinion and ideas about some hypothetical situations. For that purpose, I would first share with you the case of an imaginary person. I will provide you with some information about this person and his or her current circumstances, and then I will ask for your opinion about the degree of adequacy of several approaches to this person's situation.

Case	Felix
Persona	Felix is a teen-ager. He was diagnosed with type 1 diabetes at the age of 12. He is in the first year of secondary school and his favourite subjects are maths and sport. He lives with his parents and his 18-year-old half-sister in a cosy house next to the swimming hall of the town. Felix loves playing soccer with friends or swimming next door with his best friend, school mate and neighbour Samuel. Even though, lately, he has started enjoying eating pizza while watching a good action movie on Netflix.

Scenario	Recently, Felix has been feeling different about having to deal with diabetes. Since he started going to parties, his parents seem to be very concerned about his blood sugar levels, and they are constantly reminding him of the risks that imbalances might have for his well-being. They send him regular reminders on WhatsApp when he is away, clearly upsetting him. Lately, he has not been able to stop thinking about how much he would like to be like his sister or Samuel and not have to think constantly about controlling his blood glucose level and what he eats. He feels unlucky and frustrated and would like to find a way to live a relatively normal life despite diabetes. During the last visit to his diabetologist, he told him how he has been feeling lately. The diabetologist told him that he might be experiencing a moderate degree of diabetes distress, which is quite common and understandable among people living with diabetes but must not be ignored.
Task	Please select for each option your degree of agreement with the proposition, considering that: 1= totally disagree 2= disagree 3= nor agree, neither disagree 4=agree 5= totally agree
Options	A) He could use a voice-controlled smartwatch. The watch integrates a vocal biomarker analysis function for monitoring diabetes distress that can be controlled through a mobile application. The application runs a diagnosis of the user's health condition by integrating data about exercise, sleep, and diabetes distress thanks to voice analysis. The results are made available through a report in the application. B) He could use a smartpen or an insulin pump. The smartpen or the insulin pump has an integrated vocal biomarker analysis function that requires short voice recordings to detect diabetes distress. The device allows the registration of information related to insulin dose (time) to be combined with the voice data for analysis. C) He could use a mobile application for diabetes distress detection and monitoring. The application uses voice recordings for vocal biomarkers analysis and creates alerts and suggestions for managing stress according to the results.
Choice	Which of all these options do you think is the best option?
Format	**1. How? Input Type:** 1.1. Holding a vocal (AAAAAA sound) 1.2. Counting (1-20) 1.3. Reading a short text (A short paragraph)

	1.4. Using a voice message from another connected application (e.g., WhatsApp) 1.5. Breathing deeply in and out 3 times 1.6. Coughing 3 times 1.7. Answering a question (What is your favourite movie/book about?) 1.8. Explaining why he feels good or bad today 1.9. Free speech about any topic he wants **2. When? Frequency:** 2.1. Once a week 2.2. Twice a week 2.3. Three times a week 2.4. Daily 2.5 Whenever he feels the need to self-check his diabetes distress level **3. Where? Recording conditions: How comfortable do you think he might be to record (answer based on a Likert Scale from unlikely to very likely):** 3.1. In private: recording whenever is possible to be alone? 3.2. In front of the family: recording at home? 3.3. In front of acquaintances: recording at home or school or recurrent social spaces (club) 3.4. Anywhere: recording in the street or in front of strangers
Exp.	Why X+Y+Z (combination chosen by the participant) is the best combination possible to your perception?

