TÉCNICO LISBOA

Creation of a Mental Health Virtual Assistant for College Students

Socially Intelligent Agents for the Field of Mental Health

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Abstract

Recent research as established the potential for Virtual Agents to act as non-judgemental interviewers, eliciting greater self-disclosure though trustworthiness and credibility, in a medical care environment. We hypothesise those qualities might also be true in the mental health support field. Namely in higher education communities, where the situation has been worsening and the current system lacks the capabilities to cope with the growing need for support. The main goal of this work is to the create a Mental Health virtual Assistant and evaluate its capabilities to elicit self-disclosure with college students, about their mental health related issues. The secondary goals are tied with its ability to establish rapport with the interviewees, measure their anxiety levels and mitigate the stigma related to seeking help about mental health issues. Our findings suggest that the agent received high levels of acceptance and engagement and was able to elicit self-disclosure in students, as hypothesised. The rapport building and stigma mitigation were met with average results, while the measurement of anxiety level showed potential and accuracy, although it still needs to be further tested. In conclusion we provided strong grounds for future work to further develop and deploy a Virtual Agent as a Mental Health Virtual Assistant.

Keywords

Socially Intelligent Virtual Agents Psychology College Rapport Disclosure Mental Health

Resumo

Estudos recentes comprovam o potencial que Agentes Inteligentes têm enquanto entrevistadores devotos de julgamento, promovendo maior partilha de informação através de confiabilidade e credibilidade, em ambientes de entrevistas médicas. Nós estabelecemos a hipótese de que essas qualidades também se comprovam no campo de entrevistas de saúde mental, nomeadamente em comunidades do ensino superior, onde a situação se está a degradar e o sistema atual carece dos recursos necessários para lidar com as necessidades dos estudantis. O principal objetivo deste trabalho, é a criação de uma Assistente Virtual de Saúde Mental e a avaliação das suas capacidades para incentivar estudantes a partilhar informação quanto aos seus problemas de saúde mental. Os objectivos secundários prendem-se com a sua capacidade para estabelecer uma relação de confiança com os entrevistados, medir os seus níveis de ansiedade e mitigar o estigma relacionado com a procura de apoio quanto à saúde mental. O veredicto do nosso estudo sugere que o agente recebeu altos níveis de aceitação e interação e foi capaz de incentivar estudantes a partilhar informação quanto aos seus problemas de saúde mental, tal como teorizámos. As capacidades para estabelecer uma relação de confiança e mitigar o estigma revelaram resultados medianos, enquanto a capacidade para medir níveis de ansiedade revelou potencial e precisão, porém necessita de ser mais testada. Em suma providenciámos resultados conclusivos e criámos bases para trabalho futuro, no desenvolvimento e lançamento de um Agente Virtual enquanto Assistente Virtual de Saúde Mental.

Palavras Chave

Agentes Virtuais; Socialmente Inteligentes; Psicologia; Alunos; Faculdade; Rapport; Disclosure; Saúde Mental

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Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
ASR	Automatic Speech Recognition
CGV	Computer Generated Voice
DoD	U.S. Department of Defense
FAL	Federação Académica de Lisboa
FAtiMA	Fearnot Affective Mind Architecture
FLoRes	Forward Looking Reward Seeking
GAD	Generalised Anxiety Disorder Assessment
HCI	Human Computer Interaction
IST	Instituto Superior Técnico
MDD	Major Depressive Disorder
MHeVA	Mental Health Virtual Assistant
NLP	Natural Language Processing
PTSD	Post-traumatic Stress Disorder
RCT	Randomized Controlled Trial
SIVA	Socially Intelligent Virtual Agent
SIA	Socially Intelligent Agent
TTS	Text to Speech
UI	User Interface
UX	User Experience
VA	Virtual Agent
VH	Virtual Human

VMA Virtual Medical Agent

VR Virtual Reality

1

Introduction

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Socially Intelligent Virtual Agents (SIVAs) have been a growing part of our society, being deployed in various ways with a wide variety of objectives. With the recent developments of Artificial Intelligence (AI) across fields such as Human Computer Interaction (HCI), Natural Language Processing (NLP) and recent advances on Extended Reality systems, both in appearance and behavior they have become closer to humans than ever before. This allowed us to be able to establish stronger emotional connections with Socially Intelligent Agents (SIAs), the name attributed to computer programs designed to socially interact with humans [1, 2].

The ability to connect with humans has allowed these agents to establish trust and rapport and thus increasing their performance in tasks directly related with human interaction. For instance, the use of such agents in learning experiences, can help students to acquire knowledge more efficiently and improve the learning experience about certain topics [3]. In some cases, in accessibility and economic terms, these approaches tend to be more sustainable than using human teachers [4]. In the medical domain, for instance, where patient's health is often at risk, the use of Virtual Agents (VAs) to interview patients about their medical state was tested. Results showed that patients tended to be more honest in their answers, when interviewed by VAs, without external involvement [5].

While superficially, SIVAs have also proven to be helpful in dealing with depression and loneliness. Chat bot companions as "Replika"[1] or "Wysa"[2], are a few examples that effectively improve mental health of those who interact with them [6].

The use cases mentioned above, are but a small sample of the wide variety of studies, that have shown the positive impact SIVAs can have in our society. The focus of this work will be on one promising aspect of the human life we believe they can improve: Mental Health.

1.1 Motivation

Mental health has become a prominent issue of the 21st century, with studies estimating that around 792 million people suffer some sort of disorder [7]. This issue also affects students, mental health organizations have reported that colleges across the world are contending with rising rates of mental disorders [8]. The situation is exacerbated by the fact that the demand for services on campus far exceeds the available resources, where it is impossible to provide quick and consistent access to professional psychologists, for every student, simply due to lack of capacity and resources [9, 10]. Additionally, there is yet another problem: the stigma that is associated with somebody seeking psychological help, which affects the student community and makes them avoid seeking professional help, due to fear of judgement from other people [11].

It is impossible to ignore yet another factor. The current reality we live in, of a world coming back from

[1] https://replika.com/
[2] https://www.wysa.io/

the 2020-2022 global coronavirus pandemic, is responsible for worsening the previously enumerated problems and creating new ones [12, 13]. The Federação Académica de Lisboa (FAL) made a study that revealed that up to 55% of Lisbon's college students have worsened their mental health condition and up to 83% didn't search for psychological help, from the available systems provided [12]. We now know that a lack of academic results, anxiety issues and even deterioration of mental health, become recurrent if the proper assistance is not provided.

This is the main motivation for this work. We believe SIVAs can be used to mitigate some of these issues. Additionally, state-of-the art research already shows potential as we are going to explain further on.

1.2 Objectives

The primary goal for this work is to understand if VAs can be positive influences and be helpful tools for supporting students suffering from mental health issues, namely anxiety. We will mainly focus on their ability to promote self-disclosure, with emphasis on answering the following question:

- **Will Students Disclose with the Agent Regarding their Mental Health Issues:** Self-disclosure is the sharing of any information about oneself to another entity [14]. Self-disclosure is beneficial in numerous settings, specially when that information is needed to improve the health of the one disclosing. In dealing with mental health problems, the psychologist needs to obtain information from the patient, in order to understand the problems that affect them. However, eliciting self-disclosure can be challenging due to factors such as fear of self-disclosure [15]. This will be the core challenge, since the other objectives will either exist to make this one successful or be direct consequences. State-of-the-art research has shown interactions with VAs can lead to more self-disclosure and willingness to self-disclose, when compared to human counterparts. This due to the judgemental factor, that makes people fearful of social judgement when disclosing about personal matters [16, 17].

Furthermore, there are several factors that are related to the ability of eliciting self-disclosure and several ways the mental health support services can benefit from a VA. So in order to complement our main goal, we will also try to answer the following questions:

- **Will a Virtual Agent be Accepted:** The success of a Virtual Agent, deployed in a paradigm like this is heavily depended on its acceptance. If there is resistance from the students/users, it will be difficult for the SIVA to build trust and establish rapport, which is essential for all our objectives. Studies have shown that VAs can be effective in areas that deal with sensible issues, such as medical interviewers [5], now we have to prove that they can be accepted in the field of mental health in college.

- **Will a Virtual Agent be able to create Rapport with Students:** Rapport is defined as a relationship characterized by agreement, mutual understanding, or empathy that makes communication possible or easy [18]. In order for the student to talk about their personal issues, it is necessary for rapport to be established between them and the VA [19]. This relationship can be increased by both members of the interaction through verbal and non-verbal cues. It is something that psychologists have in mind when providing mental health assistance [20] and it is something our Mental Health Virtual Assistant (MHeVA) should be capable of mimicking.

- **Will the Virtual Agent be capable of Detecting Anxiety:** Obtaining information about mental health issues from students its very important, however all the efforts are in vain if that information is not utilized correctly. Our approach does not intend to replace doctors, psychologists or experts in the field. In dealing with mental health we must be very careful. With that line of thinking, the objective of MHeVA will be to measure the students' levels of anxiety and advise simple and no-risk solutions or in a more serious case, advise to seek professional help. This evaluation will be based on the answers provided by the student, to anxiety oriented questions that the SIVA will pose, taken from the Generalised Anxiety Disorder Assessment (GAD).

- **Will the Virtual Agent help mitigate the stigma related to searching for help about mental issues:** We hope to tackle a problem that has been hindering the strength of the support provided: The self-stigmatization or stigmatization by others, that usually surrounds those who seek psychological help and is linked to the threat of social disapproval [11]. We believe that since people tend to feel less judged by Virtual Agents when self-disclosing, that this will help the students be more predisposed to seek mental health care and fight the stigmatization.

Additionally, one of the motivations behind our approach, as previously indicated, is the lack of resources and capacity of the college mental health support systems. So naturally, we will try to deployed the agent in a way that can benefit the professionals already working on the field, and empower them to better answer to the students needs. The proposed solution places the agent as the first contact for students, consequently it will be able to have a much greater reach. This will enable it to solve simple problems that don't need serious counseling, advise professional help when they do and if agreed by the students, to provide the professionals with some information about the issues that where already encountered. We hope to achieve this by working directly with a mental health support professional, when constructing our agent [9].

1.3 Proposed Solution

Modern social architectures allow developers to design VAs capable of adapting to a multitude of situations and tasks. Affective agents, for instance, can simulate a crime suspect, with interchangeable emotions, depending on the interaction with the user [21]. While socially intelligent ones are able to store information about a certain user and use it later on in an organic conversation [22], similarly to what humans do in longer relationships. Furthermore, with abilities such as "Theory of Mind", agents are able to rationalize about other's internal states, allowing for a degree of understanding [23].

One of these architectures is Fearnot Affective Mind Architecture (FAtiMA), which uses emotions and personality to influence the agent's behaviour that is authorable in XML [24]. We will explain further on, how this architecture can help us achieve our goals and build our agent. The agent, which we will name MHeVA, will be tested as an assistant to the mental health support service, in the largest school of Architecture, Engineering, Science and Technology in Portugal, Instituto Superior Técnico (IST). It will be modeled as a 3D human, have animations, and a Computer Generated Voice (CGV). It will interact through speech and have a degree of intelligence that will allow it to choose the right questions in order to reach its objectives. More importantly, it will store beliefs about those who interacts with and through them will perceive the established relationship and understand better how to help them.

Since we are dealing with a sensitive subject it is important to note that, the mental health support services of IST will work with us, to make sure it complies with the necessary requirements to provide support without undesirable effects to the students.

1.4 Contributions

To provide a strong base for our work, we made a research of several interaction modalities that could be implemented in our agent, to best model it for the tasks ahead. We also made a research about a possible social architecture we could use to allow our MHeVA the intelligence necessary to interact organically with the students and try to complete the above mentioned objectives. In the end we developed a SIVA that had a 3D human model, used animations, had a computer generated voice and was implemented using the social architecture: FAtiMA Toolkit. After the implementation was concluded we tested the Agent in August with several college students to conclude, using a questionnaire, if the objectives were met and were did we have space for improvement. Furthermore we also tested the agent with students already diagnosed with anxiety, to see if it was able to detect it.

1.5 Thesis Outline

The rest of this document is organized as follows. In chapter 2, Background, we present the current situation, in general, regarding mental health in higher education facilities and collect relevant data about psychopedagogy interviews so we can model our agent's behaviour. In chapter 3, Related Work, we describe relevant state-of-the-art work on the use of VA in rapport and disclosure scenarios. Our goal in this chapter is find the best way to implement our agent and to structure its rationality and interaction modalities. Next, chapter 4, we describe the MHeVA's architecture and why we implemented the way we did. Proceeding to chapter 5 we will give a brief overview of the main tools we will use to implement the MHeVA. In chapter 6 we will talk about the process of implementation and the details of MHeVA and the designed interaction. After, chapter 7 explains our enquiries and presents the results they obtained, followed by a discussion on our findings. Finally, chapter 8 describes what we concluded with this project by summarizing its main points and future work.

2

Background: Anxiety in College

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Higher education is becoming a more common path for Portuguese young adults. This educational step is accompanied by significant changes and new challenges that young students must face. Naturally, such obstacles have a strong impact in their development, often hindering their success in the social, personal and academic fields [25, 26].

A student that changes their paradigm from High school to College, is presented with many challenges that they might not be able to tackle. In terms of mental health, the ineptitude to be successful, or simply the possibility of failure, creates a sense of dread, that might evolve into pathological phobias, anxiety or even psychosis [9].

The main problems that affect students are social phobia, anxiety towards exams and generalized anxiety, which might hinder their academic success and the student's lifestyle general health [27]. Furthermore, it is important underline that fact that students suffer the same problems as everybody else, be it family issues, infancy traumas or personality perturbations [28].

2.1 Psychological Support in College

In the last decades in Portugal, as well as in IST [1], several structures and services that provide Psychological support to students have been created. These are incorporated by specialized professionals, that are available to help students deal with their challenges and difficulties, in a personal, academic, social or vocational domain [29, 30].

Mental health professionals, that are part of the universities' staff, assist students that suffer from mental health problems. To achieve this, they promote student's personal development by helping to mitigate the issues that interfere with their studies, support the educational process to help students raise their academic success and in the end, make sure they are ready for their professional life experience [31]. It is important to note that, like most pathological problems, the earlier mental health problems are treated, the better. Hence a lot of work from this services is focused on prevention and identification, so the students can start solving their challenges sooner, and to make sure small problems don't develop into bigger and serious crisis (for example psychosis) [9, 10].

In IST, specifically, this type of support is subdivided in two categories, (1) Psychopedagogy Support and (2) Psychotherapy and Adult Counseling. The former consists of different and diversified activities in the assessment and resolution of each student's learning difficulties. The latter is a more serious service, that deals with psychological well-being, namely providing support in crisis situations, and therapy in the case of diagnosed disorders [9]. We will be working closely with the first category.

[1] IST is one of the top public schools of engineering and technology in Portugal and is part of University of Lisbon. We have are interested in this particular institute, since we will be studying and working with its community

2.1.1 Positive Effect on Students

As the psychological support structures evolve and become more disseminated in higher education community, it has been shown that students will more frequently look for this kind of support and realize the importance of this kind of service [32]. Multiple studies reinforce the idea that mental health support is effective, providing very positive results on retention, academic success, quality of academic life and student employability. Mental Health professionals not only help students overcome their problems, but provide them tools, to later on, allow them to face the problems by themselves. Improving personal growth and the development of valuable personal skills. [33, 34].

2.2 Psychopedagogy Interviews

The core of psychopedagogy support are interviews. There is a wide range of different types of interviews, in this work we will focus on "Help Interviews" and "Brief Evaluation Interviews", since their goals align with our work. The first dedicates itself to the establishment of a trusting relation between the interviewer and the patient, in order to create rapport and allow the professional to help their patients overcome their problems and challenges. The second, much briefer, focuses on evaluating the patient in order to identify the seriousness of his mental health issues and forward them to the right support and treatment [20].

Regardless of the interview's type, there are four key abilities an interviewer must have in order to properly obtain information from the patient. These abilities are focused on both encouraging disclosure from the patient but also to strengthen the relationship between patient and professional:

1. **Observation**. Although the interview is based on verbal interaction, it's estimated that only 7% of the message's meaning comes from its verbal component. A staggering 55% comes from the body language, for example how the patient sits, how much they smile or how they greet the interviewer [20]. Thus a psychologist must at all times observe the patient, in order to obtain more truthful information, about the patient's meaning and well being.

2. **Active Listening**. Not just what is being said but also how it is being said. Vocalization aspects, as the tone of the voice, the cadence of the speech and many others, account for 38% of the message meaning [20].

3. **Development of an Empathetic Relation**. In order to create rapport with the patient and to better comprehend their state of mind, the interviewer must not only be able to, emotionally and cognitively, place themselves on the shoes of the patient, as they need to convince the patient that they have this emphatic capacity. This will help to built a stronger relation of trust and rapport [20].

4. **Intervention Control**. This competence includes the ability to maintain control of the interaction and keep a clear path towards the objective. To control the flow of the conversation it is essential to keep all the interactions efficient and effective, be it verbal, be it non-verbal. All the interventions from the psychologist must be well thought and controlled [20].

Finally, it is important to highlight a crucial quality that a psychologist must have: the ability to be impartial to the information that the patient is sharing. Independently of how embarrassing or morally questionable it is, the interviewer must never imply judgement. If the psychologist were to react negatively to the patient's disclosure, this could prompt the latter to become defensive and resist any further sharing of intimate information [9, 20].

2.3 Insufficiency of the Support Provided

Unfortunately, even though the services provided are crucial, there is a clear shortage of resources to meet demands. The quickness of response, the duration and depth of the interventions, the shortage of human resources, are but a few of the wide range of issues afflicting the system [10]. Furthermore, the increasing number of students that look for this support makes it clear that there is a need for new solutions [35]. In IST alone, the services are increasingly in demand and the available professionals aren't enough, resulting in several months of waiting for interviews [9].

In addition to the shortage in human resources, in the last two years we've been hit by a pandemic that forced higher education to adapt and live in an online-only reality. This new paradigm, not only made impossible for the psychological support to be supplied as before, but it has also worsened the mental health of college students. Fear of academic failure, feelings of solitude, changes in sleep patterns, greater feelings of anxiety, became prominent contributing factors, for the decline of mental health. While the educational bodies provided a few alternatives, it still isn't enough [12, 13].

We believe that SIVAs might provide a solution to mitigate the increasing problems of accessibility and resource's shortage, regarding Mental Health Support in higher education. In addition to this, it is possible a SIVA might even help to mitigate the self-stigmatization or stigmatization by others, that usually surrounds those who seek psychological help and is linked to the threat of social disapproval [11].

3

Related Work

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The development of believable and empathetic intelligent agents is influenced by a wide range of different scientific fields such as Social Studies, Artificial Intelligence, Medical Practices and, to some degree, Virtual or Augmented Reality research. Extensive work has been conducted regarding studying the impact Intelligent Agents can have in the life and learning of human beings. In this section we will review several recent studies and papers, that will provide the theoretical basis for the Mental Health Support SIVA and help us understand which verbal and non-verbal behaviours should we be focused on.

We will start by describing research focused on a practical view of the field with several use cases, with pedagogic and professional objectives, were the focus is on establishing rapport and influence behavioural change. Then, we will share parameters and behaviours that were proven to be beneficial in achieving the above mentioned objectives. To conclude a report of several state of the art studies in the fields of disclosure and medical interviews.

The overview performed and presented in this thesis will then inform our decisions when it comes to the implementation of a SIVA to achieve our goals

3.1 Language Trainers

In terms of acceptance and practical uses of Virtual Agents VA, we look at the study conducted by Macedonia et al. [4]. Using a Intelligent Virtual Agent called “Billie” [4], they tried to understand the perception of the agent as a teacher, by its human students and its effectiveness and efficiency as a language trainer compared to a human counterpart. Billie had a voice and was 3D modulated to look like a young boy. Consequently, had physical appearance, and animation since it was necessary to use gestures to enforce the language learning.

Two different test groups were used, one with adults and the other with children as students. Both revealed that the Intelligent Virtual Agent was capable of training humans to learn vocabulary items, as well as a human trainer. Furthermore, both adults and children demonstrated good acceptance of Billie as a trainer.

3.2 Increase Exercise in Young Adults

The FitTrack system featured “Laura”, a relational agent that served as an exercise advisor to sedentary adults, had the objective to motivate its users to perform more walking exercises [36].

A study was conducted with 101 young adults from a college community, in order to test the agent’s relational behaviour (social dialog, empathy, nonverbal behaviour, etc.). Spanning 30 days, the students were divided in three groups, one (relational) interacted with a relational version of Laura, with all her

relational behaviour, the second (non-relational) interacted with a simplified version of Laura without the previous parameter, and finally the last group (control) acted as a non-intervention control to record daily activity.

The study provided interesting results in both fields of human-agent relation and behaviour influence. The users in the relational group, reported considerable higher Working Alliance scores on the Bond sub-scale, compared to the ones in the non-relational group (the Bond sub-scale assesses the trusting, empathetic dimension of the alliance), both from the beginning to the end of the 30 days. This proves that relational behaviour is capable of creating trust and empathy between the user and the SIVA. As for the behaviour influence, translating in agreement on the task and goals of the therapy, the results were mixed. On one hand, the use of the FitTrack system, consequently the interactions with Laura, improved the moderate or vigorous physical activity per week in at least 30 minutes. On the other hand, there were no significant differences in gains of physical activity between the relational and non-relational groups.

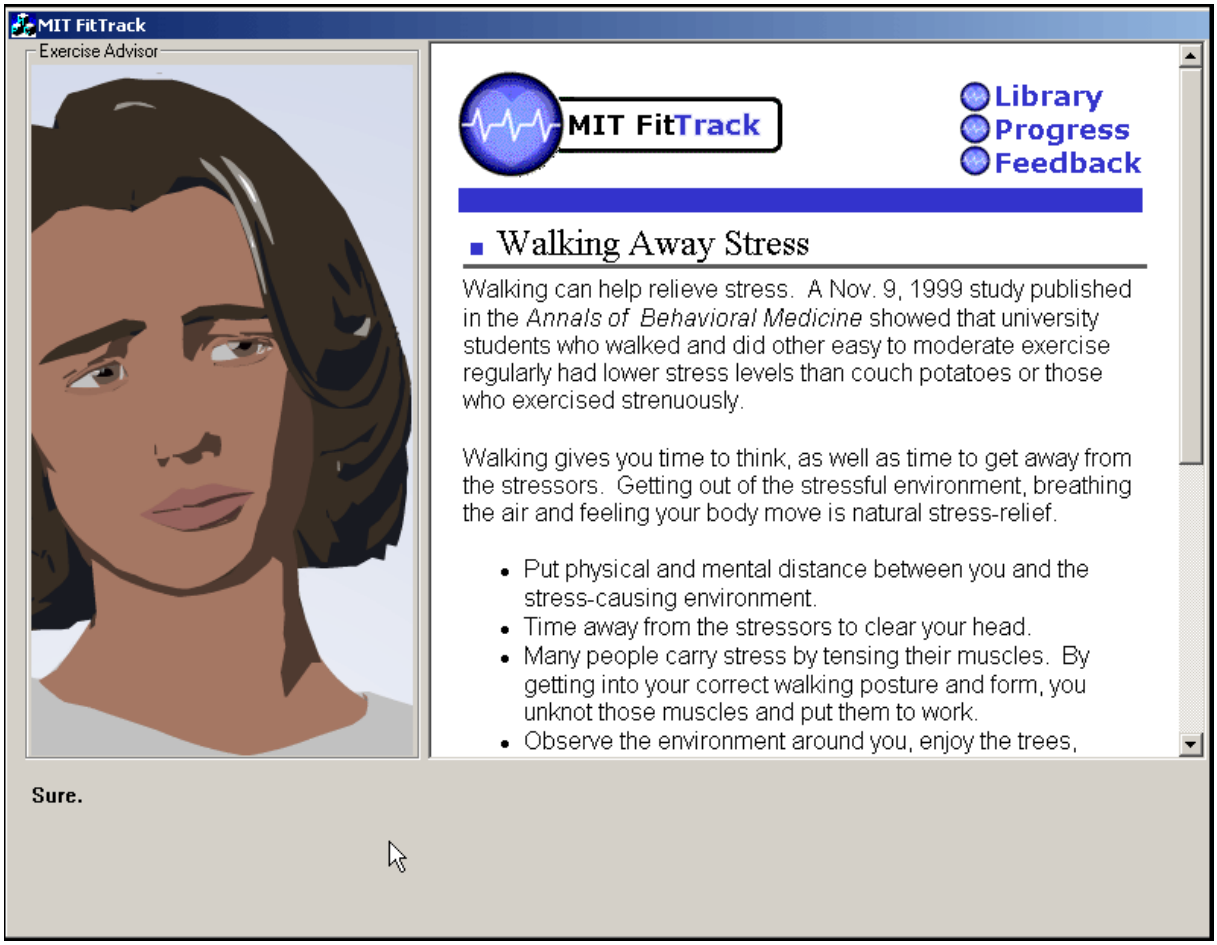

Figure 3.1: Laura, the MIT FitTrack companion [1]

The last result might hinder our expectations, but as studies indicate, one of the real advantages of

[1] https://www.researchgate.net/figure/Laura-and-the-MIT-FitTrack-System_fig1_27296500

engaging with relational agents is retention in long-term interventions [37]. And since the study only lasted 30 days, we might argue that if the users were allowed to build longer relations with Laura, the final results might have been more promising in the matters of influence and relationship building.

3.3 Medication Compliance

Looking at more sensible tasks, such as improving mentally ill patients compliance to taker their medication according to prescription, the study conducted by Robert Brian Haynes et al. [38], provides us with a deep insight. To fight this problem, they created a home-based relational agent that promoted medical adherence among adults with schizophrenia [39]. The agent interacted with the patients on a daily basis, not just to remind them to take their medication but to promote physical activity and social interaction. Its dialog and non-verbal behavior were specifically designed to interact with individuals with schizophrenia, during a one-month intervention. In the early days of the task, it was focused on its relational behavior and visit adherence before discussions of medication and health related issues. The last days where oriented towards promotion of self-maintenance behavior and addressing the patient's feelings about ending their daily conversations.

Results were quite positive. From a pool of 16 participants, the self-reported ratings of satisfaction averaged 4 on a Likert 1-5 scale, with a self-reported medication dose adherence of 89%. Patients talked with the agent 65.8% of the days available, with nine participants talking 25 times with the agent, during the 30 days experience.

3.4 SimCoach: An Intelligent Virtual Human System for Providing Healthcare Information and Support

Keeping our sights in behavioural influence in humans by VAs, we share the SimCoach project. A work aimed to develop a virtual human support agent, to serve as online guide for promoting access to psychological healthcare information and for assisting military personnel and family members in breaking down barriers to initiate the healthcare process. Similarly to our project, SimCoach wasn't oriented to be a virtual therapist but rather supporting users determined to be in need, to make the decision to take the first step toward initiating psychological or medical care with a live provider [40].

Th SimCoach was deployed through several possible Virtual Humans (VHs), that the users chose based on their preferences. These VHs had a 3D model and had access to a limited set of pre-rendered animations. The way it communicated with the user was through a text-chat, using a dialog manager called Forward Looking Reward Seeking (FLoRes) [41].

Figure 3.2: Bill Ford, a SimCoach character [2]

In another reaserch, Daniella Meeker et al. tested the summative component of SimCoach, assessing outcomes among participants in a user experience survey and a Randomized Controlled Trial (RCT) [42]. Study participants interacted with the SimCoach Beta program's virtual human. Interactions with the virtual human included conversational dialogue prior to the administration of one of two adapted instruments for assessing psychological health—the Post-traumatic Stress Disorder (PTSD) Checklist (PCL) and the nine-item Patient Health Questionnaire (PHQ-9)—followed by personalized recommendations. The RCT compared help-seeking outcomes across three study arms: (1) the SimCoach arm, in which respondents were administered questionnaires of outcome measures after interacting with the SimCoach Beta tool, (2) a content-matched control arm identical to the SimCoach arm but substituting the VH interactions with conventional online text-based methods, and (3) a no-treatment control arm in which participants completed the outcome assessments without any additional assessments or recommendations. The primary outcome measure was the intention to seek help for PTSD or depression, with secondary outcomes related to perceived barriers to seeking and accessing care.

[2] https://www.researchgate.net/profile/Fabrizio-Morbini/publication/265426775/figure/fig1/AS:613446143967286@1523268366373/Bill-Ford-a-SimCoach-character-SimCoach-virtual-humans-are-accessible-through-a-web.png

557 users participated on the study and in the end it was not detect a significant effect of the SimCoach Beta intervention on help-seeking intentions compared with participants receiving no intervention. It was concluded that although Technology-driven behavioral interventions, such as SimCoach, are being widely and rapidly developed and deployed, yet there is no established set of best practices that marries technology development and the development of interventions to improve psychological health. Although SimCoach Beta software development was consistent with the U.S. Department of Defense (DoD) best practices [43] and the results of the study suggest that users had a satisfactory experience while using SimCoach Beta, participants in the RCT did not show greater intentions to seek help than users who did not receive any questionnaires or recommendations.

3.5 Politeness Parameter

As the above study mentions, sometimes it is difficult to establish a relationship between human and VA, so that leads us to question the factors that help this relationship construction.

Based on the previous described studies, we can infer that relational behaviour can influence the user to perceive the intelligent agent as a more human-like identity and facilitate the creation of stronger social bonds [36]. Politeness of speech and non-verbal behaviour is one of the most important features of a person's conversational style. According to Brown et al. [44], there are two types of politeness: Negative politeness (an emphasis on individual autonomy and freedom from imposition), and positive politeness (an emphasis on closeness and communication with others).

Holtgraves et al. studied the perception of a VA as a function of its level of positive politeness in 2006 [45]. In this study, 49 undergraduate students of introductory psychology, interacted via text-chat with a version of ALICE [3] chat-bot named Pat. Participants were divided into two groups, one socialized with a version of Pat that was aware of the user's name and gender, using their name in the conversation, and the other interacted with a version that did not have such information, so it never referred to the user by their name. The result itself was conclusive, showing that the rather subtle manipulation of using the user's name, can have a positive effect on the perception of a VA. The results were divided into two factors, conversational skills (skilled, human, engaging) and pleasantness (thoughtful, polite, responsive) and in both, the relational version was perceived more positively (higher difference in the conversational skill factor).

[3] http://www.alicebot.org/

3.6 Virtual Humans provide Socio-Emotional Benefits

Another study that looks into verbal behaviour is the one conducted by Lisanne S. Pauw et al. [46]. They examined whether talking to a VH elicits socio-emotional benefits, and whether or not the type of support provided offers different results. Namely emotional and cognitive support.

To understand the scope of the potential effect, participants shared two personal emotional experiences, related to anger or worry, with a VH. This agent provided responded to the disclosure offering support via the Wizard-of-Oz method, where a human counterpart controlled the VH.

Participants received three instances of either type of support. All responses were recordings of a human voice. Emotional support consisted of sentences expressing sympathy (e.g., "I'm sorry to hear that"), and validation (e.g., "You have every right to be angry with them"). Cognitive support was always directed at reappraising the situation by either trying to find a more positive way of looking at the situation (e.g., "It sounds like you're learning though"), or by putting it in perspective ("Maybe with time they'll come around").

From 115 participants, the results obtained showed positive effects after the interaction with the VH, as evidenced by reduced intensity of the target emotion and generally improved affect. The emotional improvement was similar for emotional and cognitive support. Cognitive support was also experienced as equally effective as emotional support, and led to similar levels of experienced closeness and desire to interact with the virtual human again. These findings suggest that talking to a virtual human can be a valuable form of support at times of distress.

3.7 Medical Interviewers

Now directing our attention to VAs that focus in increasing willingness to disclosure, we examine the work of Lucas et al. [5].

This study was aimed at medical patients and their health related issues. Their comparisons were not between humans and machines as interviewers, but between tele-operated and automated VHs, as interviewers. Through the use of an animated SIVA that communicated verbally, capable of asking follow up questions, provide verbal empathetic feedback and produce nonverbal behaviours, the users were questioned about their health problems. Half of them were led to believe that the virtual interviewer was automated and controlled by AI, the other, that the virtual interviewer was tele-operated by a human.

The result of this experiment was a breakthrough in the way we look at a SIVA capability to create rapport with the users. Not only the users were more willing to disclosure with automated VH but they expressed more intense emotions of sadness (this was analysed by a Computer Expression Recognition Tool, which analysed expressions through video recording). This means that the "human" component was a strong factor on the willingness do disclosure, implying that the patients might feel judged or more

introverted when a human is listening. Furthermore, the AI used to control the interview in the fully automated scenarios, chose itself how to interact with the users with similar encouraging results.

3.8 Trust and Acceptance of a Virtual Psychiatric Interview

As the above study demonstrated, VAs have the ability to conduct clinical interviews. However, the factors influencing patients' engagement with these agents have not been assessed. Pierre Philip et al. [47] conducted a study whose objective was to assess in outpatients the trust and acceptance of VAs performing medical interviews and to explore their influence on outpatients' engagement.

The study followed a quantitative experimental design. Data was collected during two protocols. The first aimed to validate the efficacy of a Virtual Medical Agent (VMA) performing Major Depressive Disorder (MDD) diagnosis, according to the Diagnostic and Statistical Manual of Mental Disorder (DSM-5) criteria. The second focused on the validity of the VMA to perform screening and diagnosis for tobacco and alcohol use disorders, with an adaptation of the Cigarette Dependence Scale (CDS-549) and the CAGE50 questionnaires.

The interaction was based on a pre-determined scenario, with several options throughout the case depending on the user's answers but leading to a single end point. The interviews were adapted by sleep specialists and computer scientists to reinforce the credibility and benevolence of the agent. Both VMAs had a female appearance were displayed on a tablet and talked to the patient with a recorded real voice. The patient could answer the VMA's questions orally thanks to voice recognition. The virtual environment was generated by Unity 3D software (Unity-Technologies, 2014), and gestures were captured by motion capture technology.

A total of 318 outpatients were enrolled. The agent was perceived as trustworthy and well accepted by the patients, confirming the good engagement of patients in the interaction. Older and less-educated patients accepted the VMA more than younger and well educated ones. Credibility of the agent appeared to be the most influential component, enabling engaged and non-engaged outpatients to be classified. The results showed a high rate of engagement with the virtual agent that was mainly related to high trust and acceptance of the agent.

These results open new paths for the future use of VMAs in medicine.

3.9 A Virtual Human Interviewer for Healthcare Decision Support

To conclude the research on related works, we take a look at a study very closely related to ours.

SimSensei Kiosk is an implemented virtual human interviewer, who was designed by David DeVault et al. [48], to create an engaging face-to-face interaction and encourage disclosure from the interact-

ing user. Additionally, the interaction also intended to address distress indicators, defined as verbal and nonverbal behaviours, related with anxiety, depression or PTSD. SimSensei Kiosk is based on a general modular VH architecture, defining at an abstract level the capabilities of a VH and how these interact. These capabilities are divided in different modules: using the MultiSense framework, simSensei is able to perceive through audio and image, non-verbal behaviour such as smile intensity, head position and orientation, intensity or lack of facial expressions like anger, disgust and joy, speaking fraction, speech dynamics, gaze direction and many others; Natural language understanding, through continuous Automatic Speech Recognition (ASR) and dialogue management, using 100 fixed utterances that are implemented using the e FLoRes dialogue manager [49]; Finally, SimSensei Kiosk is capable of generating non-verbal behaviour including facial expressions, gaze, gestures and postures. It uses and extends the Cerebella behavior generation system [50, 51] that determines what behaviors a virtual character should exhibit. Most modules communicate with each other through a custom messaging system called VHMsg, which is built on top of ActiveMQ [4]. The Unity game engine [5] is used as the renderer for the system.

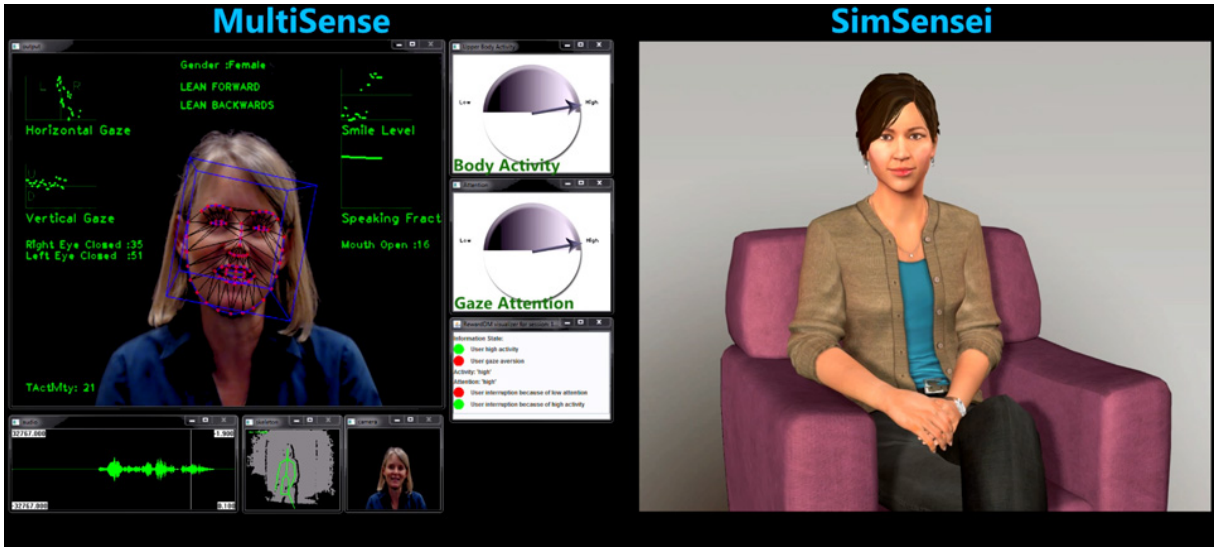

Figure 3.3: Interaction with a virtual interviewer [6]

Furthermore, David DeVault et al. [48] studied the potential of this automatic virtual human interviewer in a user study, collecting three interview datasets: face-to-face interactions with semi-expert human interviewers (referred to as Face-to-Face), Wizard-of-Oz interactions with a virtual human puppet controlled by the same human interviewers (referred to as WoZ), and "AI interactions" where the VH was controlled by the automated SimSensei Kiosk system (referred to as AI). With 351 participants, they achieved interesting results:

[4] https://activemq.apache.org/
[5] https://unity.com/
[6] https://guyrobottv.wordpress.com/2016/10/25/simsensei-a-virtual-human-assisting-with-depression-and-ptsd-therapy/

- In terms of subjective experience, participants reported willingness to disclose and general satisfaction with both the WoZ and AI versions of the system.

- In terms of rapport, participants reported feelings comparable to a face-to-face interview. Unexpectedly, participants felt more rapport when interacting with the WoZ system than they did in face-to-face interviews. One possible explanation for this effect is that people are more comfortable revealing sensitive information to computers than face-to-face interviewers [52].

- Unfortunately, the current version of SimSensei Kiosk did not perform as well as human wizards. This was reflected in significantly lower ratings of rapport and system usability. Participants also felt that the AI-controlled Ellie was less sensitive to their own body language and often produced inappropriate nonverbal behaviors.

3.10 Discussion

After researching the works and studies explained above, we manage to create a theoretical base for the construction of our MHeVA and have a better understanding of the capacity VAs have, to positively influence our lives.

They can be inserted in positions we are normally expecting a human to take and be accepted, allowing them to achieve results most of the time on par with their humans counterparts. This is exemplified by the language trainer Billie and the work on medical compliance where the use of a relational agent, which talked through text-chat predetermined inputs and had a 3D human female face, had a positive impact and was largely accepted by the patients.

However we also learned that although Technology-driven behavioral interventions, such as SimCoach and Laura, are being widely and rapidly developed and deployed, it is difficult to establish a set of best practices that marries technology development and the development of interventions to improve psychological health and influence behavioural change. Although SimCoach Beta software development was consistent with the DoD best practices [43] and the results of the study suggest that users had a satisfactory experience while using SimCoach Beta, participants in the RCT did not show greater intentions to seek help than users who did not receive any questionnaires or recommendations.

To overcome that difficulty we must always give importance to works like the one from Timothy W. Bickmore et al. [36], which proved that, when the VA shows perception of the user's identity, humans tend to perceive the agent as a more human-like identity. Or the one by Lisanne S. Pauw et al. [46], which findings suggest that cognitive and emotional support from a VA can be a valuable form of support at times of distress and helps to achieve behavioural change. However, it is important to explain that we will have to focus on cognitive support instead of emotional. Since we are dealing with mental

health issues, we were advised by a professional [9], to avoid emotional support, because it can imply misjudgement of a certain issue. One of the reasons why emotional reservation is often advise in psychological interviews [20].

The above mentioned works even mirror our efforts in similar environments, providing valuable information on how a VA can be accepted, establish rapport and obtain user disclosure. We managed to learn that even though it was shown that non-verbal behaviour, an important asset for a VA to obtain rapport, is hard to mimic in a natural way, there are other factors that can help contribute to achieve those objectives.

The promising results of these work serve as a motivation and support to our thesis. We believe it is possible to achieve our goal by creating a solution by them inspired but with a mental health focus. We theorize that a SIVA, as a Mental Health Assistant, will raise willingness to disclose in students and that the social interactions might achieve good levels of rapport.

4

MHeVA Architecture

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This chapter describes the architecture behind the proposed Socially Intelligent Virtual Agent (SIVA), which we will named MHeVA (Mental Health Virtual Assistant). In this type of work, it is important to start by framing the agent's role, following with the format of the expected interaction and requirements of the Virtual Agent (VA), so it can be adjusted to achieve its objectives. After that we will cover extensively the main component of the agent, the dialogue tree, explaining how it is organized and how the agent and the student's exchanges differ. Then we will briefly cover the appearance and voice components, as the deployment format. To conclude we will explain some final decisions and present the general structure of the agent.

4.1 Mental Health Support Assistant

Under the guidance of Instituto Superior Técnico's (IST) mental health support service, it was important to deploy the agent in a way that benefited best the systems already in place. The main challenges faced by psychologists at the moment, are the reach of the support provided and early identification of mental health issues in students, in order to prevent their worsening. Thus, a mental health support assistant accessible to students and able to identifying mental health issues was deemed our best option. Furthermore the agent should be able to advise students on how to deal with their mental health issues and forward them to mental health support professionals, if the issues are too severe. This would allow the agent to best support the system already in place and the work of the professionals on the field.

Due to the subject being of sensitive matter, it is important we be very cautious with our approach. Thus, we designed the agent to be focused on Anxiety related issues. It is the most common mental health problem affecting higher education students [9] and one less prompt to produce severe consequences.

4.2 Format of the Interaction

When dealing with mental health and disclosure about anxiety, there are two main things we must guarantee:

- It is important to give the one seeking help a certain degree of privacy, in order to protect their identity. Most people have stigma against disclosing about personal issues, because they are fearful of social judgement [11]. So in order to protect the student against this said judgment, or the prospect of judgement, every interaction and information must remain private and inaccessible to others. The only ones who should have access to sensible information are mental health professionals and even in those cases with the subject's permission [20].

- The interaction's environment should provide feelings of comfortness and be isolated from any type of distraction to promote disclosure. This way its assured that they are concentrated on the matter at hand and the one providing support has a certain degree of control over the exchange. To have control means they can apply their learned strategies to establish rapport, guarantee disclosure and identify the source of the problem [20].

Having named these requirements, there are several formats for interactions that provide mental health support. From one on one interviews, to simple questionnaires, to group therapies [20]. We believe, however, that a one on one interview will allow for better results, when using a VA. This, because, it allows for a better control of the interaction, better privacy, an ideal format to deploy a VA and it is only dependent on the student's availability and desire for help. This format also follows on the footsteps of several studies already made, that had positive results [5, 46–48].

In conclusion we will apply an one on one interview format, between MHeVA and the student, simulating a simple interview in an office, where the agent takes the role of an interviewer and asks questions to the student about himself and the problems that might be affecting him. We will ensure anonymity and hope this format will leave the student comfortable and focused, to establish rapport with the agent and disclose about their mental health problems.

4.3 Rapport Factors

Now that we established the interaction format, we will explain the needed requirements, for MHeVA to achieve it's goals, starting with rapport.

The ability to establish rapport is often considered to be one of the most important skills for effective interviewing. Rapport can be established through a range of interviewer behaviours, including courteous behaviour (honesty, civility, empathy), connecting behaviour (using humour, pleasant conversation, friendly interaction), and information sharing behaviour (offering advice, sharing knowledge, asking questions) [53].

We have to consider that some of these behaviours will not be replicated, due to the fact that we are creating a mental health virtual assistant. In the field of mental health support it is important for the interviewers to be devoted of judgement [9]. This means that emotions should be kept in check and MHeVA must be very cautious on its verdicts. For example we might be tempted to answer with positive empathy and congratulate a person that says it is in a long term relationship, but we don't know if that relationship is healthy or unbalanced. This kind of empathy and support is called **emotional support** [54] and our agent will be very careful with its use, applying it only when there is no space for misjudgement of misinformation.

The main behaviours that MHeVA will focus on will be **courteous behaviour** and **information shar-**

ing behaviour. It will try to exchange names at the start of the interaction, so it can refer to the student by their name, something that has a positive effect on the user's perception of an Agent [45]. It will always be courteous an professional, thanking every information disclosed and behaving with comprehension when the student is more reserved. Finally it will focus on the information sharing behaviour to establish the perceived rapport. Every time MHeVA feels it needs to build rapport, it will change the subject to non-sensible topics about the student, so the exchange of information might improve their relationship and the student's perception of the agent.

4.4 Disclosure Factors

Since our main goal revolves around disclosure we should understand what improves willingness to self-disclose to VAs. There are three important factors: (1)Trust in terms of security and confidentiality, (2) Credibility, normally associated with accuracy and organizational credibility and (3) Ability to listen to the user and react to their utterances [55].

We have to make sure, it is clear for the user, that all the information shared during the interaction will be protected and that their identity will be kept safe and hidden. Secondly, we can achieve credibility by associating our study with the mental health support service from our college and explaining the purpose of this research. Accuracy will be obtained by consulting our mental health support professional [9] and thus, keeping every utterance, behaviour and information provided by MHeVA, in accordance with the correct practises. Finally the ability to listen and react to the user utterances shall be obtained by follow-up interactions, that must adapt to the student's answers, thus making sure they feel they are being listened too (Fig. 4.1).

4.5 Dialogue

In order for communication to flow between the student and MHeVA, interaction must happen. Interaction can be defined as a kind of action that occurs as two or more entities have an effect upon one another [1] and this, when applied to a social environment, can explain what we are trying to achieve with these modalities. We want MHeVA to interact with the student, have an effect that allows the establishment of a certain kind of relationship, that in turn, facilitates the student to self-disclosure. To be clear, we will have two actors, the agent and the student, so, we have to define the interactions MHeVA is able to have with the student, and also the interactions the student can have with it. In a simpler way, we will define the agent's input and output.