Case	Charlotte
Persona	Charlotte also has T1D. She lives with her mother and grandmother near her school. She is a teen-ager, but cannot wait to reach the age of maturity. Turning 18 is not just a reason to organise a party, but also to get a driving licence. Being able to go wherever and whenever she likes is the most fascinating part of turning 18 years old. H-r father said he might give her a small car if she gets a good grade on her final exam, allowing her to apply for university. Charlotte's thing is hanging around with friends. She loves to be surrounded by people and make them laugh. Her friends are always saying that she would be a great comedian. She has been seriously thinking about going for a degree in dramatic arts

	after school, but she also thinks her family would not like this idea: somehow, they always saw her as an academic, as most of the family members are.
Scenario	When she was 13, Charlotte started having problems controlling her body weight. She did not do much about her weight until her doctor warned her about the risk of obesity. After that last warning, Charlotte started trying to lose weight, but after ten days of trying diet and sports, she saw absolutely no changes and felt a lot of frustration, so she decided to quit. She recently met her diabetologist and told her what had happened. Her doctor explained that for people with type 1 diabetes, losing weight can take longer because of the need to adjust their insulin intake to new eating and training habits. She encouraged her to try again, mainly focusing on her nutrition, and also suggested waiting at least three weeks to check for changes. Weight and body shape have always been complicated topics for Charlotte. She would like to find a way to create new healthy habits that could help her get fit without feeling overwhelmed.
Task	Please select for each option your degree of agreement with the proposition, considering that: 1= totally disagree 2= disagree 3= nor agree, neither disagree 4=agree 5= totally agree
Options	A) She could use a digital scale with integrated voice sensors for integrated body weight and diabetes distress control. The scale is connected to a mobile application that alerts and creates customised recommendations according to the results of the analyses. B) She could subscribe to a digital workshop for diabetes management. The workshop includes 20 minutes of teleconsultations with a diabetologist for optimising glycaemic levels and diabetes distress management. The teleconsultations are also processed by a computerised program that analyses vocal biomarkers for signs of hypoglycaemia and diabetes distress. C) She could use a voice-controlled smart mirror. The mirror integrates vocal biomarkers and facial recognition to elaborate a diagnosis of the user's health condition, including hypoglycaemia and diabetes distress recognition and monitoring. The mirror analyses voice components and processes visual data while the user is carrying out daily activities (e.g., Toothbrushing). The analyses' results are displayed on the smart mirror directly.

	D) She could use an interactive virtual assistant (bot), an expert in glycaemic control and diabetes distress management. The assistant is analysing vocal biomarkers and uses them for diagnosis and monitoring.
Choice	Which of all these options do you think is the best option?
Format	**1. How? Input Type:** 1.1. Holding a vocal (AAAAAA sound) 1.2. Counting (1-20) 1.3. Reading a short text (A short paragraph) 1.4. Using a voice message from another connected application (e.g. WhatsApp) 1.5. Breathing deeply in and out 3 times 1.6. Coughing 3 times 1.7. Answering a question (What is your favourite movie/book about?) 1.8. Explaining why he feels good or bad today 1.9. Free speech about any topic he wants 2. When? Frequency: 2.1. Once every three months 2.2. Once a month 2.3. Once a week 2.4. Daily 2.5 Whenever he needs to self-check her diabetes distress level 3. Where? Recording conditions: How comfortable do you think he might be to record (answer based on a Likert Scale from unlikely to very likely): 3.1. In private: recording whenever it is possible to be alone? 3.2. In front of the family: recording at home? 3.3. In front of acquaintances: recording at home, work/school, or recurrent social spaces (club) 3.4. Anywhere: recording in the street or in front of strangers
Exp.	Why X+Y+Z (combination chosen by the participant) is the best combination possible to your perception?