The main modality of interaction will be dialog. We will opt for a scripted dialog that will present

[1] https://en.wikipedia.org/wiki/Interaction#Sociology

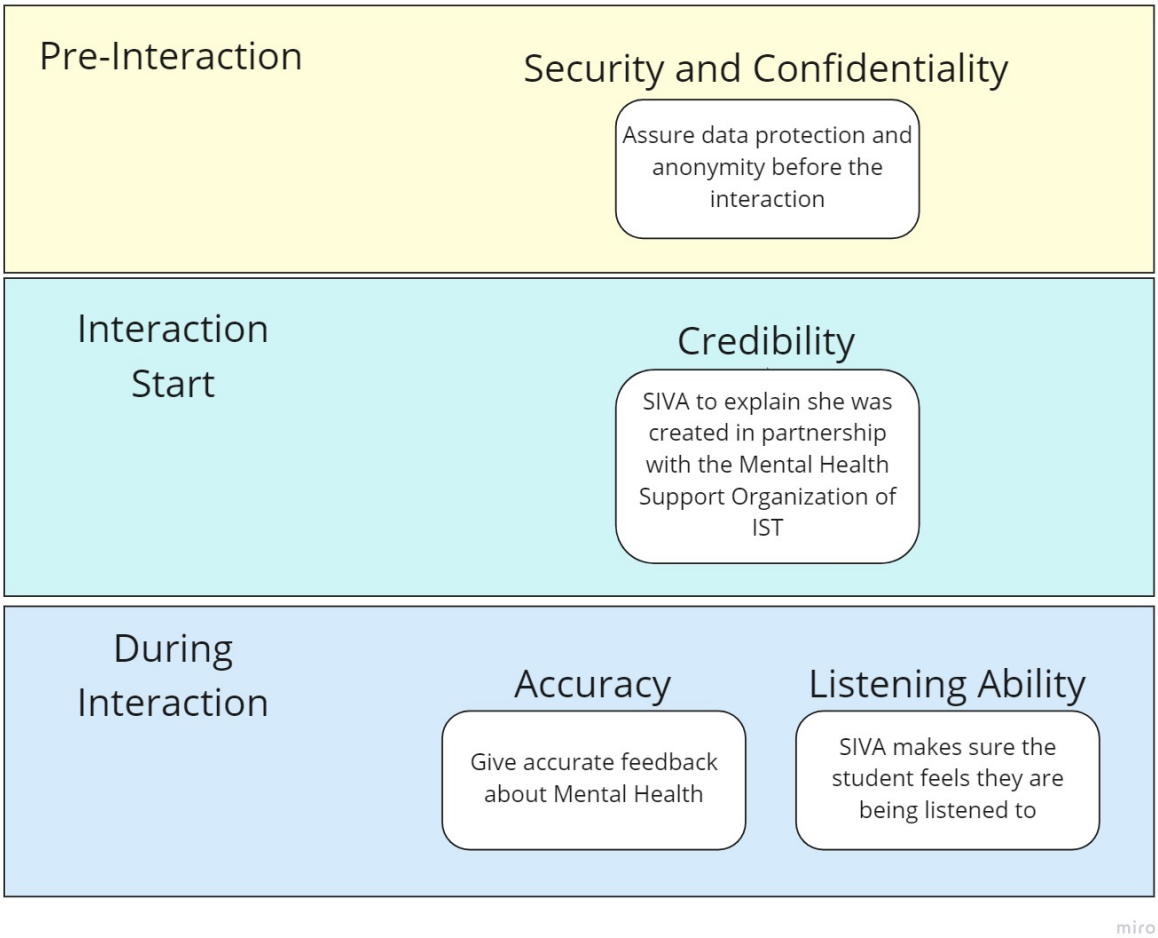

Figure 4.1: Disclosure Factors

MHeVA with choices to pursue its goals, and choices for the student to answer to the posed questions. The interaction will be turn based, where the agent will ask questions and the student will answer and none of them will be able to act before the other one finishes its utterance. This will generate a deterministic environment, where the next state of the environment is solely determined by the current state and the actions selected by the agents (MHeVA and student). The deterministic environment will allow MHeVA total control of the interaction an its possible outcomes.

4.5.1 MHeVA's Questions

MHeVA will interact mainly by asking the student questions. Questions that will fall in one of two categories:

- **Anxiety Screening Questions** - These questions will try to assess if the student has anxiety

problems and if so, what is the seriousness of it. They will cover a wide array of topics, related with the student's behaviours and physical or psychological consequences of anxiety. These questions will be selected by a mental health support professional [9], based on GAD, in accordance to their practises and all of them will help to measure anxiety levels. These questions shall only be asked if MHeVA has already established rapport with the student, in order to guarantee maximum disclosure.

- **Rapport Building Questions** - These questions will have the objective of creating a trusting relationship between MHeVA and the student. They won't cover sensitive topics as the questions above, on the contrary, they will have day to day topics of conversation. They will allow the student to share information about himself, that isn't related with mental issues, strengthening the bond with the agent [53]. Additionally, in order to take full advantage of every shared information, this questions will be oriented towards obtaining some insight on the origins of anxiety, if the students have any. For example, academic, social and parental relationship topics are normally perceived as day to day topics, but are often related to problems of anxiety and depression. So innocently speaking about this issues, might help MHeVA achieve both rapport and knowledge about anxiety problems.

Equipping the Agent with the ability to understand what is the best question for the current state of the interaction, will, we hope, make it successful towards reaching its objectives and making the student comfortable to self disclose.

4.5.2 Sub-Tree Dialog Logic

Our intention with MHeVA's interaction is for it to be close to a mental health related conversation and not to be interpreted as a mental health questionnaire. Hence, one thing to note about human conversations, is that not only are there socially sanctioned rules for appropriate topics of conversation, but also, in its course, it is impolite to make an abrupt change of topic even to another socially sanctioned topic [56]. This behaviour might endanger the healthiness of the interaction and the possible pre-established rapport.

MHeVA should always complete the current topic, before moving to another one. So in order to facilitate this process we will divide the dialog tree, into several sub-trees, that will be identified by a main question, covering a specific topic. Additionally, the MHeVA 's evaluation of its goals and the choice of what next question to pursue will only happen at the end of each sub-tree (Fig.4.2). The process will only end when the agent has asked enough anxiety screening questions to render a verdict on the student's anxiety levels.

Even though this structure is still more related to an interview than a normal conversation, since it

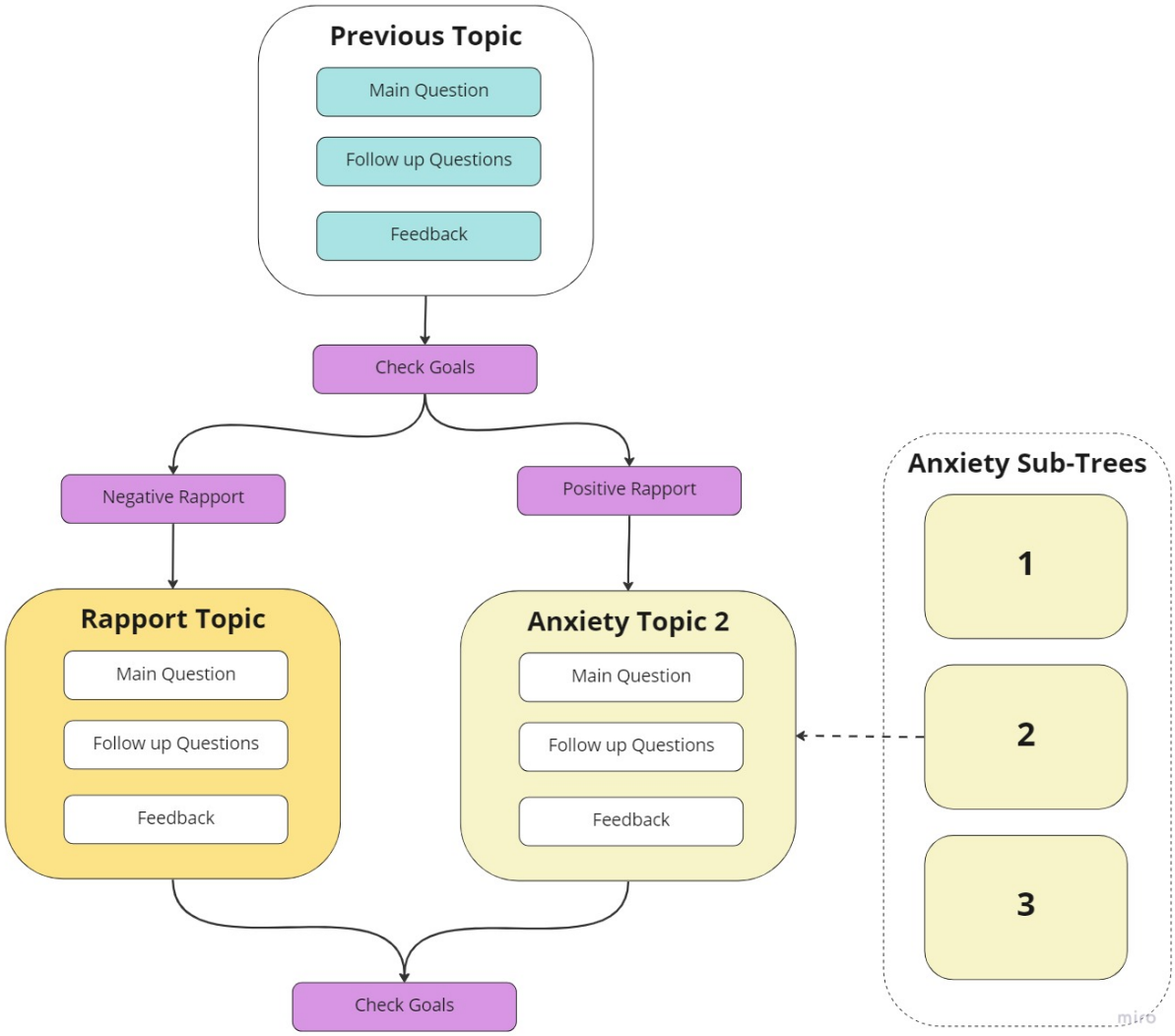

Figure 4.2: Sub-Trees dialog structure

revolves around MHeVA questioning the student, it is important to underline that students will reach our agent, already predisposed to talk about mental health issues. So they will be expecting some sort of an interview, knowing the agent's objectives. That help us assume the structure will provide a degree of fluidity to the interaction, that will allow for a better establishment of rapport.

4.5.3 Student's Answers

Since the projected application will use a controlled, scripted and semi-linear dialog tree, we will opt into more control, costing uniqueness and repeatability. However it is important to give the student enough choices of answer, so they can be honest about the information they share and so they can give the answer which would best represent their wishes, even if that response doesn't answer to the agent's

question.

For each question asked by MHeVA, the student will have available several choices of answer. They will compromise a representative range that although sometimes might not allow for precision, will always allow for veracity. We show an example:

- **MHeVA**: ”Have you ever had an anxiety attack?”
- **Choice 1**: “At least once”
- **Choice 2**: “Several times”
- **Choice 3**: “Never”

Furthermore, to every question there shall be a choice that allows the student not to answer to the given question (eg:“I don’t feel comfortable answering this question”). This is mandatory, because in mental health interviews we shall never force an answer from the interviewee. They shall only disclose information of their own accord [9, 20]. Forcefully demanding an answer from the student, might prompt them to give up on the conversation, choosing a dishonest answer or having a feeling of breached privacy.

4.6 Voice and Appearance

Besides the spoken interaction, it is important not to ignore aspects such as audio, visual morphology and animation aspects of the agent.

Studies have shown that, to some degree, high anthropomorphic levels, lead to perceive a VA as more competent and trustworthy [57]. In terms of vocalization, recent qualitative research suggests that humanness of synthesis leads users to associate VAs with intelligence and personality [58, 59]. Moreover, it can lead to greater learner perceptions of agent credibility in the context of a learning environment [60].

However, voice alone (human or machine generated) is not sufficient. Research confirms that for motivational and affective outcomes, in particular, the visual presence of an agent is critical; It can enhance one’s perception that ‘someone’ is socially present and collaborating in the same space [61,62].

Thus we will embody the agent with a human model, give it a computer-generated voice CGV and equip it with Lip-Sync animation.

4.7 Deployment

The higher education world is one deeply connected with technology and its students tend to be very proficient in it. When choosing our deployment method, which there are many, we have to have in

consideration the future of mental health support and the chosen format for the interaction.

One of our objectives is to not just mitigate the stigma associated with seeking help but also to ease the access to mental health support, empowering and sharing the workload that the professionals on the field are saturated with. This means that our VA should be of easy access to any student.

We will be using Unity 3D as the render engine for MHeVA, which allows us to build for browser (WebGL), computer (Windows, Mac and Linux), mobile (Android and IOS) or even deploy it with Virtual Reality (VR) or Augmented Reality (AR) components. Although the mobile version would allow for a faster and easier access, it would probably compromise isolation and lack of distractions, adding problems related to the screen size. Another interesting components to pursue, would be VR and AR, which have already proven that can allow for better immersion of the user [63], guaranteeing isolation and focus. Unfortunately they pose a great issue in terms of accessibility, since VR and AR sets are still not well widespread throughout the population. So that left us the most grounded choice of deploying MHeVA in a computer build. Having in mind almost every student, if not every single one, has a computer, is proficient in its use and this deployment allows a strong degree of accessibility and isolation of external factors. Although the browser and OS builds seemed good choices, we chose the latter for an easier debug process.

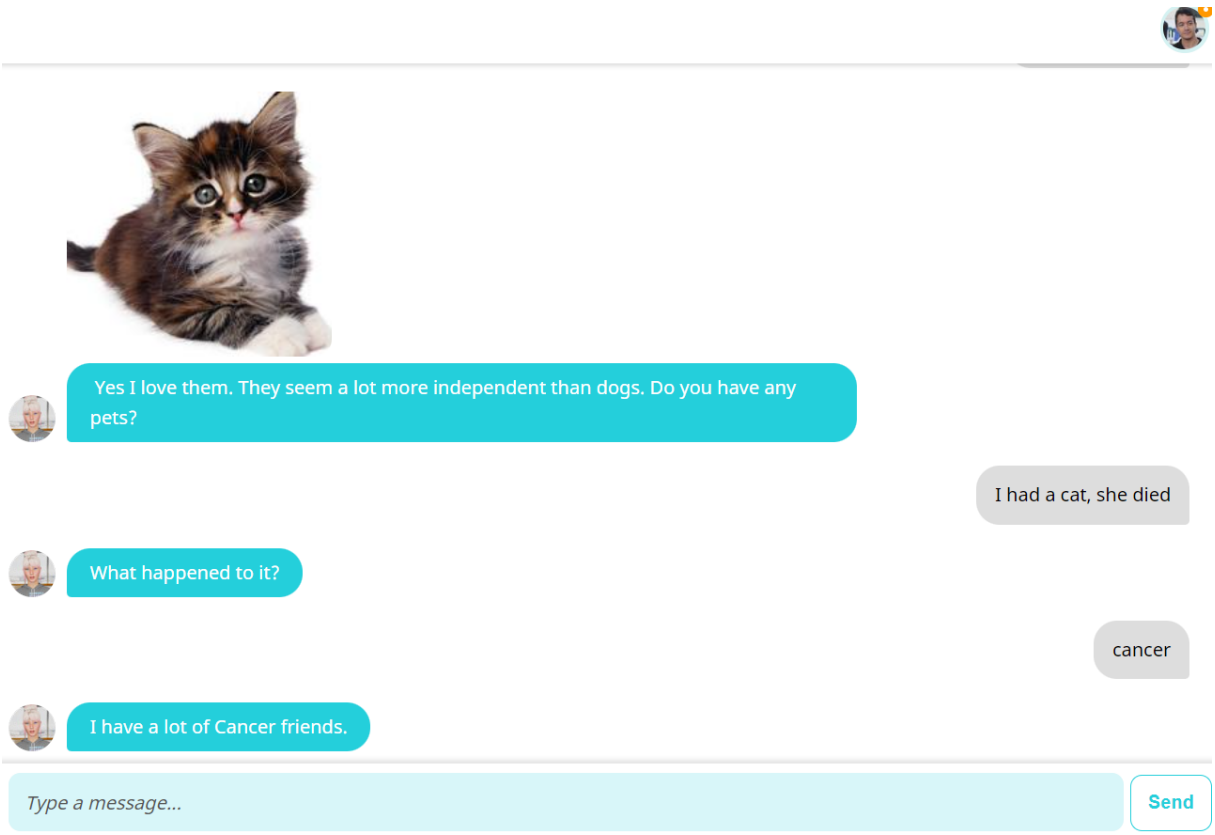

Figure 4.3: A small recorded interaction I had with the chatbot “Kuki AI”, 2021

4.8 Authorial Control

In general, it is of high importance to create an VA that seems both responsive and natural [55]. The value in robust conversational systems has been demonstrated in rapport building scenarios [19], however, we decided to avoid implementing a system based on natural language processing, for the following reasons:

- **Unwanted Interactions:** It is important to understand that when dealing with mental health issues, we must assure we have total control of MHeVA's interactions and interpretations. Any miscalculation, wrongful interpretation of the student's speech or even prejudicial reaction from the interviewer, might have dire consequences and dialog systems with natural language processing are still susceptible to those occurrences [64]. Here (Fig.4.3) we have an example of a brief conversation we recorded with the chat bot "Kuki AI" [2], an agent that utilizes natural language processing. After this last utterance any chance of rapport building disappeared and if we simulated a similar interaction in an interview dealing with mental health issues, the consequences would have been severe. Having that in consideration, we decided to implement a structured dialog tree, that we can assure it won't have misinterpretations or prejudicial reactions.
- **Complexity:** The construction or adaptation of a natural language processing unit is complex and time consuming. Moreover the use of natural language and a free-flowing input, means that we, human interlocutors, expect a more organic and natural conversation, becoming increasingly frustrated when they don't correspond to our expectations [65]. Consequently we found no befits in pursuing this kind of approach.

4.9 General Structure

Now we are able to understand the general architecture of our agent.

In order to achieve our objectives we are looking to design a VA that acts as a mental health support assistant, for college students. The simulated interaction will be of a one on one interview, were MHeVA will act as the interviewer and try to pose anxiety screened questions to the student, with the objective of quantifying the levels of anxiety of the interviewee. The structure of the interaction will be supported by the FAtiMA dialog manager and a dialog tree, that will enumerate all the possible utterances.

In terms of rational behaviour, MHeVA will create a mental model of the user's internal states and will consequently create beliefs about their levels of rapport and anxiety. This User State will help MHeVA better understand the social situation of the interaction and to choose the best action in order to reach its two goals:

[2] https://www.kuki.ai/

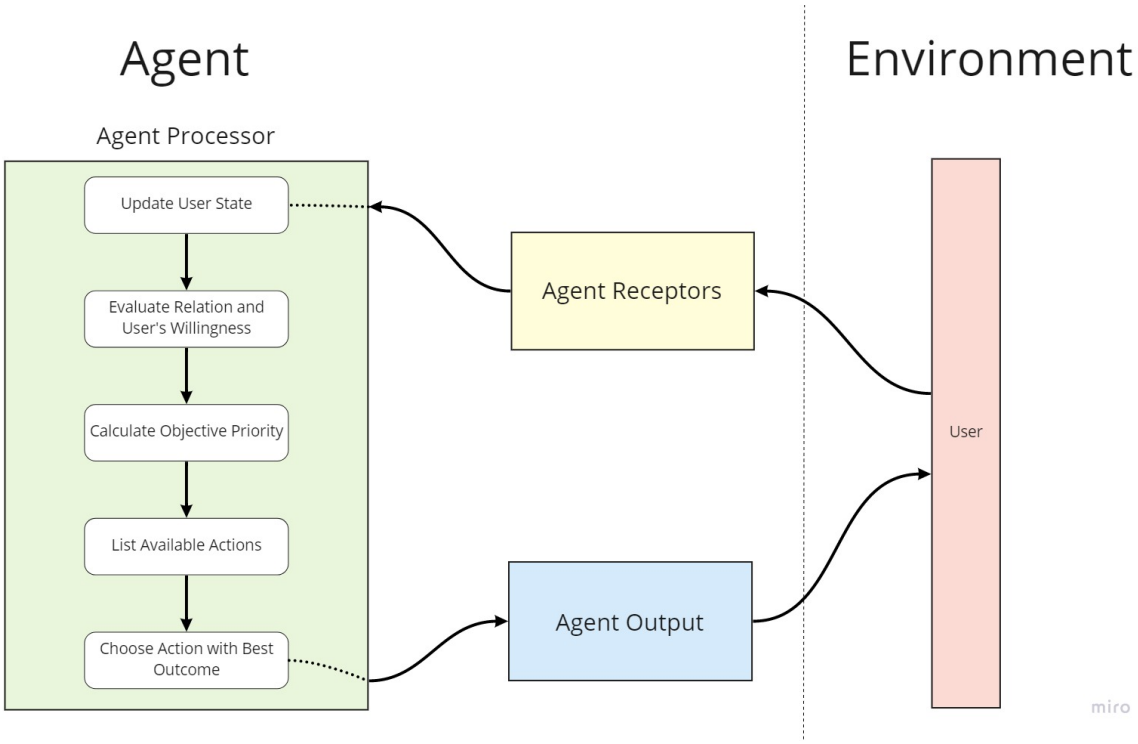

Figure 4.4: Diagram of MHeVA's Rational Behaviour

- **Rapport Creation**
- **Obtaining Disclosure**

Since disclosure is directly dependent on rapport creation [19], both goals are intertwined and can be achieved sequentially. It's first objective is to create rapport, its second goal is to obtain disclosure, changing between actions that will help it achieve the most urgent goal (Fig. 4.4). Once the interaction is concluded, MHeVA will advise the student on solutions to cope with their anxiety, based on its seriousness.

Our agent will be embodied, have a CGV and will be equipped with Lip-Sync animation, to achieve human likeness and, we hope, facilitate its anthropomorphization and rapport building.

It is important to underline, that we are in no way trying to create a Psychologist, only an Assistant.

5

Agent Modelling Tools

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The implementation and design of a VA is heavily dependent on the tools we use. Each architecture brings their strengths and weaknesses to the table and we have to be decisive when choosing one.

To create a MHeVA we need two tools: (1) An agent's architecture, responsible for creating the agent, the world model and the actions and rules both actors have to obey. It is also through this tool, that we implement the rationality behind our agent and give it the ability to adapt to different interactions, with different users. (2) A render engine. So that we can create a visual scenario where the agent can be embodied and use animations and voice. The render engine is also responsible for the User Interface (UI) that accompanies the User Experience (UX) and provides the necessary interface for the user to better understand and interact with MHeVA.

We chose FAtiMA Toolkit as agent's architecture and Unity 3D as the render engine to build the scenario. Here in this chapter we will give a small insight on each on each of them and explain how they define the implementation process. We will focus on the components that we will use.

5.1 FAtiMA Toolkit

FAtiMA Toolkit is a collection of libraries and tools, that help us to build believable and engaging characters, with an emotional understanding that makes them behave like humans [24].

One of the most important features of the toolkit is its authoring tool, in which it is possible to create intelligent characters within an interactive scenario. This tool connects several different FAtiMA components with each other, such as the **Characters** and its **Cognitive Rules**, the **World Model**, the **Dialog Manager**, the **Simulator** among others [66].

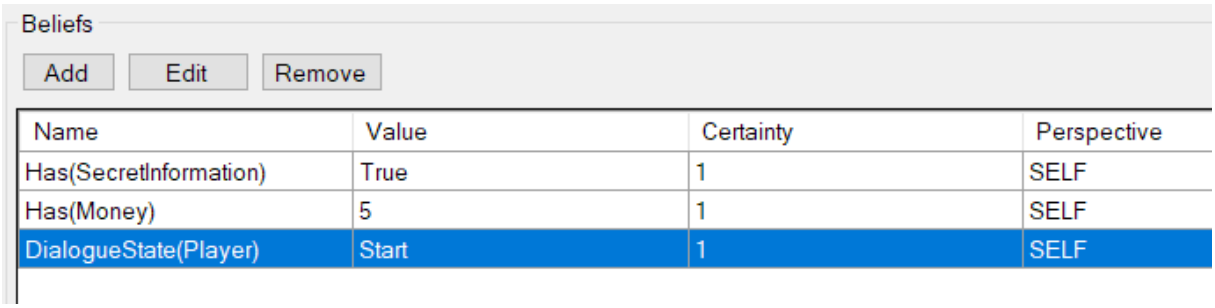

Figure 5.1: An example of several beliefs of a certain agent [1]

The **Dialog Manager** is a key component that uses a hybrid approach, combining the structure of a dialog tree, to the flexibility and richness of an agent-based solution. Essentially, a dialog tree ensures that after a player performs a dialog action d1, the agent will always respond with d2, without necessity for rationalization. However, FAtiMA Toolkit allows us to introduce rationalization on the moment the agent chooses its dialog action: We can still limit the possible interactions and build a certain narrative,

[1] https://fatima-toolkit.eu/4-internal-structures/

but the agent will be able to choose the best dialog action (from a list made available by the dialog manager), in order to reach its goal.