Case	Ralph
Persona	Ralph is in his forties. He works as an accountant for a renowned company in Luxembourg. For the last four years, he has lived with his partner Susan, an accountant. They share an interest in fitness activities and spend most of their free time doing outdoor activities when the weather allows. Ralph is a well-organised and goal-oriented person. For him, balance and discipline are the keys to success in all areas of life.
Scenario	Ralph was diagnosed with type 1 diabetes when he was five. He generally thinks he has reasonable control of his blood sugar levels. Still, lately, after hearing about a friend in a critical situation with the same condition as him, Ralph felt scared about the possible consequences that the periods of imbalance in his life might have in the future. Consequently, he has been checking his levels more often. This has led to some problems with Susan, who cannot understand these changes. He would like to find out what is going on with himself and find a better way to deal with his concerns.
Task	Please select for each option your degree of agreement with the following proposition, considering that: 1= totally disagree 2= disagree 3= nor agree, neither disagree 4=agree 5= totally agree
Options	A) He could use a smartpen connected via Bluetooth to a smartphone application. The application has an integrated vocal biomarkers analysis function that requires just short voice recordings to detect diabetes distress. The application also allows the register of information related to insulin dose (time) to be combined with the voice data for analysis. B) He could use a digital scale with integrated voice sensors for integrated body weight and diabetes distress control. The scale is connected to a mobile application that alerts and creates customised recommendations according to the results of the analyses. C) He could use a voice-controlled smartwatch. The watch integrates a vocal biomarker analysis function for monitoring diabetes distress that can be controlled through a mobile application. The application runs a diagnosis of the user's health condition by integrating data about exercise, sleep, and diabetes distress. The results are made available through a report in the application.
Choice	Which of all these options do you think is the best option?
Format	1. How? Input Type: 1.1. Holding a vocal (AAAAAA sound)

	1.2. Counting (1-20) 1.3. Reading a short text (A short paragraph) 1.4. Using a voice message from another connected application (e.g., WhatsApp) 1.5. Breathing deeply in and out 3 times 1.6. Coughing 3 times 1.7. Answering a question (What is your favorite movie/book about?) 1.8. Explaining why he feels good or bad today 1.9. Free speech about any topic he wants 2. When? Frequency: 2.1. Once a week 2.2. Twice a week 2.3. Three times a week 2.4. Daily 2.5 Whenever he needs to self-check his diabetes distress level 3. Where? Recording conditions: How comfortable do you think he might be to record (answer based on a Likert Scale from unlikely to very likely): 3.1. In private: recording whenever is possible to be alone? 3.2. In front of the family: recording at home? 3.3. In front of acquaintances: recording at home or work or recurrent social spaces (e.g., club) 3.4. Anywhere: recording in the street or in front of strangers
Exp.	Why X+Y+Z (combination chosen by the participant) is the best combination possible to your perception?

Part 2: *Previous experiences* *(Estimated time: 5 minutes)*

I would like to know about your experiences with technology, particularly,

1. What kind of technological developments for diabetes monitoring or self-management are you familiar with?

* NR: You can ask if he or she knows about or has been using devices (insulin pumps / close loops, CGMs, insulin pens, smartwatches, smartphones, smart scales, smart mirrors, etc.), or platforms -including websites and apps-, like social media and forums.

2. What are your perceptions about these technologies?

*NR: consult him or her about the attributes that he or she likes/dislikes or considers useful/useless.

Notice: If the interviewee cannot recall any kind of technology for diabetes monitoring and/or self-management, it might be convenient to ask them about their experiences with technologies for well-being in general. Examples of this last kind of development would be forums, chats, groups for healthy nutrition, physical training, counselling, etc.

Part 3: *Expectations and wishes* *(Estimated time: 15 minutes)*

In the following exercise, I would like to invite you to expand your imagination even further than before: Imagine that in the LIH we found a way to recognise when a person feels a high level of "diabetes distress" by analysing signals from his or her voice. In other words, through using vocal biomarkers. First of all:

3. What would be your first thoughts about it?

*NR: Here we want to know the first thing that crosses the person's mind when told about voice recognition technology able to identify mood or mental issues. Ask them about their general expectations, fantasies, concerns, hopes, etc.

4. Where would you visualise this technology as successfully integrated? How?

*NR: suggest some examples: application software, platforms, telemedicine consultations, devices (smartphone, tablet, smartwatch, smart mirror, etc.)

5. If voice analysis is something a device or program can do, Do you think it would be convenient to mix it with other "things" a device can do?