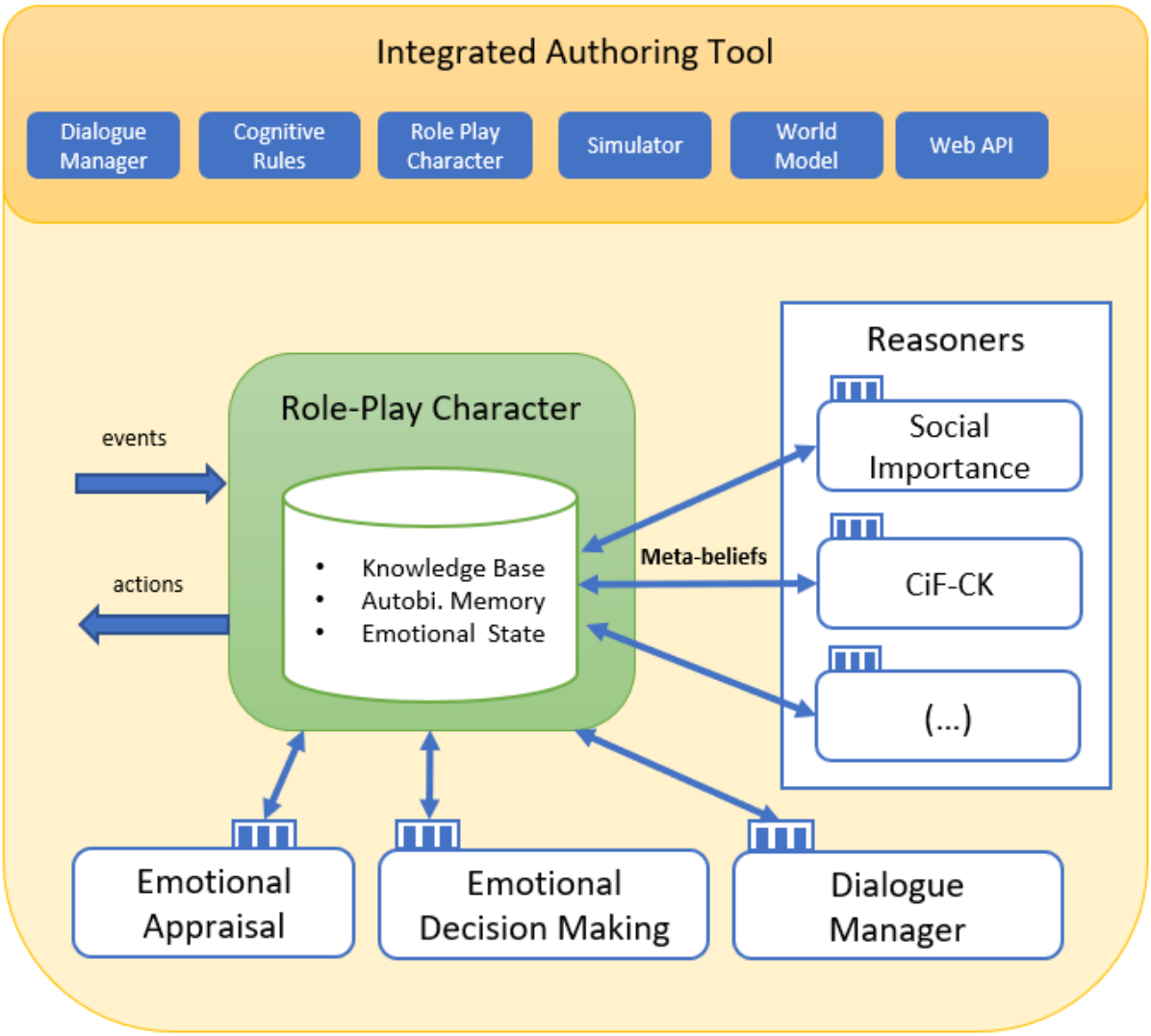

Figure 5.2: FAtiMA Toolkit components [2]

Each agent in FAtiMA has a **Knowledge Base**, another component that we will use. Its objectives are to store the agent's beliefs about the environment, namely properties of another agent and their relationship. In FAtiMA beliefs and events are described by "Well-Formed-Names" (WFN):

- **Symbols:** Represent constant entities (actions, objects, name of properties, name of relations). For example "Sam", "A1", "Table".
- **Variables:** Represent an entity or value that is not specified yet and can be replaced by symbols. For example "[x]", "[target]".

[2] https://fatima-toolkit.eu/1-what-is-fatima-toolkit/

- **Composed Names:** Represent properties or relations. For example “Likes(Emys,Chocolate)”, “Has(Sam, [x])”

Character’s created in FAtiMA, can use its decision making algorithm, which is influenced by this concept called **Belief**. **Belief** is a way to store information about the environment and the other agents/users, as the agent perceives it (eg: The belief that the user has a puppy at home). Each belief can have several arguments, including a certainty degree and which entity that holds it (Fig.4). We will use the **Knowledge Base** to store MHeVA’s needed information to understand the actual state of the conversation and the final anxiety values. It will also allow the agent to implement an ability, that in humans is referred to as a Theory of Mind.

Theory of mind is when an individual stores beliefs about the beliefs of another person [23]. Allowing a person to understand another, by building mental states associated with them. It will be quintessential for our agent to map an emotional state of the patient and decide, based on that information, what are the best dialogues and behavioural actions to take, in order to create rapport. FAtiMA Toolkit supports Theory of mind, agents are able to build mental states regarding other agents (or humans) through their Knowledge Base [24].

Although mainly used in interactive storytelling scenarios, FAtiMA Toolkit can be used in serious games and educational agents, since it grants the developers, the possibility to add decision making, emotional appraisal and responses, different reasoner components, among others [67].

To summarize the importance of this specific tool, FAtiMA will be the foundation for our MHeVA. It will be responsible for the rationalization, the scenario creation, the Dialog Tree construction and in the end it will glue every other tool together, to give life to our “Mental Health Assistant”.

5.2 Unity 3D

Aside from a Dialog Manager and an authoring tool to help us construct the scenario, we will need to render it and present the interaction in a simple and engaging way. That’s where Unity 3D comes in. Unity 3D is a cross-platform game engine developed by Unity Technologies, that supports a variety of desktop, mobile, console and virtual reality platforms, which include Windows, Mac and Linux. The engine can be used to create three-dimensional (3D) games, as well as interactive simulations and other experiences [68, 69]. It offers a primary scripting API in C# using Mono, for both the Unity editor in the form of plugins, and games themselves, as well as drag and drop functionality.

With unity we will be able to render and animate a Virtual Human model and add the sound files to simulate the voice. Also important, we will be able to create the UI, that will allow the player to talk with MHeVA and progress in the interaction.

We chose Unity 3D for the render engine, not just because it is a powerful engine that we are

accustomed too, but mainly because FAtiMA has tools that allow it to be integrated with Unity 3D [24]. Namely its modular architecture coded in C#, which allows FAtiMA Toolkit to work as an independent C# library and to be imported into other projects. Furthermore there is already a Unity Demo, which allows us to speed up the integration and already render the dialogues we create.

There will still be a lot of work to make our scenario completed, but this integration means we can code in C#, in unity Mono behaviour, and complement any shortcomings on the FAtiMA Toolkit. We will be able to access the beliefs, world model and agents directly and add, if necessary, new layers of complexity.

6

Implementation

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In this Chapter we will take a deeper look into how we implemented the MHeVA's architecture, described in chapter 4, using the tools described on the previous chapter 5.

We will detail the world model, with its states and actors and how we adapted our solution to the FAtiMA Toolkit framework. The several components that allow interaction and progress in the conversation, along the variables necessary to store all the data MHeVA needs to understand the student and choose the next action, will be listed.

We will not go into detail about the scripting necessary to build the scene in the render engine, rather focus on the intrinsic nuances about the agent's rationality and how they had to be implemented in the authoring tool.

One thing to note is that the nomenclature "MHeVA" was only created after the implementation phase, so all the variable references to the agent will be named as "Siva".

6.1 World Model

Since we will have a one on one interview, we will create a world model that adjusts to that interaction. There will only be two characters, or two actors, and the only action they will have to interact with each other will be "Speak".

6.1.1 Actions

It is important for a conversation to be turn based, where only one actor will be speaking, while the other will be listening. And after, when the speaking actor ends their utterance, it will be the other's turn to speak. So we will create a variable called "Has(Floor)", that will identify the speaking character. Both the MHeVA and the student will store this variable in their **Knowledge Base** as a **Belief**, and they should always have the same value, so they both know which turn is it to speak. The starting value will be "Siva" since our agent will start the exchange.

FAtiMA works mainly as a state machine, where the characters are in a certain state, that has certain values and when they act, they often move to another state, having an impact on the world model and on the other characters. Here the states are directly correlated with the **Dialogue Tree** and the utterances that will be spoken, so each change of state will represent an advancement in the **Dialogue Tree**. Furthermore both characters will share the state and will save it in a variable called "DialogState(A)", where the "A" will refer to the opposite character. The action "Speak" will have the current state and the next state, so the characters know what is the next step. Additionally the dialogues will have a **Meaning** and a **Style**, that we will cover later on.

There are three values to have in consideration when creating an action and they are all quite self-explanatory: **Subject**, the one that acts, **Target**, the target of the action and **Priority**, responsible for

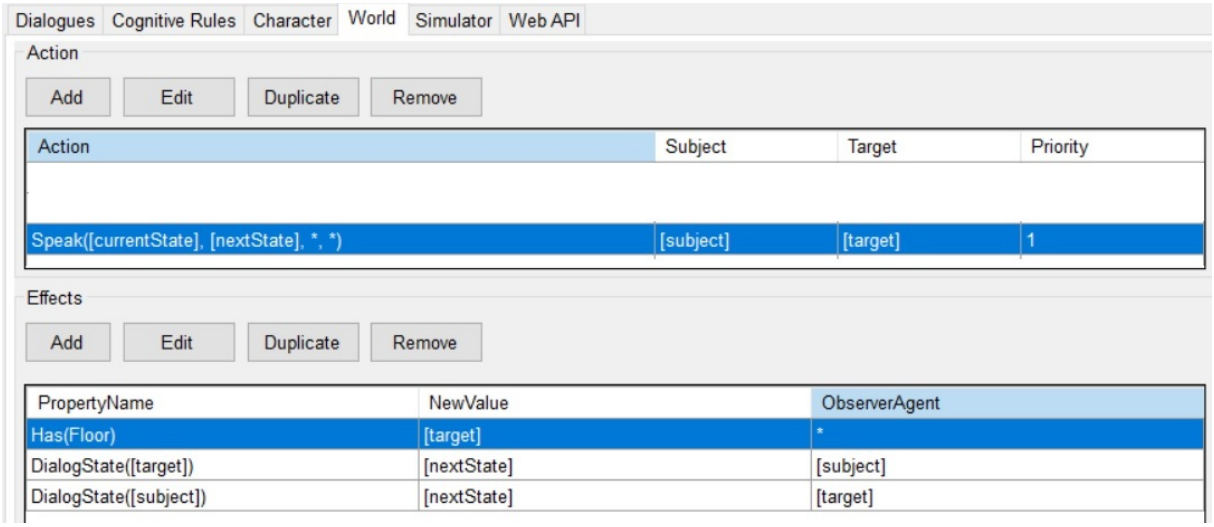

Figure 6.1: The base action in FAtiMA for speaking

deciding which action to take when there are several possibilities.

So with all this in mind we can create the action “Speak”, that will have three effects. The variable “Has(Floor)” will be assigned with the name of the other character and the “DialogState(A)” of each character will be updated with the next state (Fig.6.1).

6.1.2 Characters

Now that we established how the characters will act, it is time to create them both. There is a categorical difference between them, MHeVA will be an automated character, with a degree of artificial intelligence and the student will be controlled by the student themselves.

The student’s character just needs to hold in its **Knowledge Base**, the variables necessary for the user to interact and exchange dialogue with MHeVA, “Has(Floor)” and “DialogState(Siva))”.

On the other hand, the agent’s character needs several variables to operate:

- **Has(Floor)**, stores that character currently speaking.
- **DialogState(Student)** Stores the current state of the student’s character.
- **Rapport(A)**, stores the amount of rapport that MHeVA calculated it has been built. Starts at “0” and will increase and decrease in relation to the student’s positive and negative answers.
- **Anxiety(A)**, stores the anxiety level of the student, based on the anxiety screened questions answered. Starts at “0” and can only increment.
- **StudentName(A)**, stores the name of the student if they share it with MHeVA, otherwise stores the word “Student”.

- **StudentCourse(A)**, stores the name of the student's course, if they share it with MHeVA.
- **FamilyCause(A)**, stores the weight family issues have on the student's anxiety.
- **AcademicCause(A)**, stores the weight academic issues have on the student's anxiety.
- **SocialCause(A)**, stores the weight general social issues have on the student's anxiety.
- **PartnerCause(A)**, stores the weight romantic and relationship issues have on the student's anxiety.
- **AnxietyQuestions(A)**, keeps track of how many anxiety questions are still to be asked.
- **RapportQuestions(A)**, keeps track of how many rapport questions are still to be asked.

Most of these variables will help the agent build the student's State of Mind, helping it evaluate how the interaction is going and what is the next best action to take. It also helps it understand if its goals have been reached and when the conversation should come to an end.

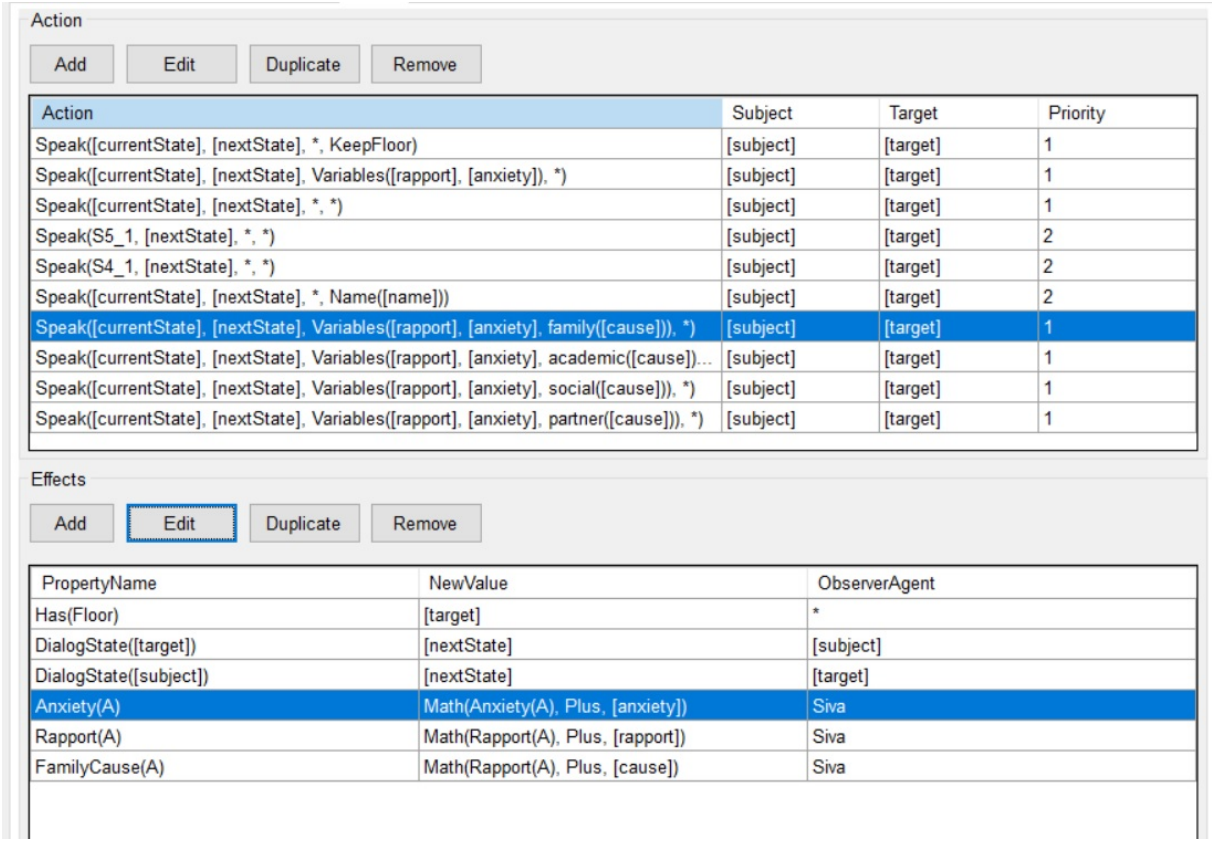

Figure 6.2: The action "Speak" with its effects on the MHeVA's variables

6.1.3 Additional Actions

Now that we have enumerated all the variables, we can add a new layer of complexity to the actions. The action above will only allow a character to say an utterance before surrendering the floor to the other one. So if we want to allow a character to say more than one utterance before giving the floor, we need to create a flag “KeepFloor” that will signal a continuity of the speaking power. We will store this flag on the action’s **Meaning**.

We have to allow the variables stored on the MHeVA’s **Knowledge Base** to be changed too, consequently we will use the **Style** of the action to signal this changes. Following the nomenclature **Variables([1], [2], [3])**, where each one of the three slots will have the value to be added to the respective variables. (1) Rapport, (2) Anxiety and (3) will be the causes of anxiety, that will need to be identified. So the example **Variables(1, 2, family(2))**, will increase the rapport value by one, the anxiety value by two and the family cause value by two.

The “subject”, “target” and “priority” will remain the same. The image (Fig.6.2) exemplifies the effects of said action, using the FAtiMA function **Math(variable, Plus, value)** to change the variables value.

6.1.4 Action Rules

We already have establish the effects and variables that the action ”Speak” has, now we have to establish the conditions that have to be met, for a character to use this action. This conditions are evaluated by the character’s themselves, so they have to be programmed in their perspective.

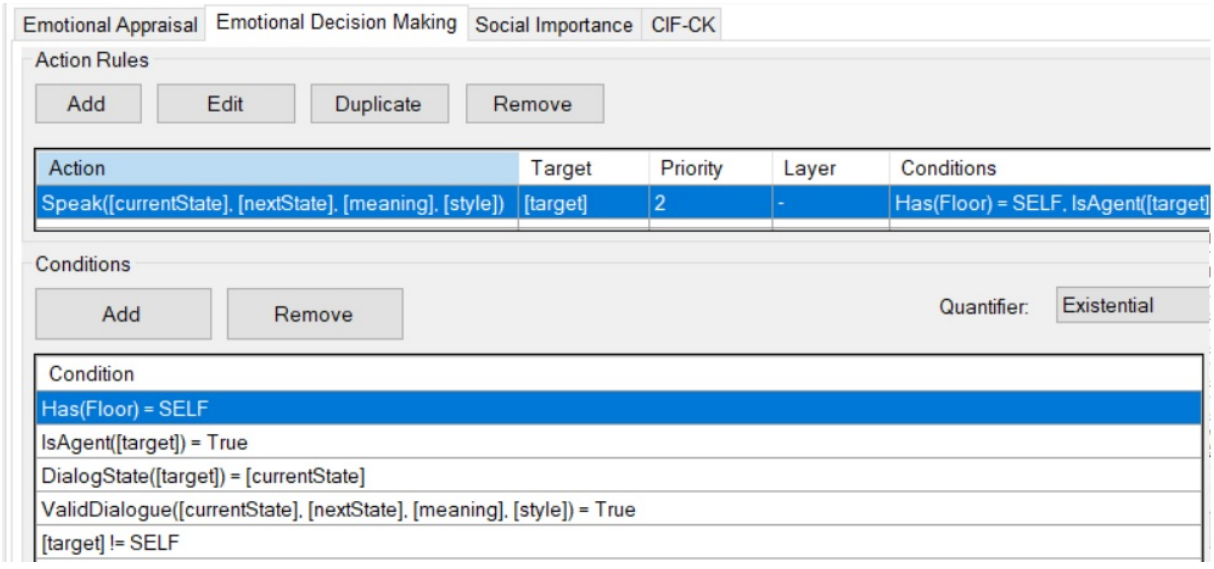

Figure 6.3: The conditions of the “Speak” action

Firstly the character must have the floor in order to speak. Secondly, the target must be a valid

character in the world and it can't be itself; so a character can't talk to itself. Thirdly the dialog state of the target must correspond to the current state, verifying that they are in sync. Finally the dialogue entry must be a valid one, with four variables: "currentState", "nextState", "meaning" and "style" (Fig.6.3).

6.2 Dialogue

The structure of the dialogue is the most complex component of this work. Since we implemented a structured **Dialogue Tree**, we had to make sure the tree was deep and dynamic enough to simulate a real conversation. It had also to allow for several ramifications, guaranteeing adaptability to the student interacting with the agent.

6.2.1 Dialog State

The structure of a **Dialog State** is given by five components:

- **Current State**, identifies the actual state of the current dialogue.
- **Next State**, identifies the next state to where the conversation will progress.
- **Meaning**, will store the values that increase of decrease the variables of MHeVA's student's State of Mind. These values will only appear on a dialogue state that has an utterance spoken by the student.
- **Style**, will signal if the next dialog state will also be spoken by the same character as the actual one, storing the variable "KeepFloor".
- **Utterance**, stores the actual sentence that will be spoken by the character.

Our Dialogue Tree has more than four hundred utterances, or dialog states, so we had to come up with a nomenclature that helped us situate the given dialogue and understand who is speaking it and in what context. It is divided into four important slots. The first one is a letter, that identifies the speaker; "S" for Siva and "P" for the student. The second one is a number that identifies the context of the utterance, more precisely, the classification of the sub-tree. The third one identifies the sub-tree itself and the last one is the specific state in the sub-tree. So the example **P5—4_2**, will be the second dialog state spoken by the student, belonging to the fourth anxiety sub-tree.

The following table (Fig. 6.4), lists all the possible identifiers of the dialog state nomenclature.

Slot	Value	Meaning
Slot 1	P	Student speaks
	S	Siva speaks
Slot 2	1	Introductions and Name Exchange Sub-Tree
	2	Initial Question Sub-Tree
	3	Main Decision Making HubSub-Tree
	4	Rapport Sub-Tree
	5	Anxiety Sub-Tree
	6	Depression Sub-Tree (Not Used)
	7	Anxiety Verdict and Conclusion Sub-Tree
Slot 3	1 to 6	Number of the Sub-Tree of the given classification
Slot 4	1 to 34	Number of the specific Dialog State in the Sub-Tree

Figure 6.4: Dialog State nomenclature explained.

6.2.2 MHeVA's Dialogue Types

Looking to build an agent equipped with the necessary utterances to be effective as a mental health assistant, we created four dialogue types, and classified them appropriately:

- **Main Question**, this is the utterance that starts a sub-tree, or a conversation subject and it identifies the main issue to be discussed. It is normally subdivided into rapport or anxiety oriented questions.
- **Follow-up Question**, these are much more numerous and give continuity to the conversation started by the main question. They are more specific and intended to deconstruct the issue being discussed to obtain better information about the student.
- **Responses**, usually simple utterances that give a general reaction to the student's answer, to give a sense of empathy and acknowledgement, and to make the student feel they are being listened to.
- **Informative Feedback**, although it is not the main focus of MHeVA to give feedback about the student's problems and help them find a solution to their anxiety issues, we found that it was important to not just ensure the student that MHeVA had important knowledge about mental health, but also that MHeVA could provide understanding about their problems and short term solutions in case the anxiety wasn't too severe. So these types of dialogue normally give clarification about some questions orientated towards anxiety issues and provide some feedback about how to deal with low levels of anxiety.