5.1. What would you think about

5.1.1. An insulin pump (or a smartpen) with or without CGM, with integrated voice sensors for vocal biomarkers analysis?

5.1.2. Telemedicine with voice recordings for vocal biomarkers analysis? Would it be fine for you to have your voice recorded?

5.1.2.1. (*If a voice recording during teleconsultations is an option*) Would you prefer to integrate this function into your teleconsultations with your diabetologist, psychologist, GP, or a virtual assistant (bot)?

6. Would you be willing to use this kind of technology? If yes: Under which circumstances and how often would you use it?

*NR: Explain active and passive voice recording. Active voice recording is when you record your voice on purpose. In contrast, passive voice recording is when your voice is recorded and sent to a system without your active intervention.

6.1. Would you rather consider using a device or application with a vocal biomarkers analysis function if it does passive voice recording or active voice recording?

6.2. Who should have access to the data from your voice analyses? Your GP? Your diabetologist? How about researchers?

6.3. If vocal biomarkers analysis will be something that a virtual assistant like Alexa, Siri, or Google can do, will it be fine for you if these companies keep and own your data??

7. What would be the best way to let people know about this kind of technology if we want to make it accessible to every person who could benefit from it?

*NR: give her all the following examples and ask which of them might be, in their opinion, the best for the purpose above: health practitioners, institutions where people with diabetes diagnosis come together (as patient's associations), laboratories, or peer recommendation.

8. Should vocal biomarkers-based technology be available free of charge, or should it be for paying? Why? Would you pay for it if your physician prescribed it? Or recommended by a peer with diabetes? If yes, would you be willing to pay for it even if it is not reimbursed?

Closure: *(Estimated time: 7 minutes)*

a. Ask for questions and concerns concerning the interview or the research itself

b. Thank the interviewee for his or her participation.

Supplemental Table 2. Final Codebook

Theme	Categories	Description	Example Quote
Experience of T1D	-Burden of Disease -Previous Experiences	Data referring to a participant's descriptions relating to their daily life with T1D including the burden of the disease, previous experience living with the disease (e.g. management in daily life), and where or how they get their information as this can inform their actions	"Well, let's put it this way: until a few years ago, digital technology did nothing for me as a diabetic. But it started very positively and helped greatly with the sensors in my arms. And it's been a huge win for me ever since."
Barriers to Novel Technology	-Barriers to use -Data management -Financing	Data encompassing participant views on aspects of novel technology in T1D management that would prevent its use or discourage the integration of it into their condition management	"But it might be worrying, isn't it? Because you would have to know exactly by whom or who wants to use the data… Someone who uses the data specifically and not a company behind it and then uses it to do business with it."
Facilitators to Novel Technology	-Facilitators to use -Financing	Data encompassing participant views on aspects of novel technology in T1D management that would promote its use or encourage the integration of it into their condition management	"I'm pro technologies. I'm happy when something is simplified, for everyday use. It shouldn't just be something I do twice a week... No, it should make my everyday life easier."

Expectations of T1D Management Technology	-Expectations of novel technology -Data management	Data refers to participants' expectations of technology-assisted management of T1D.	“It's supposed to be as simple as possible so that I'm not always reminded that I'm sick. And when I count, I don't have to think. I do it, and then I get my analysis, and that's it.”
Role of Healthcare Professionals	-Information sources -Facilitators to use	Data encompassing participant views on the role of healthcare professionals concerning their experience of T1D, T1D management and technological developments for T1D management	“When you hear from the doctor himself... you'll do it… and if you realise that you're maybe more stressed than it's good for you to be, then one could say: "okay, then you have the device or the app".

Supplemental Table 3. Information sources mentioned by participants during the interviews

Primary Information Sources	
Actual	Potential
Health professionals	Health insurance
Patients association	Ministry of Health
Technology manufacturers	
Secondary Information Sources	
Traditional media	New media
TV advertisements	Online advertisements (ads)
Newspapers	Social media
Word-of-mouth	Mobile-App updates

Infographic: Results of the study for the participants

Voice Technology vs. Diabetes Distress
What did you think?
PsyVoice Study results

Thank you!