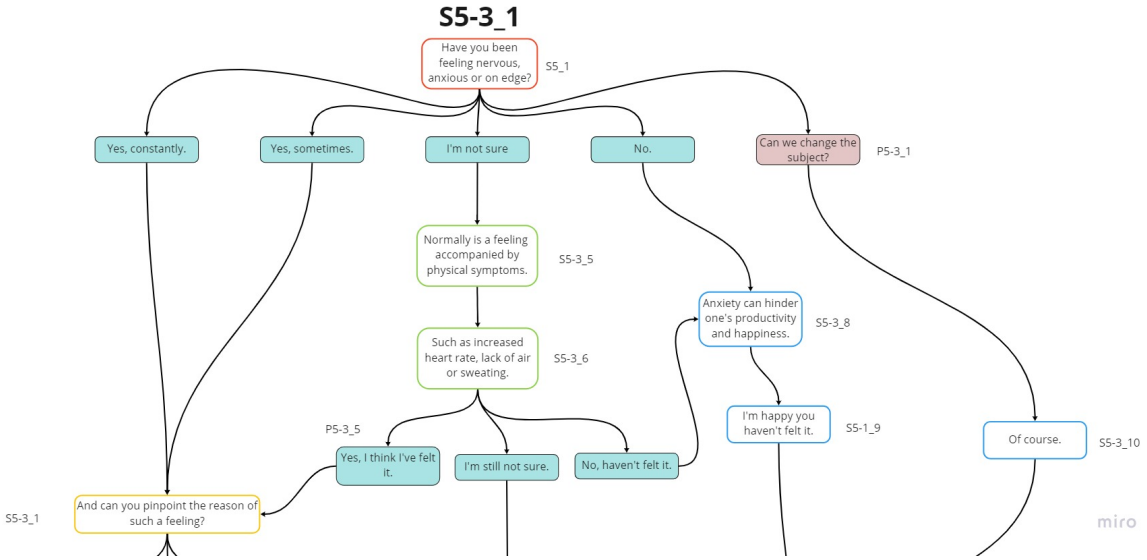

Figure 6.5: Examples of the types of answer, identified by the color of their border: Main Question (red), Follow-up Question (yellow), Responses (Blue) and Informative Feedback (Green).

This classification helped us to create a dynamic and healthy conversation. It helped us to better organize our dialogue tree and to better identify and debug problems that arose with specific interactions and utterances. It also allowed the mental health specialist that helped us build this agent, to better evaluate every utterance and give us precious feedback on how to better construct this MHeVA.

6.2.3 Student's Dialogue Types

Since linear and structured dialogues tend to sacrifice user's freedom of interaction for better interaction control, we had to make sure the possible answers the students had at their disposal, would be clear and could reflect their honest responses. So we created several types of dialogue choices classified in the following manner:

- **Positive Answer**, this is a response that gives an answer to the question previously posed and provides information for MHeVA to use. It normally encapsulates two to five choices, that offer a certain range of answer to the student. This dialog types increase the rapport perceived by MHeVA and can change the anxiety or cause of anxiety values.

- **Negative Answer**, this option allows the student to avoid the question at hand. It does not give any specific answer, normally asking to change the subject and move forward with the conversation. This choice always decreases the perceived rapport, does not influence the anxiety value but might increase the cause of anxiety value, since MHeVA might perceive the avoidance as a signal that the question asked had a sensitive subject.

- **Null Answer**, although the least common, we created on several questions, the chance for the student to answer honestly that they don't know the answer to the given question. In most cases this answer is followed by informative feedback from MHeVA, but lastly, it can be the definitive answer from the student.
- **Open Answer**, we wanted to allow the student to answer more precisely to questions more specific. Firstly to obtain necessary personal information, for example the student's name and college course. Secondly to allow more freedom and obtain more quantity of information, that most of the times is too specific to the person being questioned, for us to generalize in pre-made choices. Unfortunately MHeVA won't be able to react accordingly to this open answers (except the ones about name and course), since it does not have natural language understanding.
- **Clarification Question**, since we are dealing with problems that often aren't identified by those who suffer them, it is important to allow the student to clarify and receive more information about the mental health problems and symptoms.

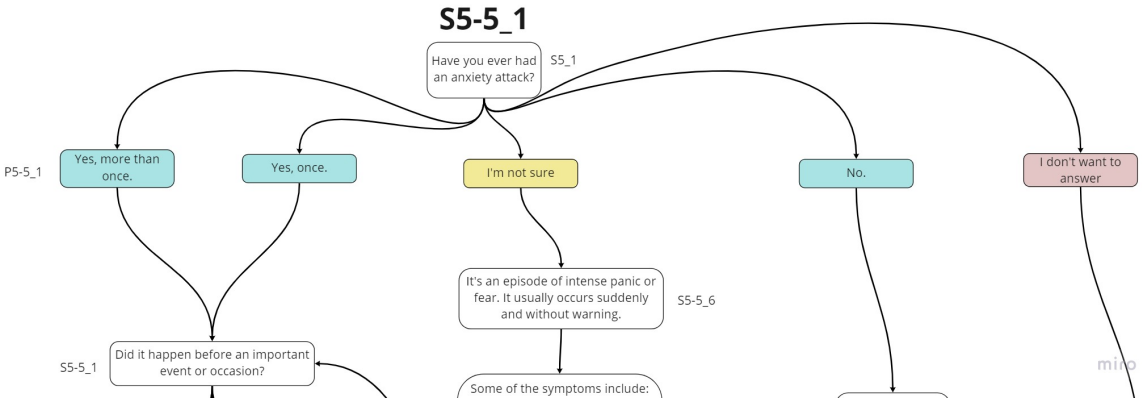

Figure 6.6: Examples of the types of answer, identified by the color of their box: Positive Answer (blue), Negative Answer (red), Null Answer (yellow).

This classification helped us to better organize the student's answers and to better identify and debug problems that might arise with specific interactions or utterances. It also allows the user testing to offer more precise feedback on the freedom and precision of the answers available to the users.

6.2.4 Dialogue Organization

In order to have a insightful overview of the dialogue tree, we need a way to visualise its many branches and ramifications. This can provide us a faster way to debug the conversation and understand its strengths and weaknesses. Otherwise we wouldn't be able to efficiently change and add complexion to a dialogue tree with several hundreds of utterances.

We utilized “Miro”[1], a collaborative whiteboard tool, to draw all the sub-trees of our conversation, using the above listed nomenclature. We represented the utterances with boxes and the available progress with connected arrows. This simple representation was also available to our mental health support professional [9], which they used to give us feedback on several utterances and exchanges.

Although FAtiMA Toolkit is equipped with generate a dialogue tree from the dialog states created, its representation is quite basic and the sheer size of our tree meant we had to use something more flexible.

We annexed most of our dialogue tree, in its “Miro” representation, to this work.

6.3 Decision Making

Every conversation has its own particularities and every person is different. We want our MHeVA to adapt to every student and make choices about what to ask, having in mind the cumulative answers the student is giving. In order to keep control of all MHeVA’s responses, the process of decision making will only happen between sub-trees, this way we will also guarantee consistency on the conversation.

The sub-tree **3** is the main hub for this decision making. Once a sub-tree ends its dialog, it will come to this one. As the first state of this sub-tree is reached, several variables will be evaluated and the agent will chose one of three types of sub-tree to start next. To achieve this processing power we will use the **Emotional Decision Making** from the FAtiMA Authoring Tool, that will allow MHeVA to choose the next sub-tree based on pre-established conditions and their priority.

Next State	Priority	Conditions
S5_1 (Anxiety sub-	3	Base conditions Rapport must be superior to 0
S5_1 (Anxiety sub-trees)	3	Base conditions No more rapport questions unused
S4_1 (Rapport sub-trees)	3	Base conditions Rapport smaller than 1 More than one rapport questions unused
S7_1 (Anxiety Veredict)	4	Base conditions No more anxiety questions unused

Figure 6.7: The conditions and priorities for the MHeVA’s decision making. The base conditions are the ones necessary for a normal ”Speak” action to occur.

[1] https://miro.com/

The three possible outcomes are the choice of a rapport oriented sub-tree, an anxiety oriented sub-tree or the final verdict on the levels of anxiety of the given student.

- **Rapport sub-tree**. For the first outcome there is only one condition, the null or negative rapport between MHeVA and the student. Each positive answer from the student will increase the rapport by one and any negative answer will decrease by the same amount. The main objective of MHeVA is to obtain disclosure from the student, so, although normally correlated, rapport is secondary, meaning it is possible for an interaction to end without any rapport sub-tree being used. Initially this variable was unlimited, meaning one could obtain great values of rapport and never being able to then lower it to negative values. We understood that this lacked realism, since people might become defensive faster, even if they had been able to disclose. So later on we limited the rapport values between -2 and 2, so it was more responsive to the most recent interactions.
- **Anxiety sub-tree**. For the second outcome there are two ways to reach it, each with a unique condition. If the rapport is positive, then MHeVA will interpret that there is room for disclosure and so move to anxiety screened questions. Alternatively, even if the rapport is null or negative, if there are no more rapport orientated sub-trees, there is no point in trying to increase rapport; and since stopping the interaction without trying to obtain disclosure is contra-productive, MHeVA will try to pose anxiety screened questions, if those haven not been asked yet.
- **Final Verdict sub-tree**. At the end of the interaction, once MHeVA tried to obtain disclosure about the student's anxiety issues, it will give council to the student about their tribulations: Revealing if there are signs of anxiety, how serious they appear to be and how to best cope with them. MHeVA will move to this sub-tree once it has asked at least five anxiety questions, a number we agreed, with our mental health professional [9], to be a good one to obtain enough information without compromising the patience of the student, by making too many questions and extending too much the interaction.

All their priorities are quite high because they need to be chosen over the other decisions on normal conditions. If this wasn't the case any choice would be valid, since they all respect the base conditions that a dialog must have. Also important, the choice of the final sub-tree (final verdict on the levels of anxiety), should always be prioritized, because it condition implies that the main objective was reached. Which is that at least five anxiety questions were asked.

6.4 Anxiety Evaluation

Our goal at the end of the conversation is for MHeVA to give council to the student about their tribulations, revealing if there are signs of anxiety, how serious they appear to be and how to best cope with them.

Next State	Value	Level	Advise
S7-1_1	0	Inexistent	Attention to signals
			Don't be afraid of seeking help
S7-2_1	1 to 4	Not Troublesome	Activities and behaviour to improve anxiety levels
			Seeking help if anxiety issues start negatively affecting their life
S7-3_1	5 to 7	Anxiety Crisis	Activities and behaviour to improve anxiety levels
			Against isolation
			Seeking help from professionals
S7-4_1	More than 7	Severe Anxiety Crisis	Compreension and calmness dealing with the news
			Not being afraid of asking for help
			Schedueling na appointment with a psychologist from their college

Figure 6.8: The several outcomes of the conversation and their respective anxiety levels.

For this we have inserted another fork on the dialogue tree, where the final MHeVA's dialog states are dependent on the anxiety score of the student.

Although there are several ways for a psychologist to diagnose anxiety on someone, answering positively to anxiety screened questions is one of them and a reliable one. So with the help of our mental health support professional [9], we came up with a score to a variety of questions that, in the end, will sum up to give MHeVA the anxiety level of a student. There are main questions and follow-up questions about a variety of issues ranging from physical to psychological pathology.

There are six main questions, based on GAD: (1) Recent tiredness, (2) Feeling something bad and inexplicable is about to happen, (3) Recent feelings of nervousness, (4) Frequency of getting upset, (5) Anxiety attacks and (6) Sleeping difficulties.

The following table show the levels of anxiety and their outcomes on the sub-tree 7 (Fig.6.8).

6.5 Unity Implementation

As mention before, in order to render the interaction we used Unity 3D, which FAtiMA toolkit is ready to be integrated with. We just have to install FAtiMA plugin and all the .dll files will be on the right folder.

FAtiMA toolkit creates two .Json files, one containing the information about the scenario, characters and dialog states; and another storing the cognitive rules of the interaction. The path to both files must be incorporated in the unity scripts.

6.5.1 Modelling and Animation

We will use the already existing human model, that the FAtiMA Starter Kit Source for Unity brings. This model is already equipped with a rigged 3D model of a male human that allows for simple body animation and lip-sync animation.

We will not use any major animation, since it is a simple interview interaction, however, we will use the lip-sync to its maximum, so we can achieve some realism pairing it with a CG Voice.

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <LipSyncVisemes wavFile="TTS-5D41402ABC4B2A76B9719D911017C592.wav">
3    <viseme type="12" time="0.1" duration="0.07" />
4    <viseme type="4" time="0.17" duration="0.065" />
5    <viseme type="14" time="0.235" duration="0.095" />
6    <viseme type="8" time="0.33" duration="0.2" />
7  </LipSyncVisemes>
```

Figure 6.9: The .XML file of the utterance ”Hello”.

6.5.2 Lip-Sync Animation

When we generate the Text to Speech (TTS) files, FAtiMA Authoring Tool creates two distinct files, an .WAV audio file, with the CG Voice speaking the utterance and a .XML text file. The .XML file has the necessary information for unity to run the right animations and play the sound file. It has the sound file name and the visemes [2]. The visemes have three variables: (1) Type, (2) Starting time and (3) Duration. The image (Fig.6.9) gives an example of the .XML file for the utterance ”Hello”, where the first viseme is the ”H”, the second ”EyEhUh”, the third ”L” and the last ”Ow”.

This logic is already implemented in the FAtiMA Starter Kit Source, however we had to understand this logic to make a few adjustments, since we wanted to use the student's name and it was impossible for the Unity 3D build to generate the TTS files in run-time, using the recently obtained information. So the solution was to edit the sound file and the .XML file, to silence the use of the variable “StudentName(A)”, so the variable can appear in the subtitles but the agent won't pronounce it (otherwise the sound file would utter the “StudentName(A)”, which is the name of the variable. We silenced the use of the name using a sound editing software called **Audacity**[3] and we erased the corresponding visemes from the .XML file.

6.5.3 User Interface and Interaction Rules

In order to make the interaction accessible we built a UI that helped the student to navigate the conversation, chose its dialog options and understand better what MHeVA uttered.

[2] A viseme is any of several speech sounds that look the same, for example when lip reading (Fisher 1968).
[3] https://forceclaw.com/

The UI is quite simple and divided into two frames, the User's Frame and the MHeVA's Frame. The User's Frame is situated on the left side and its composed of (1) **Choices**, rendered as dialog boxes, and (2) the **Next Button**, that allows for the user to progress in the conversation, when MHeVA speaks consecutive utterances. The MHeVA's Frame is composed of the VA 3D Model and the subtitles of it's utterances, so the user can read what was said, in case it didn't understand something through the CG Voice.

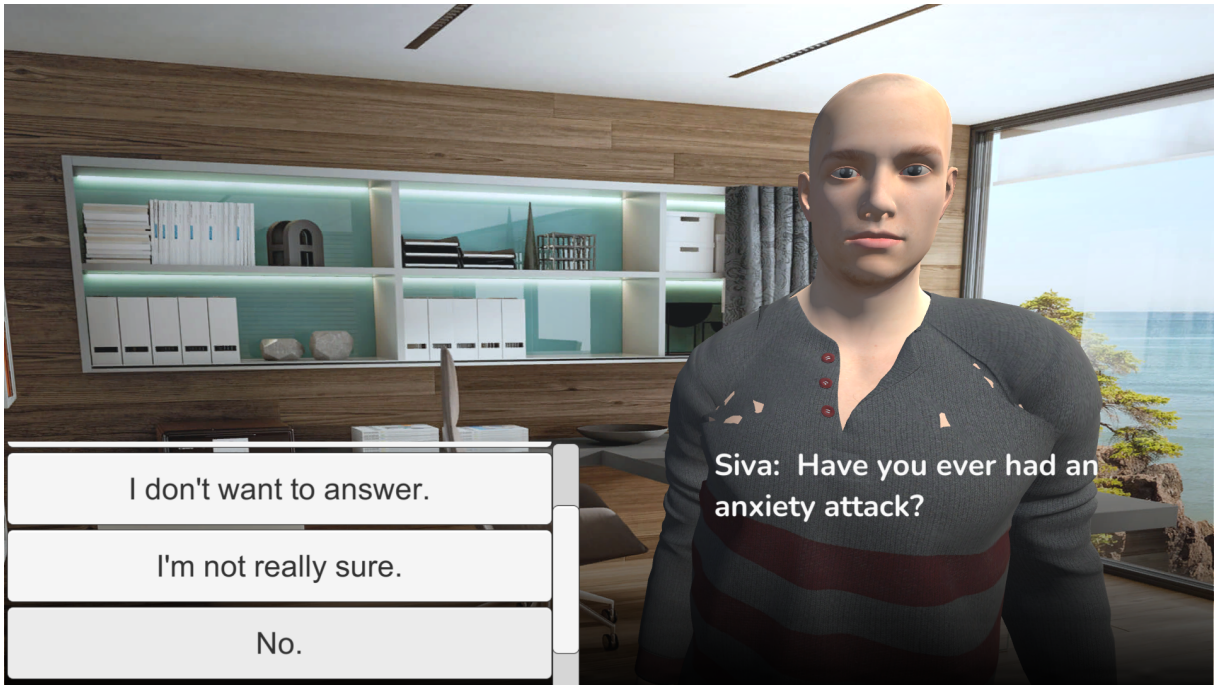

Figure 6.10: The final Unity 3D build of the MHeVA interaction.

The **Next Button** is an important element to allow the user to progress at their own pace. Sometimes MHeVA will speak several utterances in sequence, before surrendering the floor to the student and those utterances are separated in sound and text, so in order to allow the student to only progress to the next utterance after reading or hearing everything, this button is the only trigger that advances the conversation if MHeVA is speaking several utterances. However clicking this button will only take effect after MHeVA finishes the current utterance, to allow consistency of interaction and avoid interrupting MHeVA, otherwise the student might not hear something important. Additionally it is important that the interviewer controls the interaction in psychology interviews [20], so if the student was able to interrupt MHeVA's utterances, the agent would lose control of the interview.

6.5.4 Open Answers

As previously explained, we wanted to allow the student to answer more precisely to questions more specific and implement an open answer possibility. Although FAtiMA Toolkit is not ready to receive written utterances by the user, we can implement that functionality through Unity 3D.

We have a script that processes the choices made and applies their effects on the Student State variables. To allow for open answers we created another function that stored the input written by the student. If it was the answer to their name or their academic course, the script will update the belief related to this information, otherwise it will store the answer on the output file. The script will know its an open answer if the utterance of the current state is precisely **(Open Answer)**, consequently it will generate a text input box where the student can write their answer.

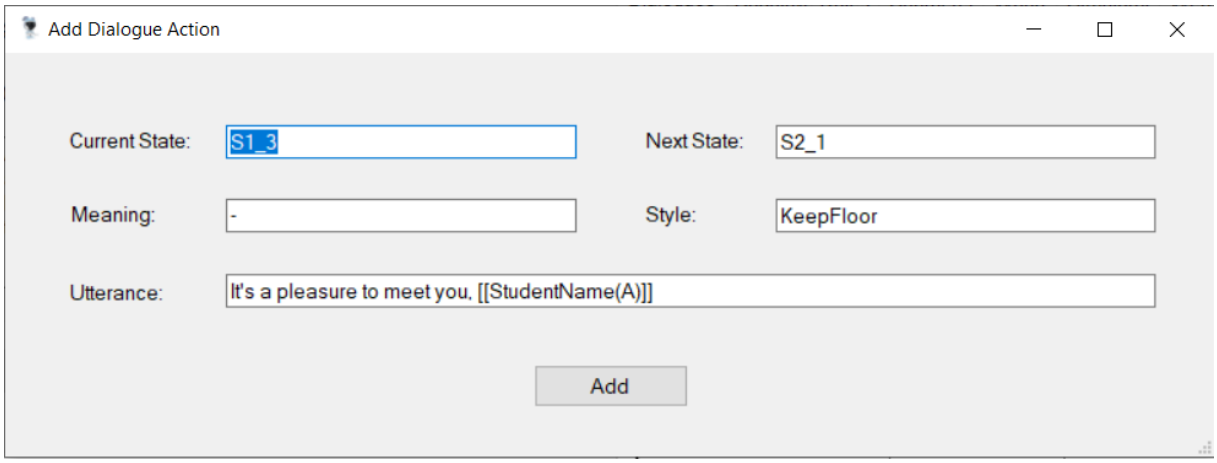

Figure 6.11: The use of a variable in an utterance, in FAtiMA Authoring Tool.

To use the student's name, FAtiMA needs to know when to use the variable "StudentName(A)". So in the utterances we want it to use, we simply have to put the variable between two sets of square brackets, as the image shows (Fig. 6.11). At run-time the the variable reference will be replaced by its value, the student's name. In case the student does not feel comfortable sharing it, MHeVA will use the default name "Student".

Unfortunately, for FAtiMA toolkit to store a certain variable, there can't be any empty spaces so we had to replace them by underscores. Meaning the name "André Antunes", will be stored as "André_Antunes", which is a minor setback but we believe it won't hinder the interaction.

6.5.5 Writer Output

It is important that in the end of the interaction, we are able to obtain information for research purposes and perhaps in the future, if SIVA is deployed on the field, for it to send valuable information to the mental health support professionals of a given higher education institution.

There is specific data that is advantageous for our study, that does not break the anonymity of our users' participation. That data is:

- **Rapport and Anxiety Values**
- **Duration of the Interaction**
- **Choices Selected**
- **Duration of each Choice**

To achieve this objective we scripted a "Writer" class in Unity that would output all this information, during the interaction, into a text file. While this class did not have access to the FAtiMA Toolkit variables, it was notified when to write and what to write by the main class "ManagerScript", which was able to access and even edit those variables.