Your help in the PsyVoice study really mattered. It allows us do better research that can make a big impact!

Why we did this research

PsyVoice wanted to know what people with type 1 diabetes think about using voice technology to help with diabetes distress.

Diabetes distress describes the emotional experience of when managing diabetes feels tough. It's normal to feel worried about diabetes, but too much worry can make life and diabetes control harder. So, having tools to help check this is very important.

This study is part of an effort to make voice-based technology that can make life better for people with Type 1 diabetes.

Who was in the study

12 adults from Luxembourg joined PsyVoice. The ages ranged from 27 and 64 years old when we did the interviews.

Half of the participants were women, and the other half were men.

Half of the participants used a hybrid closed insulin loop (HCL), with the rest using a continuous glucose monitoring system (CGM), an insulin pump, or a sensor-augmented pump (SAP).

What we did together

You filled out three questionnaires. They asked about your age, whether you are a man or a woman, and other things like your studies.

We also asked about how you manage diabetes, how you have felt about diabetes distress, and how much you know about using technology for health management.

You also had a video chat with us. We talked about ideas for devices that use voice-based technology to help with diabetes.

WHAT WE LEARNED

Feeling Worried

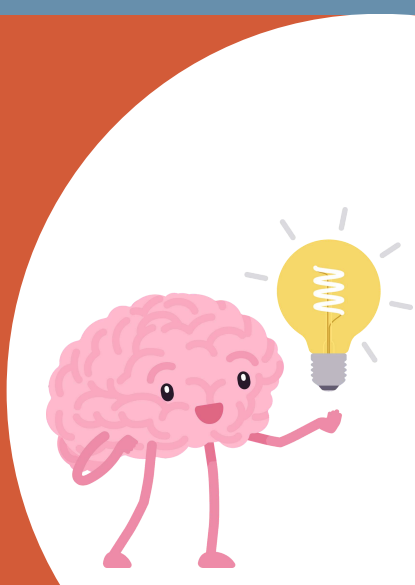
Some participants were concerned about using voice-based technology in public because they thought others might judge them.

Trust Matters

Participants trusted the technology more when doctors said it was reliable and effective. Their doctors' approval and support made the technology feel well-suited to their diabetes management.

Past Experiences Count

Good or bad experiences with diabetes management technology made a difference in how open participants were to new inventions. The kind of device participants used also made a difference in how they felt about new diabetes technology. Participants who used HCL and SAP devices were more open to trying voice-based technology.

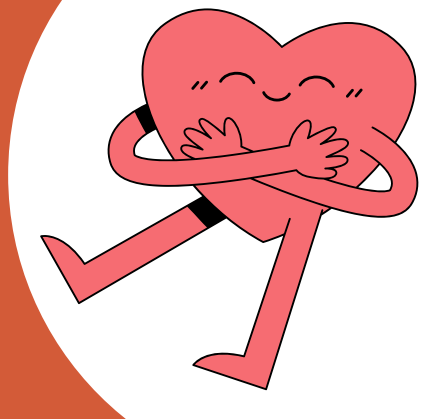


Keeping Information Safe

Participants cared about the privacy of their information. They were open to sharing information with doctors to manage diabetes better, but not with commercial companies.

Helpful and Easy

Participants wanted voice-based technology to fit into their life without trouble. They want tools that are flexible so that they can change to match their wants and needs. It should make life better, and reduce the workload of managing diabetes.



No matter your age, gender, or background - you thought the same way about these 5 topics!

Voice Technology vs. Diabetes Distress
What did you think?
PsyVoice Study results

What this means for you

We think that when you help make tools for yourself, those tools will work better for you. They'll fit into your everyday life more easily. This research is like a map that guides us in making better tools to help you manage type 1 diabetes and have a better life.

To view the full scientific article about the study, please click the following link:

https://bmjopen.bmj.com/content/13/9/e068264

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