```
P5-6_3resposta: Sometimes.
7.511978
P5-6_4resposta: Yes.
5.664658
P5-6_5resposta: (answer)
3.676208
P5-6_5resposta: (answer)
16.43091
Answer: Classes and other academic issues
16.43091
P5-3_1resposta: Yes, sometimes.
3.519562
P5-3_2resposta: Yes.
2.238342
P5-3_3resposta: (answer)
3.654388
P5-3_3_1resposta: (Open Answer).
0.6224976
Rapport: 2
Made: 5 anxiety questions
Anxiety Level: 6
Conversation total duration: 374.2834
```

Figure 6.12: An example of an Output.txt generated at the end of the interaction.

In the end, one an interaction is over, a text file called "Outuput.txt" is generated, with all the above mentioned information. The image (Fig.6.12) shows us an example of what is printed by MHeVA. As we can see all the personal information is not printed, so the identity of the user remains secured as promised in the begging of the exchange.

6.5.6 Professional Advisor

It is important to understand, that during all the process of ideation and implementation, we were advised by a mental health professional from IST psycopedagogical support department.

The objective of this consultation was to make sure we understood how current systems deal with mental health issues in higher education. The subject of this thesis is of a sensitive matter, thus it was important to make sure we properly addressed and were aware of any potential issues during the development, implementation and testing phases. Thus, we asked for the expert to validate each step of the process. It was specially important to make sure the VA acted accordingly with psycopedagogical practices and didn't endanger the students it was supposed to help.

In order to achieve the previously stated goal, we met early on to understand how the system was dealing with student's mental health issues and what were is main difficulties. Taking this information into consideration we then tried to understand how could a VA be deployed on the field and were should be its focus. Mental health issue identification and mental health support guidance were the objectives that we believed to be attainable and best fitted our VA, so it could maximize the help provided to the current system.

We were also advised into dealing with a single mental health issue, to lower the complexity of our study and be more objective. Anxiety was chosen precisely because it was the most common problem and its consequences weren't as severe as other ailments.

Combining this professional insight with out study of VAs, we came up with the general architecture, interaction format and method of deployment. At this stage the professional advised focused on giving us guidelines for the VA's behaviour, so it would not produce undesired interactions. Additionally she shared with us the best questions to identify anxiety and what the answers would mean.

The implementation phase followed and we built our MHeVA with all the data we collected. After the dialog tree was constructed, the mental health professional examined every utterance and made corrections. These corrections, were mainly aimed at avoiding undesired emotional support, correcting mental health advises given by MHeVA and making sure the agent would not influence the student into giving certain answers.

Once the implementation as concluded the mental health professional helped us gather students for the last testing phase, which was focused on students that were already diagnosed with mental health issues.

7

Results

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Once the implementation was concluded, in order to understand if the agent was effective and efficient towards accomplishing the objectives set out by this thesis, we had to evaluate its performance through testing and statistical analyses.

Since its objectives are heavily dependent on user interaction, it was clear that we had to implement a user testing methodology, where we gather feedback from our users through a self-reported survey, that followed a direct interaction with MHeVA. The interaction should mimic the ideal scenario of deployment, without external interference that would endanger the agent's performance.

Additionally, there was some data that we needed to obtain actively through scripting, namely data gathered by MHeVA and general data about the interaction duration. This data would later help us obtain a more practical registry of the interaction's details.

The main goal of the testing phase was to understand **if students were willing and able to disclose mental health issues with our agent**. Additionally we posed several questions that would help us evaluate MHeVA's performance and which factors had an impact on the main goal:

- Will a SIVA be Accepted as a mental health support assistant by college students?
- Will MHeVA be able to create Rapport with students?
- Will MHeVA be capable of measuring anxiety levels?
- Will MHeVA help to fight the stigma related to searching for help about mental issues?

To answer these questions, we realized two different testing phases. One in August and another in October. The first had a greater number of testers and was participated by college students, indiscriminately selected, so we could try to represent the general higher education community. Nonetheless, we felt it was important to evaluate the capacity of MHeVA, to detect levels of anxiety and that could not be accurately measured with students we had no official diagnose. So, we conducted a second testing phase, participated by college students diagnosed with anxiety by mental health service professionals.

7.1 Survey

We believed that any external presence, to provide technical support or to observe and register the interaction, would negatively affect the tests. We wanted to replicate the best way we could, the environment of the expected interaction, between a student with mental health issues and MHeVA. So in order to achieve this, we chose a self-reported survey has the main tool for data gathering.

The survey was constructed having in mind several questions that measure the success of our objectives. It was divided into two parts, the first one to obtain some basic information about the user. Previous experiences interacting with Virtual Agents, mental health support and experiencing anxiety

related issues. The second one questioned the tester about their interaction with MHeVA, how they felt about the agent and the effects of the conversation.

One thing to note is that the nomenclature ”MHeVA” was only created after the testing phase, so all the questions on the survey and interaction’s utterances refer the agent as ”SIVA.

7.1.1 Pre-Interaction Form

The first part of the Survey was to be answered before the interaction. Here we started by assuring our users that their identity would remain anonymous.

The first questions were about the user’s age, genre and current college. This information was not relevant for the final results, instead, it was focused on assuring variety and representation of the college community; and that there was no great contrast between a specific group and the rest.

The next questions were focused on the users’ previous mental health related issues, past experience with mental health support services and their perception towards these services. This so we could better frame each participation, better interpret the results and understand the perception of the students about MHeVA, the interaction and its results. This helped understand if the user had anxiety problems in the past, if they had looked for help and if they had any stigma about it.

After this form was complete, the user was prompted to interact with MHeVA.

7.1.2 Post-Interaction Form

This was a much more complex and longer form, with a total of 24 questions focused on understanding the efficiency and effectiveness of our MHeVA. It was divided into four sections:

- A series of introductory questions about the user’s perception of the duration of the interaction and satisfaction about the available choices of answer.
- A section orientated to evaluate the student’s perceived Rapport and acceptance of MHeVA.
- Disclosure focused questions, with the goal of understanding the perceived difficulty to share sensible information and the level of honesty with which it was conducted.
- A chance for the tester to share their opinion on the interaction modalities and appearance of the agent.

It was also asked of the tester, to upload a text file **Output.txt**, created at the interaction’s conclusion, were the data reported by MHeVA was stored. So we could compare what was perceived by both parties and evaluate better our agent’s performance.

		Looked for Support		
		No	Yes	Total
Had Anxiety	Don't Know	4	1	5
	No	4	0	4
	Yes	15	20	35
Number of Valid Cases		23	21	44

Table 7.1: The intersection between participants with self-reported anxiety and students who looked for mental health support

7.2 Deployment

We deployed our agent through an itch.io page, were the users had to download a .RAR file, extract it and execute the Unity 3D build. We left a four step instruction on the website for the users to know what to do and in what order. The survey itself was deployed via Google forms and the link to it was attached in the itch.io page.

We reached all the testers through personal messaging and discord servers, making a small announcement for students to help in our testing phase. Our target population was college students or recent graduates mainly from the University of Lisbon.

7.3 Results

We managed a participation of 44 testers, 27 males and 17 females, from which 3 were recent graduates. Only one was older than 29 year while the rest were compromised between 18 and 29. The vast majority was from IST, 30, while the rest came from different colleges, namely Faculdade de Belas Artes, Instituto de Educação, Faculdade de Medicina Dentária, Faculdade de Ciências e Tecnologias, Instituto Superior de Engenharia de Lisboa, Escola Superior de Educação de Coimbra and Faculdade de Ciências Sociais e Humanas.

7.3.1 Mental Health Support

The first data related to mental health helped us prove the insufficiency of the support provided in colleges and how students tend to avoid seeking help.

Even though the vast majority reported to have had problems related with anxiety or depression, almost half (43%) of that majority didn't seek help in dealing with this issues. This might be justified by the stigma that normally is related to the act of seeking mental health support, but the responses suggest very low levels of this preconception. We studied the association between both variables, obtaining a Cramer's V value of 0.199, indicating a weak link, between those who did look for support and those

who had stigma against it.

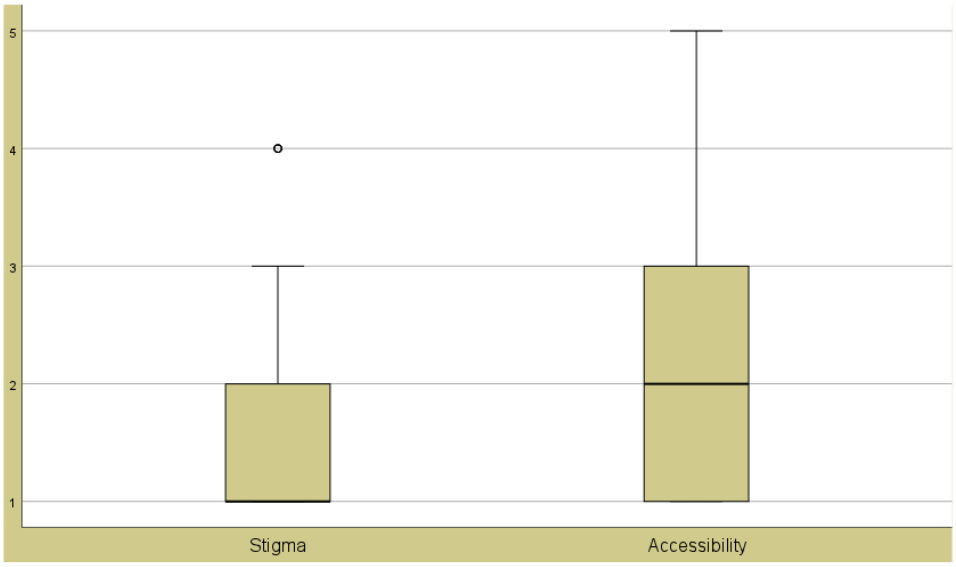

Figure 7.1: The opinion of the participants about their own stigma and mental health support accessibility in college.

Of course being a self-reported form, there might be misjudgement on what stigma really is and how it affects one's actions, however, we prefer to look for answers in the question related to accessibility, were most of them think this kind of support is lacking in college (Fig.7.1).

Although this was not an objective of our thesis it help us to assure the needs we are trying to answer and enhances the importance of this study.

7.3.2 Duration

The duration of a conversation is a vital information to understand it, although it might not be related to the engagement of its participants. The tested interactions varied in terms of duration. We managed to record it, since MHeVA kept track of it from the first utterance to the last and wrote it on the output text file.

The interactions lasted from 2 minutes and 16 seconds, to 10 minutes and 30 second (M = 4:24, SD = 1:25), providing reasonable variety.

We asked the users what they though about the duration of the interaction, using a 5-point Likert scale, from 1 (too short) to 5 (too long), revealing a general satisfactory opinion (M = 2.74, SD = 0.59). However when calculating the Pearson Correlation between the interaction time and the satisfaction rating, we found a weak correlation (P = 0.186). This probably means that the desired time of interaction varies too much from student to student or it might be related with different kinds of perception towards the passage of time.

7.3.3 Freedom of Answer and Clarity of Choice

Since we opted for a structured dialogue tree, mostly composed by pre-written choices, we had to test if this approach did not hinder the students' satisfaction and capacity of disclosure. We used a 5-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree).

Although we were expecting lower ratings on these questions, we were surprised by a quite positive feedback, especially about the freedom of answer. When prompt with the sentence "I had perfect freedom of answer", we gathered moderate positive results (M = 3.37, SD = 1.02), revealing a certain satisfaction in the choices the students had at their disposal. This is not indicative that the testers wouldn't enjoy more freedom of speech, a natural processing or voice recognition systems. It only allow us to confirm that the freedom of choice did not generally impact negatively the testers' experience.

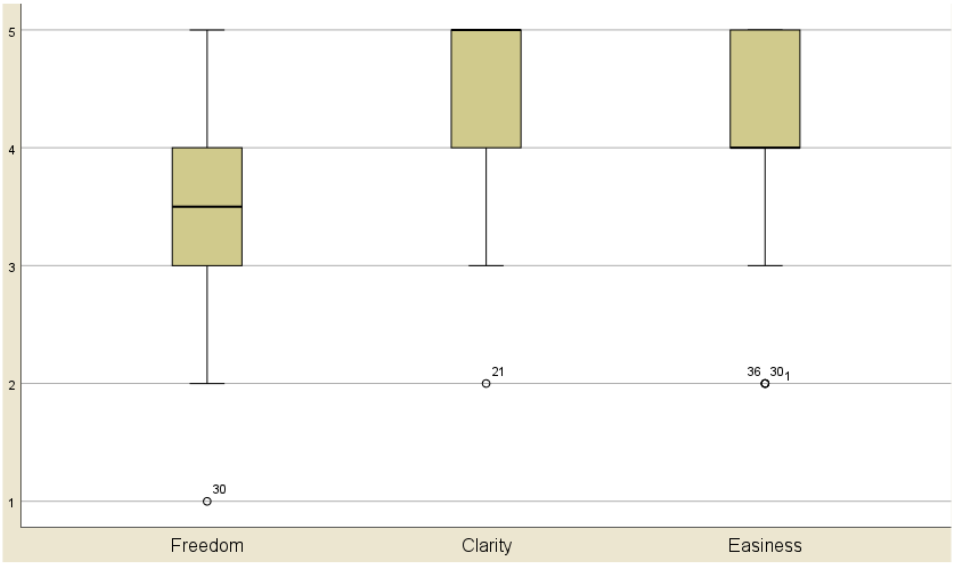

Figure 7.2: The participant's opinion about their freedom of choice.

When having in mind the clarity of the available options and the easiness to chose one of them, the results were even more positive, for both clarity (M = 4.42, SD = 0.7) and easiness (M = 4.19, SD = 0.88).

Moreover we questioned the students about some possible improvements that might be lacking, namely if they felt the need to pose questions to MHeVA and if they desired more open answers. With the answers we wanted to justify the expected lack of freedom and lay some valuable feedback for future work. The possibility of questioning the agent was met with moderate positivism (M = 3.66, SD = 1.16), has was the bigger number of open answers (M = 3.41, SD = 1.26). Since the means did not break the 4.00 barrier and the standard deviation was low, we might assume they are both improvements the students found positive but did not bear in mind during the interaction. A statistic that might prove beneficial for future work on MHeVA.

7.3.4 Acceptance and Engagement

To measure acceptance and engagement of the students towards MHeVA, we utilized five prompts, rated in the base Likert scale already mentioned above.

To start, we tested the likableness with the prompt ”I liked to interact with SIVA”, to understand if the interaction was enjoyable to the students and the politeness parameter with the prompt ”I think SIVA was nice to me”, since the politeness parameter is important for positive perception of a VA [45]. Both likableness (M = 3.95, SD = 0.86) and politeness (M = 4.39, SD = 0.69) had positive results, revealing the students perceived a level of politeness from SIVA and all in all enjoyed the interaction.

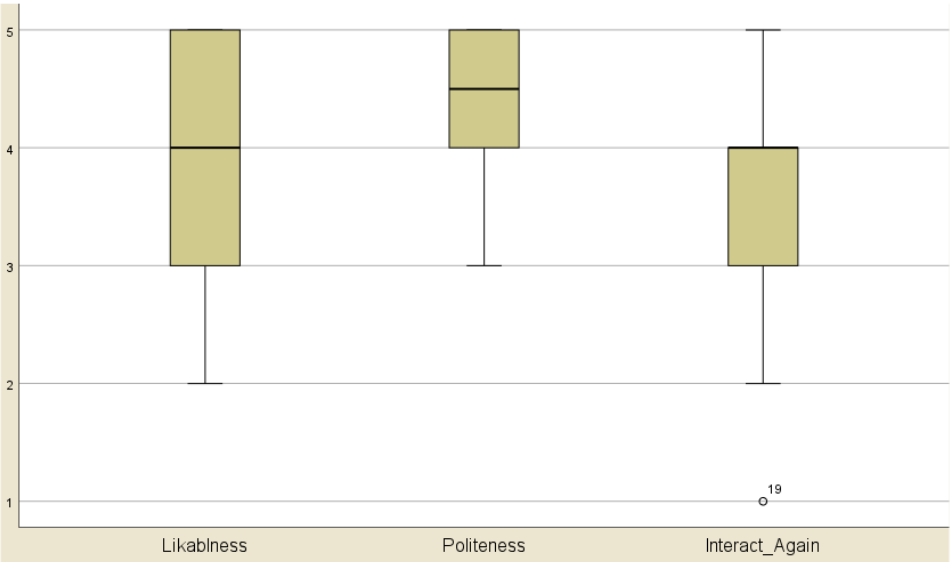

Figure 7.3: The acceptance and engagement ratings.

We also tested the students willingness to engage in a new interaction with MHeVA, a good measure of acceptance and engagement [47] (M = 3.70, SD = 0.95). This shows that even if our interaction did not expect a follow-up one and MHeVA was quite final in its last utterances, most of the students were willing to interact again, revealing a certain level of acceptance and engagement.

Lastly to try and understand if the communicative abilities of MHeVA were well met and well understood checking if its messages were clear and natural. The ratings were considerably high for clarity (M = 4.57, SD = 0.55), revealing that the language and utterances used was clearly understood by the students. And although the second ratings were lower (M = 3.66, SD = 1.10) it still gave us grounds to conclude the utterances were perceived mostly as natural ones, as opposed to scripted and robotic.

To conclude the engagement measurements, we took advantage of the agent’s output file, were we registered if during the interaction, the testers exchanged names with MHeVA (we did not store the actual names, only the positive or negative disclosure). From the 44 testers, 40 of them exchanged names (90%), allowing MHeVA to communicate on a first name basis.

7.3.5 Rapport

The establishment of rapport was always quintessential for the creation of a relationship between the students and SIVA, that would allow for trust and disclosure.

We measured the rapport in to three scales, following the definitions by Jonathan Gratch et al. [19], using a 5-point Likert scale.

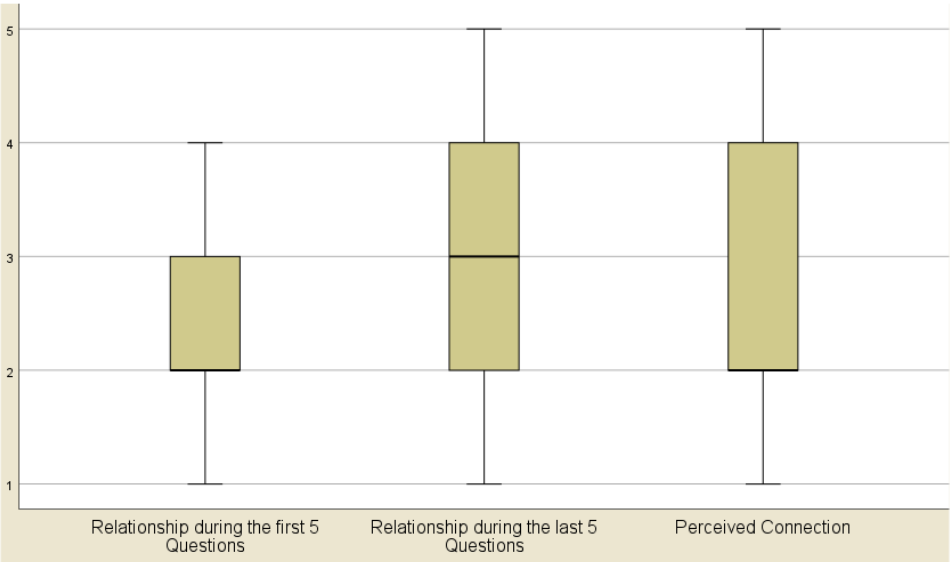

Figure 7.4: The participant's perceived relationship between them and MHeVA.

First we measured the **Emotional Rapport** using the items "I felt a connection with SIVA" and the related pair, "How was your relationship with SIVA during the first 5 questions?" and "How was your relationship with SIVA during the last 5 questions?", to understand the evolution of the relationship perceived by the students. In this field the results were a bit lackluster, with only two testers fully agreeing they had established a connection (M = 2.64, SD = 1.26). Moreover the perceived initial relationship ratings (Fig.7.6) were reasonably lower too (M = 2.27, SD = 0.85). However there was a clear improvement on the perceived relationship by 0.87 points (M = 3.14, SD = 1.25), revealing that MHeVA was able to improve rapport during the conversation, on most interactions.

Further on we measured the **Cognitive Rapport** through the item "SIVA and I understood each other", from 1 (strongly disagree) to 5 (strongly agree). The results were slightly positive (M = 3.18, SD = 1.195), closely related to the perceived strength of the relationship in the last five questions.

7.3.6 Disclosure

The main goal of this thesis was to understand if a VA could achieve disclosure with students, about mental health issues. So the measurements of disclosure were always paramount for the success of

MHeVA.

We decided not just to measure the amount of disclosure obtained but how difficult it was for the students to share their issues. In order to obtain more accurate results, we gathered data not just from the survey, but from the output file, relating the interaction.

It was important to understand possible judgemental factors regarding mental health disclosure, which often hinder the interviewers' job in this field. The majority of participants strongly disagreed with the item "I felt judged by SIVA" (M = 1.14, SD = 0.35), in a scale of 1 (strongly disagree) to 5 (strongly agree). Previous studies in the literature had shown this before [5] and our work confirmed this effect in the field of mental health issues. A VA is not perceived as judgemental.

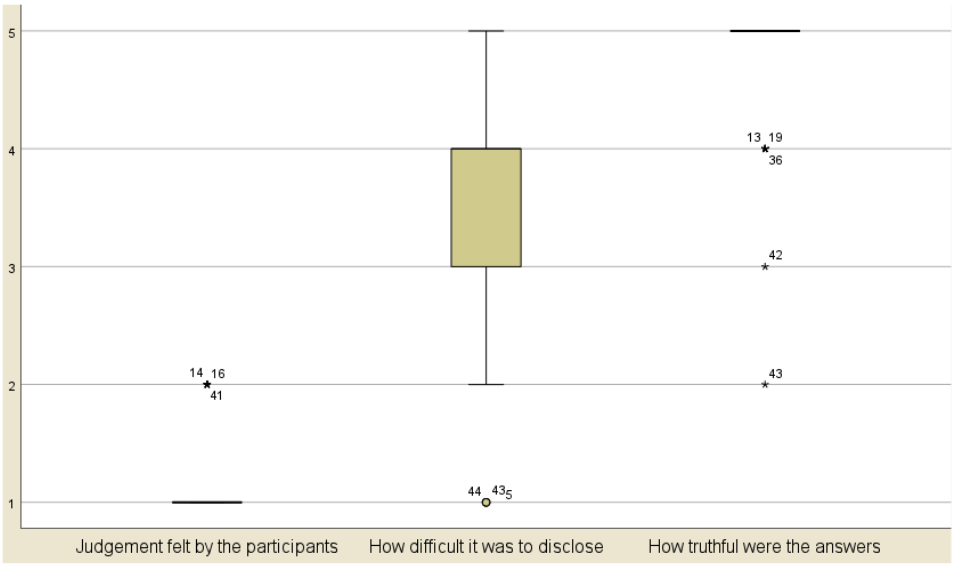

Figure 7.5: The participant's disclosure related ratings.

Participants were also asked to report their own feelings of disclosure and level of honesty behind their answers. The study obtained good values (M = 3.66, SD = 1.14) from the prompt "How difficult was it for you to open yourself about personal issues?", scaled from 1 (Hard) to 5 (Easy), with only 3 rating it 1. Truthfulness, a very important aspect to understand if the disclosed information was honest, obtained even more positive results (M = 4.70, SD = 0.63). However both these ratings are self-reported, so we can't be totally sure they are accurate. Many times, in Mental Health Support interview, the patient might not be totally honest [9, 20] about their ailments, so this prompts were focused on evaluating the interaction's influence in creating an environment favourable to self-disclosure and honesty about it.

In order to properly confirm our findings without self-assessment questions alone, we have also looked into participants experience when interacting with MHeVA, through the registered the answers in the output file (except the name of the student, to assure anonymity). From 501 anxiety screened questions, including the main and the follow-up questions, 472 were answered, obtaining a very positive

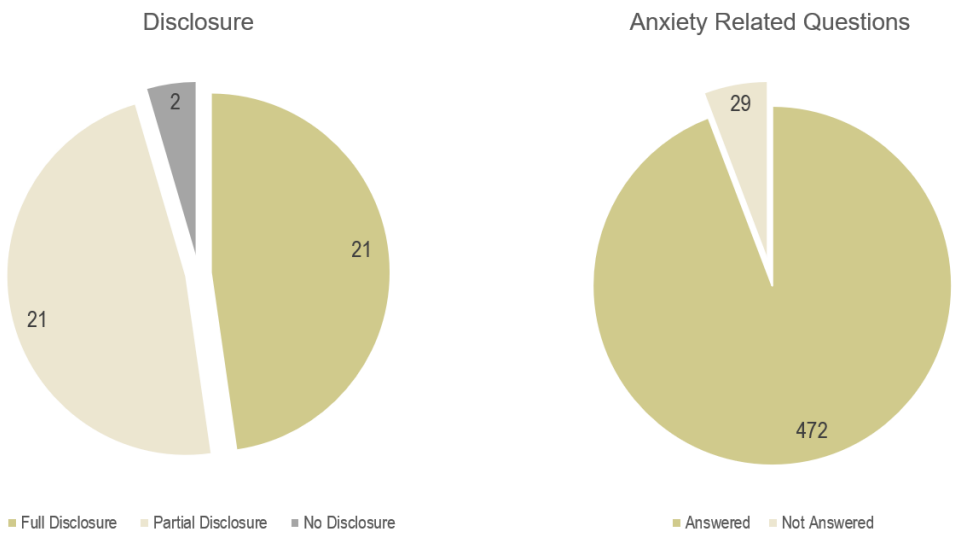

Figure 7.6: The participant's registered numbers of disclosure.

value of disclosure (94%). Additionally, from the 44 participants, 21 answered all anxiety related questions asked by MHeVA and only 2 out of 44, did not answer at least one anxiety screened question. This values allowed us to understand the high level of disclosure obtained.

7.3.7 Appearance and Interaction Modalities

Although the appearance and interaction modalities were not the focus of this thesis, it was important to understand the possible effects of their design in the study.

We asked participants to grade the MHeVA's appearance, animation and Computer Generated Voice CGV, using three prompts, rated in a 5-point Likert scale, from 1 (Strongly Disagree) to 5 (Strongly Agree).

The feedback was neutral, for appearance (M = 2.75, SD = 0.97), animations including lip-sync (M = 2.89, SD = 1.02) and voice (M = 3.02, SD = 1.02), which all in all was quite positive since we didn't focus on these aspects.

These results lead us to believe that the appearance and interaction modalities of MHeVA did not have a significant impact in the experience.And while these components could be used to promote rapport, in our case, they did not influence willingness to self-disclose.

7.3.8 Effects on Mental Health

The deployment of a VA as a mental health support assistant MHeVA has to be able to positively influence the system already in place and try to fight the stigma and misconception related to seeking help for mental health related issues. To try and understand if our agent was a positive influence, we used two questions: (1) ”Did your opinion about mental support improve after this interaction?” and (2) ”Do you feel SIVA helped you with some issues you might have?”.

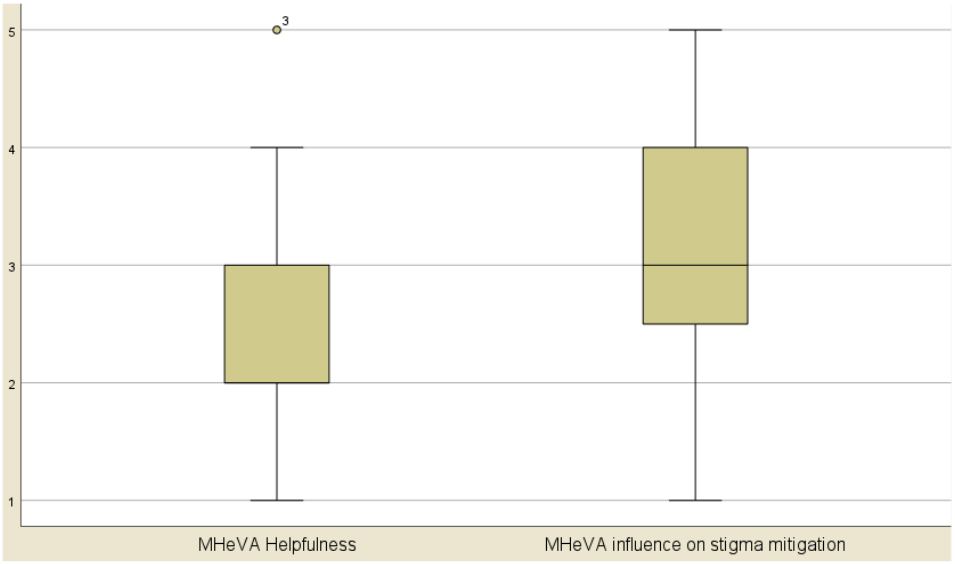

Figure 7.7: The MHeVA’s impact on participants’ mental health perception

Not corresponding to our expectations, the ratings were lower than what was desired, achieving neutrality in stigma mitigation (M = 2.95, SD = 1.01) and neutral to low ratings in mental health understanding improvement (M = 2.59, SD = 1.04).

Our agent wasn’t prepared to extend deep advises about mental health, so if someone already contacted a mental health support professional, they would feel a lack of depth from our agent’s answers. This fact might explain part of agent’s low score regarding this metric. However that does not mean it can’t help with mental health issues if its properly equipped. Regarding improvement on the opinion about mental health support, the score reflects a slightly higher rating but not influential enough.

7.3.9 Testers Feedback

To conclude the survey the left an optional prompt that asked the testers what improvements they thought MHeVA would benefit from.

The majority of the testers were more conscious towards the visual appearance of our agent and its interaction modalities. They identified some imperfections on the 3D model’s clothes which would dis-

		Had Anxiety			
		Don't Know	No	Yes	Total
Anxiety level	0-1	2	1	1	4
	2-4	0	2	10	12
	5-7	2	1	13	16
	>7	1	0	11	12
Total		5	4	35	44

Table 7.2: Compared values between the self-reported anxiety and the MHeVA's evaluation.

		Value	Approximate Significance
Nominal by Nominal	Phi	.749	.424
	Cramer's V	.530	.424
Number of Valid Cases		44	

Table 7.3: The calculated correlation between the self-reported anxiety and the MHeVA's evaluation

appear. Some also asked for better animations and a less robotic gaze, others to improve the Computer Generated Voice CGV.

It is possible that to some testers our agent might have achieved a uncanny valley aesthetic, a concept suggesting humanoid objects that imperfectly resemble actual human beings provoke uncanny or strangely familiar feelings of uneasiness and revulsion in observers [70]. This might have been one of the reasons why the perceived rapport was lower than expected and some testers might have failed perceive MHeVA as a entity with personality.

On the other hand it is positive that the main focus of advice was oriented to something that was not our main goal. Since we focused mainly on the dialog tree structure and the rationality behind MHeVA's choices of sub-trees, it is comprehensible the visual components of our agent were considered the weak link.

7.4 Ability to identify Anxiety

In order to understand if the final verdict given by SIVA and consequently its evaluation of anxiety levels were accurate, we had to cross examine some data obtained, by both SIVA and the students and posteriorly, test our Agent with students that were already diagnosed with anxiety problems, by professionals in the field of Mental Health Support.

7.4.1 First Survey

The first group of testers, was compromised of 44 students, none of them professionally diagnosed with anxiety problems. Thus, in order to examine MHeVA's accuracy, we compared the self-reported question

about previous anxiety issues, and the levels the agent reported.

From the 44 students, 4 were reported having no anxiety problems, 12 a not troublesome level, 11 having at least one anxiety crisis and 17 having experienced several anxiety crisis. This had to be compared with the self-reported question that had half (52%) of the students revealing they had anxiety problems. Of the 35 students who reported having had anxiety problems, 11 were evaluated with the maximum anxiety level (more than 7), 13 with the middle level (5 to 7), 10 with the low level (2 to 4) and 1 with no anxiety (less than 2) (Tab.7.2). It is important to note however, that the one who was reported with no anxiety did not answer anxiety screened questions, providing no measurements for MHeVA and consequently cannot be considered an evaluation of anxiety levels.

We calculated the correlation between the self-reported anxiety and the anxiety level evaluation and found moderate levels as presented in the table (Tab.7.3).

We have to understand that this statistical study is merely theoretical and that there are several factors that unfortunately highly reduce its accuracy and for that we must understand anxiety. Anxiety is a problems that affects a great number of students and its believed that most of them don't know they have it [9]. So the self-reported anxiety issues is a flawed data set, since the students are not qualified to diagnose anxiety. Furthermore the survey question did not precise how recent were the anxiety issues, so students might be referring to past occurrences.

7.4.2 Second Survey

In order to have better assurances MHeVA was able to detected anxiety levels to a certain extent, we decided to test it with students that had already been diagnosed with anxiety issues by a mental health support professional. Rendering that information as a more precise verdict.

At the time of writing this document, we have, so far tested our agent with two students that were diagnosed with anxiety. Participants were willing to disclose information, sharing both their names and answering 25 of the 26 anxiety screened questions they were asked by MHeVA. They scored 7 and 8 for anxiety levels, which places them on the most serious level, corresponding to have experienced several anxiety crisis.

We also tested our agent with a student that was diagnosed as not having anxiety issues and for that student MHeVA did not detect any level of anxiety. This might be an indicator that MHeVA is not biased render a verdict with high levels of anxiety.

Conclusively, MHeVA's evaluation of anxiety levels, corresponded with the professional diagnose. Nevertheless since our study is dependent on the availability and interest of testers, we didn't manage to have a group big enough to generalize the accuracy of our agent. We still hope to conduct more tests to verify the agent's accuracy but for now these are the results we achieved.

8

Conclusion

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8.1 Conclusions

In this thesis we looked at Virtual Agents VAs as a possible answer to the ever growing problems in mental health services in higher education. We tried to understand if college students would be willing to disclose mental health related issues with a VA deployed as a MHeVA and consequently provide grounds for a possible future deployment.

In order understand the current situation of the mental health support in higher education, we studied several works and studies on the subject and interviewed mental health support professionals from IST [9]. In order to gather which architecture would allow us to best achieve our goals, we collected data regarding already established VAs, incorporated in both pedagogic and professional environments. The main focus of this section was to understand how each work established rapport with humans, influenced behavioural change and obtained disclosure about healthcare related issues. Finally, to complement this, we further looked into psychopedagogy interviews, their practices and regulations, so we could frame the agent's behaviour and interactions, allowing it to pose as a MHeVA, without endangering the students mental health.

Equipped with the necessary knowledge we constructed MHeVA's architecture and implemented it with the help of FAtiMA toolkit. A complex dialog tree with more than 400 utterances was created, divided into sub-trees that would group the dialog states of a given subject and allow for measured and natural changes during the conversation.

The agent's rationality and intelligence came from a combination of previous works on VA and current knowledge on psychopedagogy interviews. The agent was able to change between rapport building and eliciting self-disclosure, in accordance to its understanding of the Student's State, making use of its Theory of Mind capabilities.

In order to render a verdict on our agent and our findings, we conducted two testing phases, where college students interacted with MHeVA in a simulation of a one on one interview, and gathered data through a survey and registered values of the interaction.

The results obtained provided valuable information for the future insertion of VAs in the world of mental health support:

- We managed to prove conclusively, that students are able and willing to disclose with a VA, about their mental health related issues. Furthermore, our VA was not perceived as judgemental. A statement previous studies in the literature had shown before [5] and now confirmed, in the field of mental health issues.

- MHeVA was well accepted as a Mental Health Assistant. It was perceived as polite with clear and natural utterances, and most of the students were willing to interact again with it.

- Our agent had difficulties establishing rapport with the students. Although the perceived connection between participants and our MHeVA was strength during the interaction, it never reached the levels we desired. This might be justified by the overall appearance, voice and animations of our model, since they were singled out as the main fields to improve. Lastly we proved that the establishment of rapport is not essential for a VA to promote Self-Disclosure about sensible issues.
- The agent showed potential to identify anxiety issues and classify their severity. The survey with non-diagnosed students had positive results and the survey with diagnosed students achieved perfect precision and recall. However there is the need for further testing, to find conclusive results, since the study group was too small.
- Finally our agent was unable to mitigate the stigma related to seeking help about mental health related issues. This might be because the students did not associate MHeVA directly to the system already in place, since it is still a research tool. Perhaps if it shared more information about the mental health support channels in college, it would help improve this ability.

It is also important to highlight the importance of designing a MHeVA under the guidance and counseling of a mental health support professional, that helped tailor the agent's behaviour and interactions, to best correspond with the requirements and practices necessary to deal with mental health issues. Consequently ensuring accuracy of the support provided and a greater degree of credibility and assurance to those who interact with a MHeVA.

8.2 Future Work

Although we consider our work to have successfully completed the objectives it was set out to, we also understand even better now, the amount of work that still needs to be done, before a VA can be finally deployed as a Mental Health Virtual Assistant and provide the so much need help, the mental health college services need.

Since early stages of implementation, there was the possibility for our agent to focus on both anxiety and depression. We decided to focus on the first, because it is more common in college students and it does not result in such dangerous consequences as depression. So to deal with anxiety was a first good test before advancing into more serious matters. But now that our work is concluded and we already have some strong proven bases to deal with mental health issues, we can set our goals towards also dealing with depression. Identify it, evaluate its seriousness and provide adequate tools an insight for students to deal with it and mitigate its consequences.

Other component that we were also interested in developing was an emotional tracker and facial recognition, that would provide the agent with the ability to perceive emotion and eye gazing, through

the use of a small camera. As we explained in this thesis' background, a lot of information about mental issues comes from non-verbal behaviour and it would be as interesting as it would be useful, if the agent could take advantage of those systems. It might provide even more information, not just about rapport building but identifying what issues might be originating the feelings of anxiety in a given student.

Finally, it would be interesting if the agent would be able to process natural language and understand voice communication. As mentioned before, voice cues give valuable insight to mental health interviewers and it would be a beneficial system, not just to identify the emotions the student is feeling but to also allow for better and more free flowing conversation.

We consider the work performed during this thesis to be highly important for the society. This is a serious issue that endanger millions of students in the world [71] and that has been consistently overlooked. We believe VAs in the future can make a difference in this field and help the mental health services improve the lives of so many students. We hope the work described here can guide and encourage further studies and progress in the field and that one day the now distant reality of a Mental Health Virtual Assistant might come to past.

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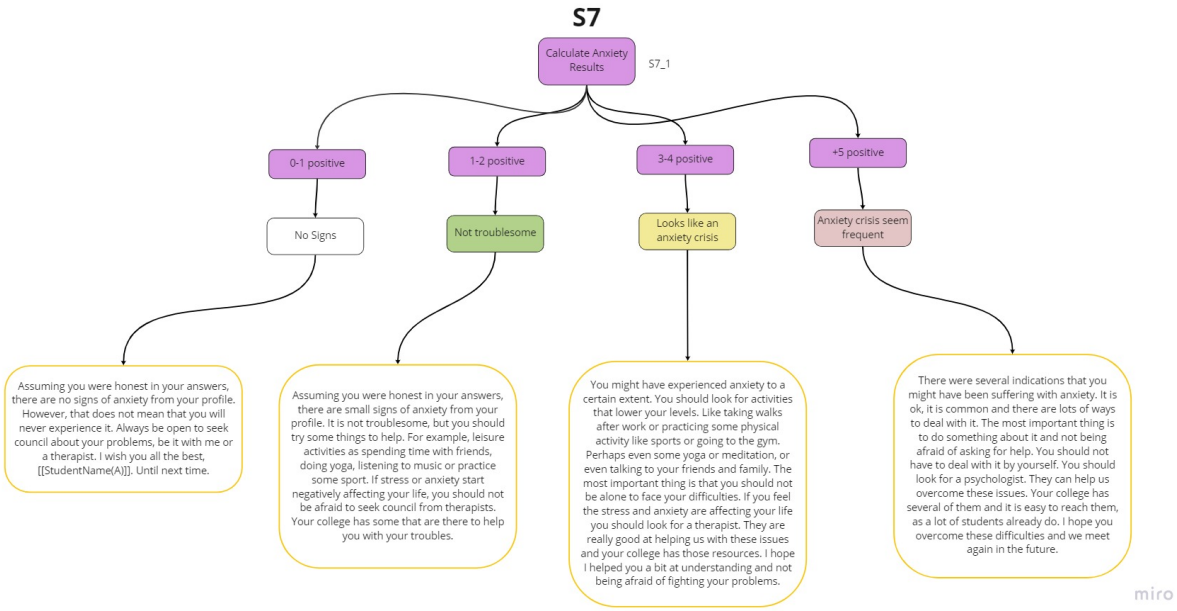
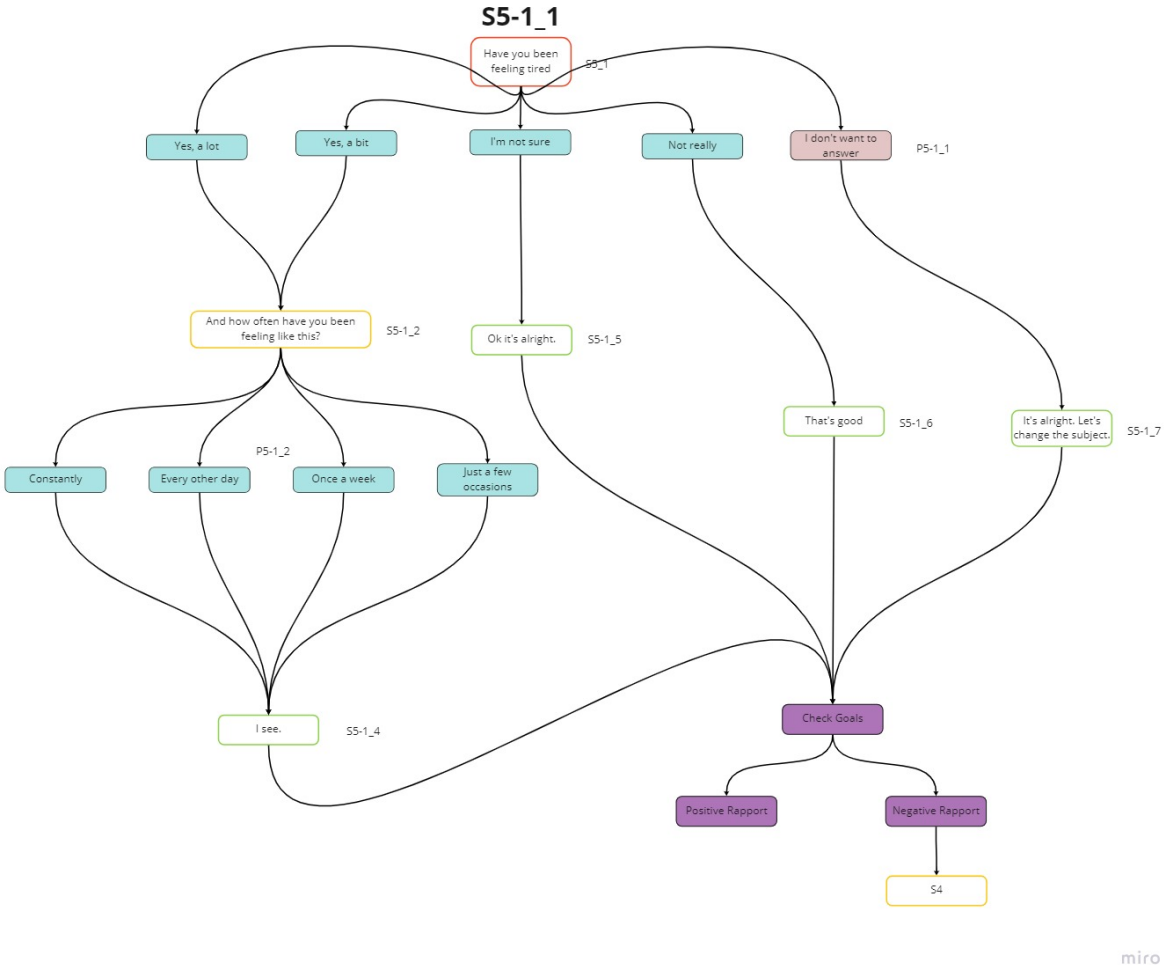
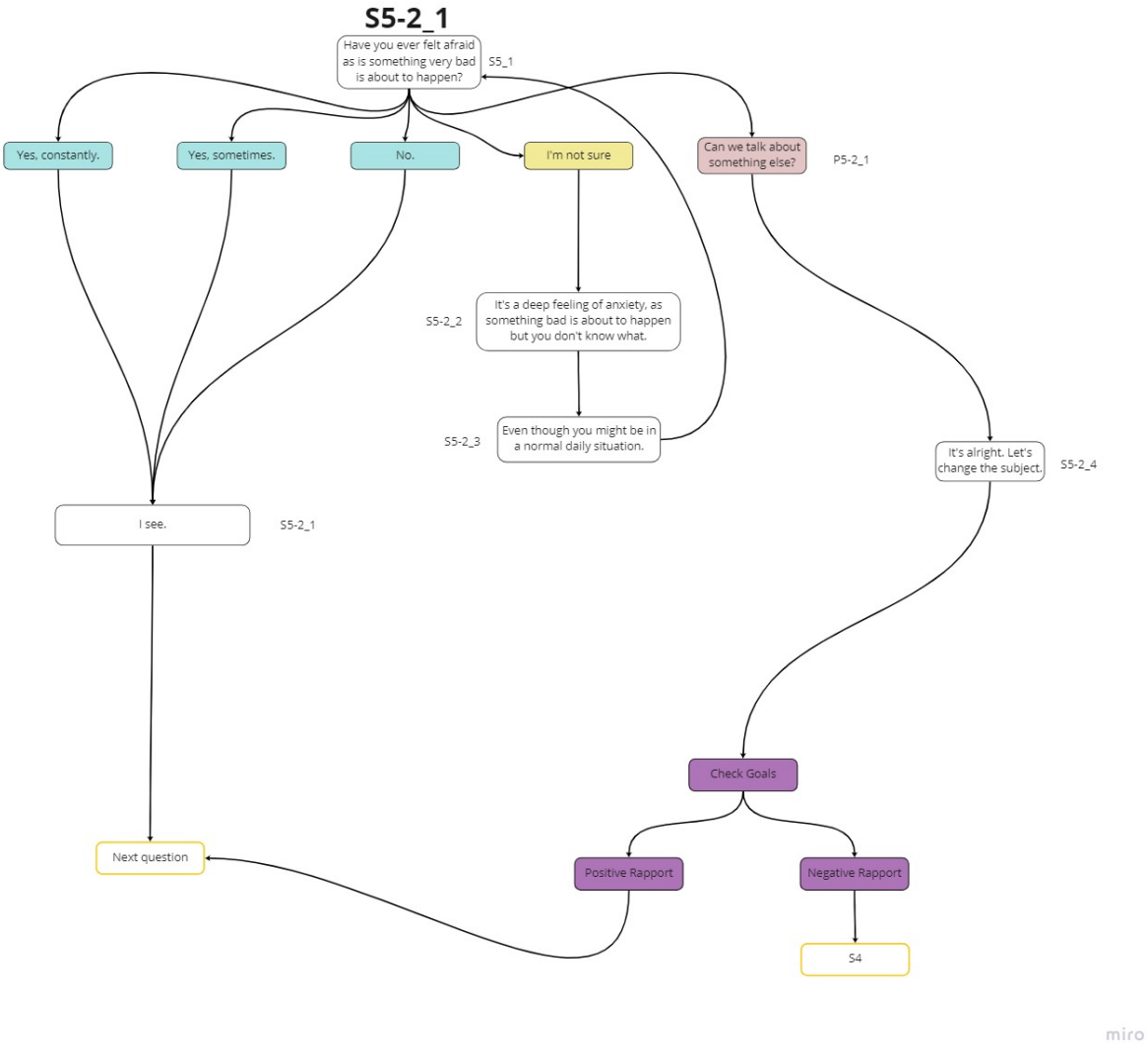
A

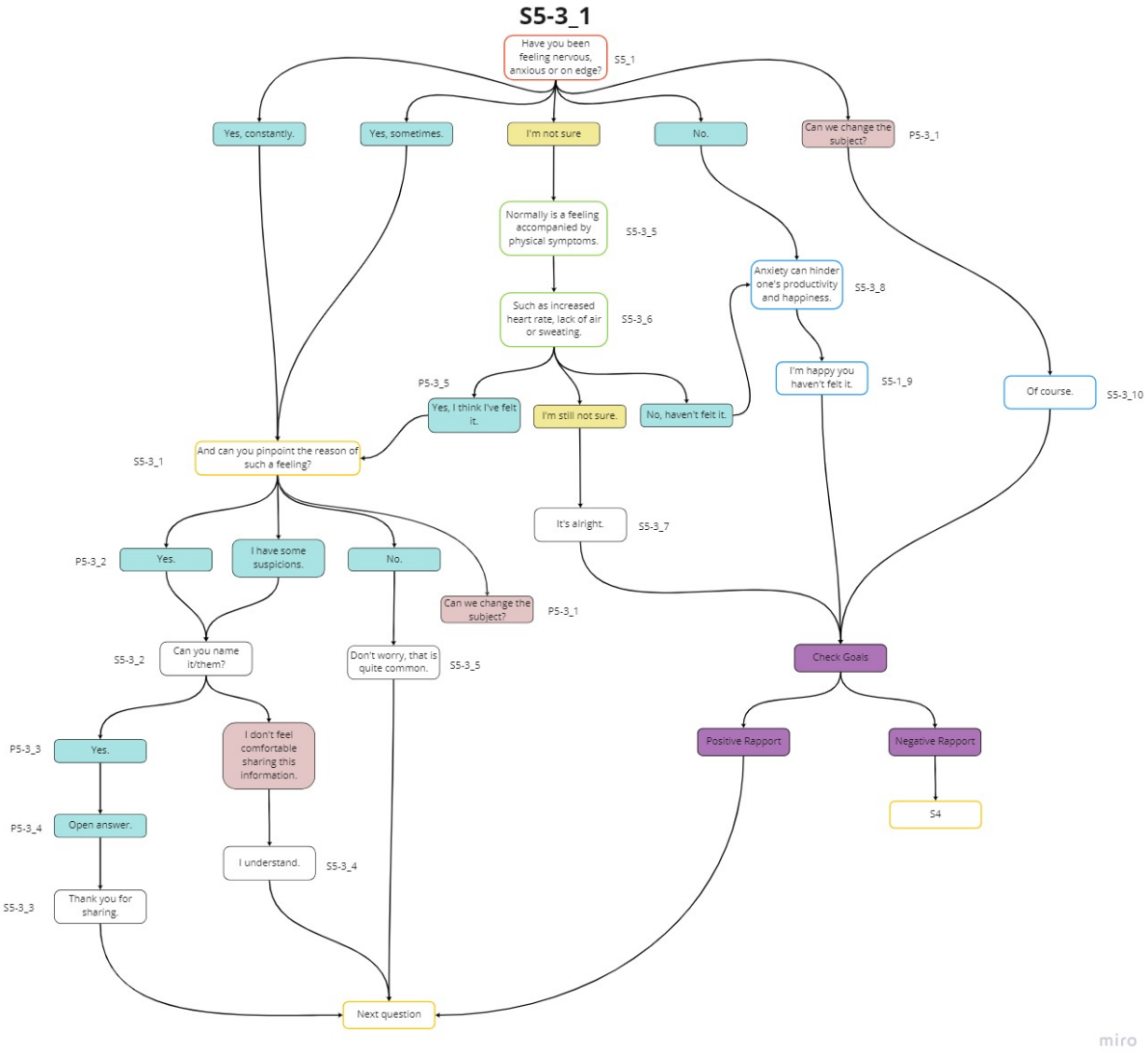
Dialogue Tree

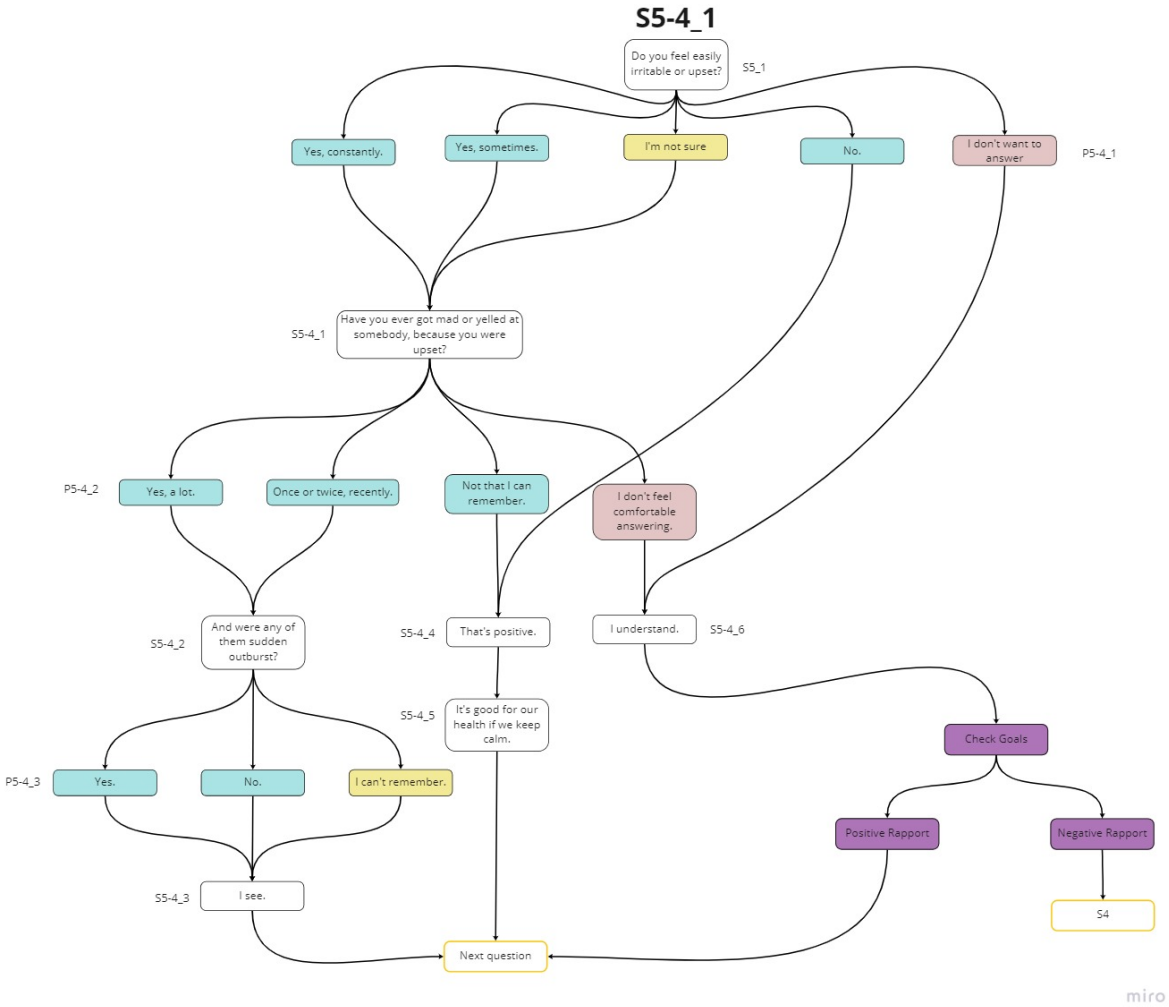
Here we share the main sub-trees of our dialogue, with all their ramifications and classifications and the link for our main build: https://antunes10.itch.io/tese1

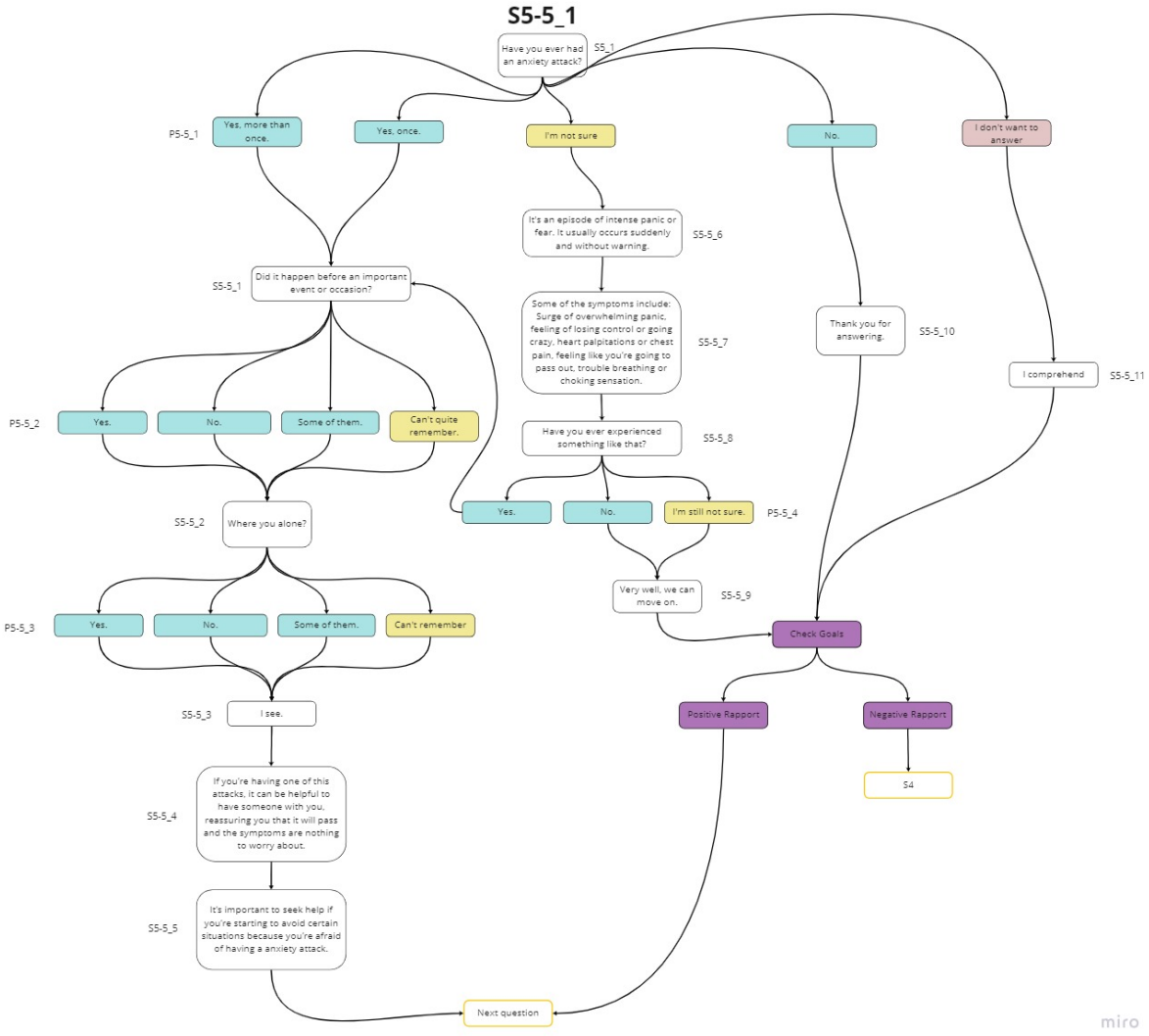

S7
Calculate Anxiety Results
S7_1
0-1 positive
1-2 positive
3-4 positive
+5 positive
No Signs
Not troublesome
Looks like an anxiety crisis
Anxiety crisis seem frequent
Assuming you were honest in your answers, there are no signs of anxiety from your profile. However, that does not mean that you will never experience it. Always be open to seek council about your problems, be it with me or a therapist. I wish you all the best, [[StudentName(A)]]. Until next time.
Assuming you were honest in your answers, there are small signs of anxiety from your profile. It is not troublesome, but you should try some things to help. For example, leisure activities as spending time with friends, doing yoga, listening to music or practice some sport. If stress or anxiety start negatively affecting your life, you should not be afraid to seek council from therapists. Your college has some that are there to help you with your troubles.
You might have experienced anxiety to a certain extent. You should look for activities that lower your levels. Like taking walks after work or practicing some physical activity like sports or going to the gym. Perhaps even some yoga or meditation, or even talking to your friends and family. The most important thing is that you should not be alone to face your difficulties. If you feel the stress and anxiety are affecting your life you should look for a therapist. They are really good at helping us with these issues and your college has those resources. I hope I helped you a bit at understanding and not being afraid of fighting your problems.
There were several indications that you might have been suffering with anxiety. It is ok, it is common and there are lots of ways to deal with it. The most important thing is to do something about it and not being afraid of asking for help. You should not have to deal with it by yourself. You should look for a psychologist. They can help us overcome these issues. Your college has several of them and it is easy to reach them, as a lot of students already do. I hope you overcome these difficulties and we meet again in the future.
miro

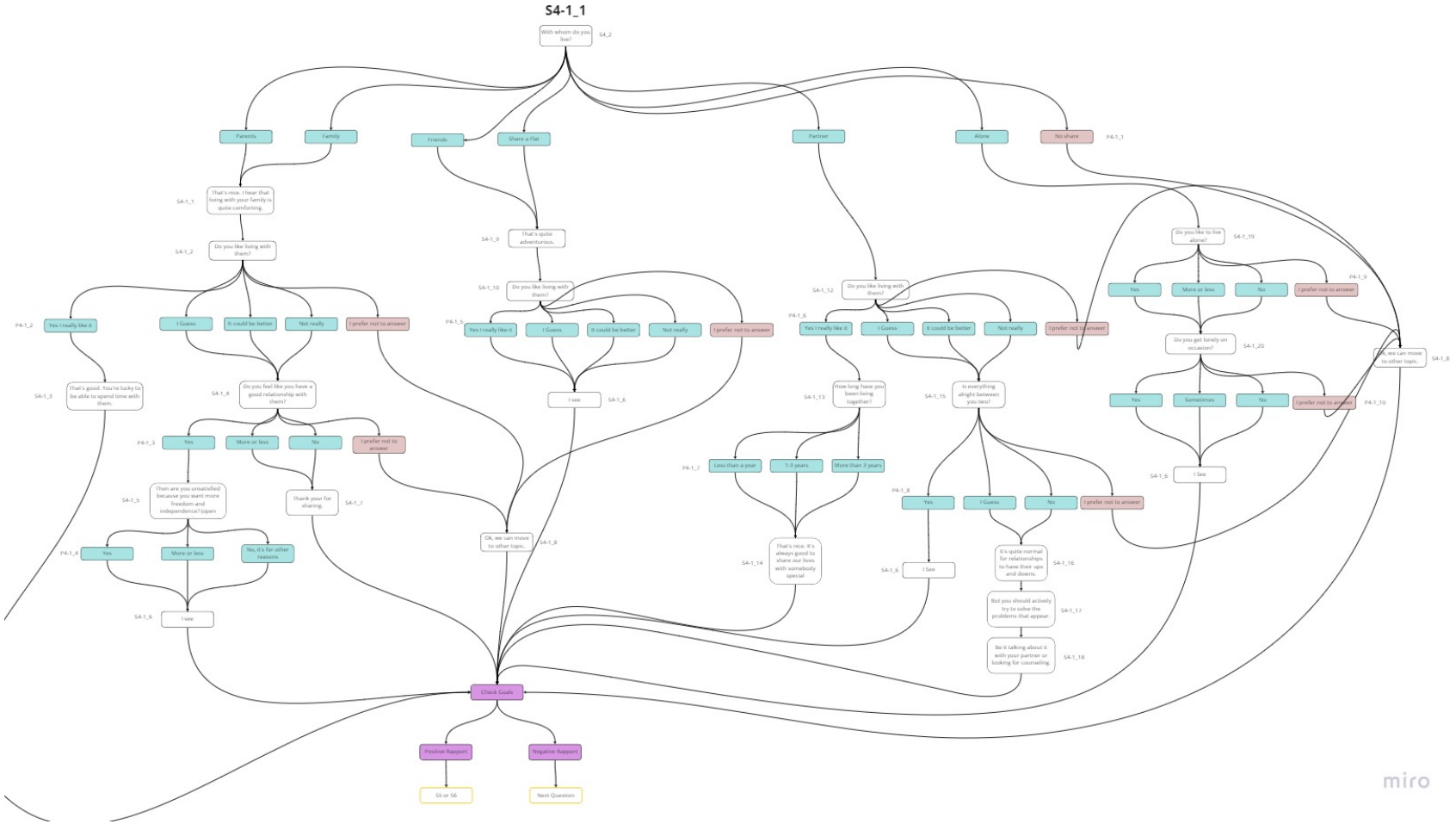

S5-1_1
Have you been feeling tired
S5_1
Yes, a lot
Yes, a bit
I'm not sure
Not really
I don't want to answer
P5-1_1
And how often have you been feeling like this?
S5-1_2
Ok it's alright.
S5-1_5
That's good
S5-1_6
It's alright. Let's change the subject.
S5-1_7
P5-1_2
Constantly
Every other day
Once a week
Just a few occasions
I see.
S5-1_4
Check Goals
Positive Rapport
Negative Rapport
S4
miro

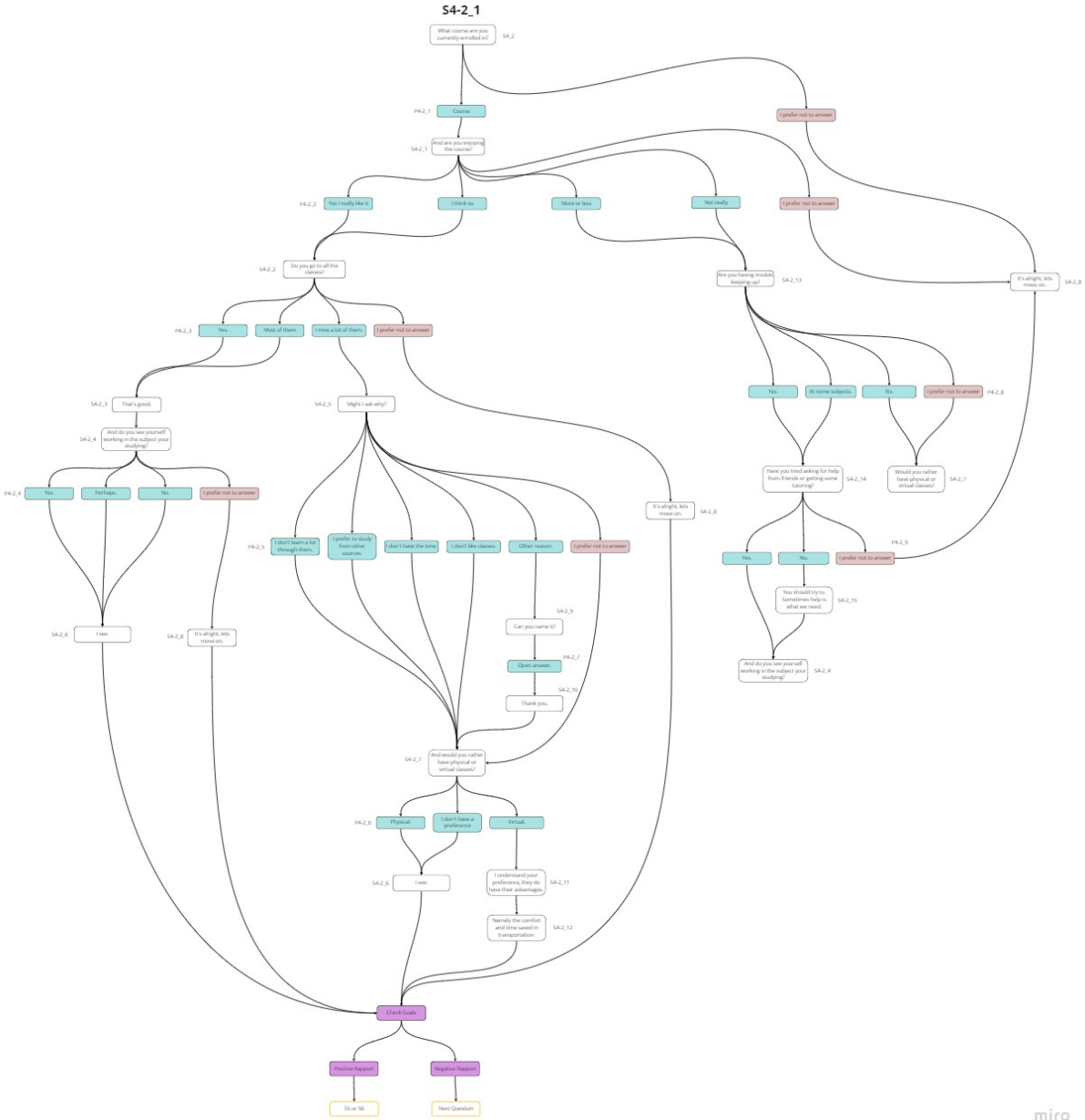

S5-2_1
Have you ever felt afraid as is something very bad is about to happen?
S5_1
Yes, constantly.
Yes, sometimes.
No.
I'm not sure
Can we talk about something else?
P5-2_1
S5-2_2
It's a deep feeling of anxiety, as something bad is about to happen but you don't know what.
S5-2_3
Even though you might be in a normal daily situation.
It's alright. Let's change the subject.
S5-2_4
I see.
S5-2_1
Check Goals
Next question
Positive Rapport
Negative Rapport
S4
miro

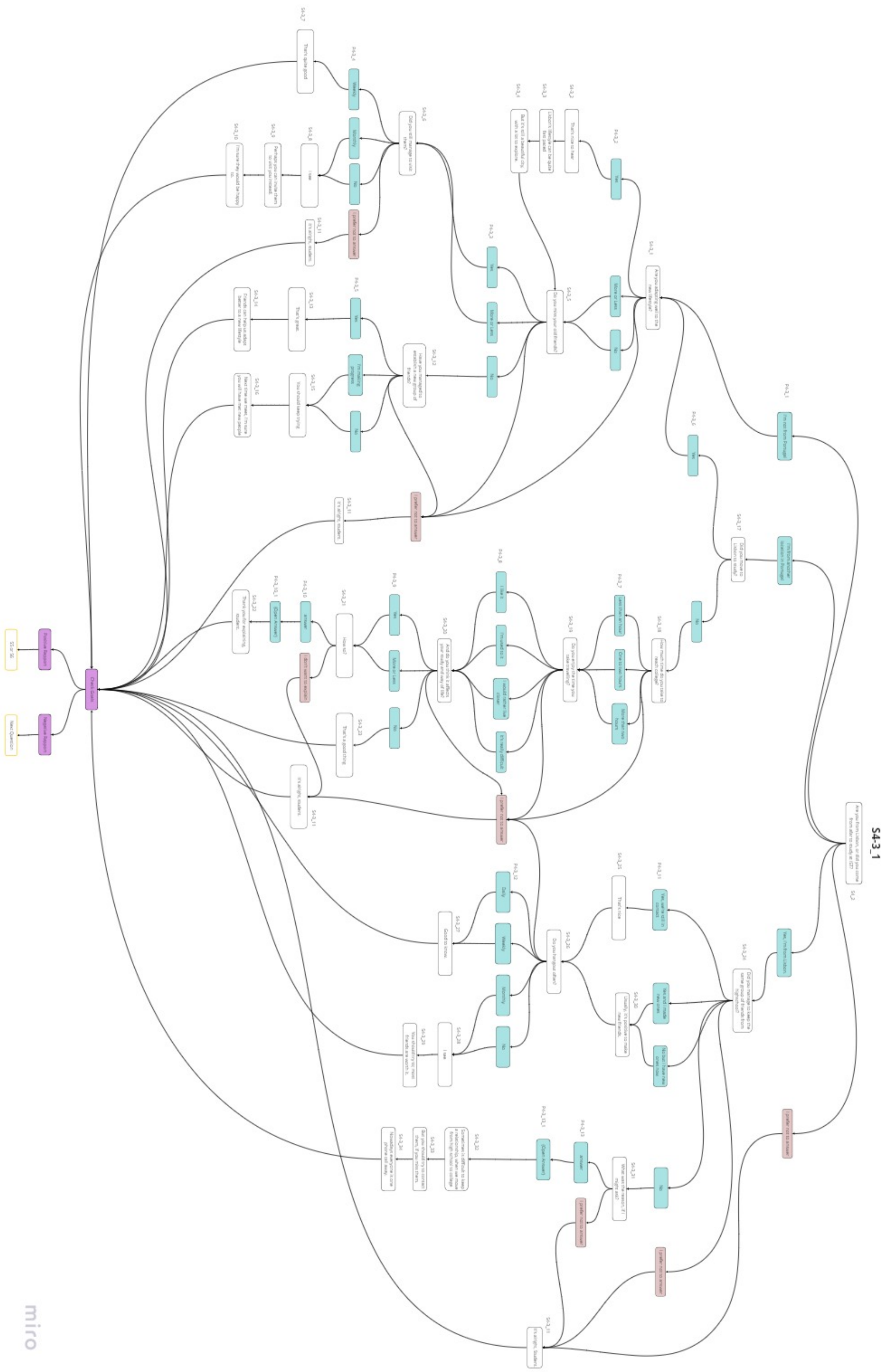

S5-3_1
Have you been feeling nervous, anxious or on edge?
S5_1
Yes, constantly.
Yes, sometimes.
I'm not sure
No.
Can we change the subject?
P5-3_1
Normally is a feeling accompanied by physical symptoms.
S5-3_5
Such as increased heart rate, lack of air or sweating.
S5-3_6
Anxiety can hinder one's productivity and happiness.
S5-3_8
I'm happy you haven't felt it.
S5-1_9
Of course.
S5-3_10
P5-3_5
Yes, I think I've felt it.
I'm still not sure.
No, haven't felt it.
S5-3_1
And can you pinpoint the reason of such a feeling?
It's alright.
S5-3_7
P5-3_2
Yes.
I have some suspicions.
No.
Can we change the subject?
P5-3_1
S5-3_2
Can you name it/them?
Don't worry, that is quite common.
S5-3_5
Check Goals
P5-3_3
Yes.
I don't feel comfortable sharing this information.
Positive Rapport
Negative Rapport
P5-3_4
Open answer.
S4
I understand.
S5-3_4
S5-3_3
Thank you for sharing.
Next question
miro


S5-4_1
Do you feel easily irritable or upset?
S5_1
Yes, constantly.
Yes, sometimes.
I'm not sure
No.
I don't want to answer
P5-4_1
S5-4_1
Have you ever got mad or yelled at somebody, because you were upset?
P5-4_2
Yes, a lot.
Once or twice, recently.
Not that I can remember.
I don't feel comfortable answering.
S5-4_2
And were any of them sudden outburst?
S5-4_4
That's positive.
I understand.
S5-4_6
S5-4_5
It's good for our health if we keep calm.
Check Goals
P5-4_3
Yes.
No.
I can't remember.
Positive Rapport
Negative Rapport
S5-4_3
I see.
S4
Next question
miro


S5-5_1
Have you ever had an anxiety attack?
S5_1
P5-5_1
Yes, more than once.
Yes, once.
I'm not sure
No.
I don't want to answer
It's an episode of intense panic or fear. It usually occurs suddenly and without warning.
S5-5_6
S5-5_1
Did it happen before an important event or occasion?
Some of the symptoms include: Surge of overwhelming panic, feeling of losing control or going crazy, heart palpitations or chest pain, feeling like you're going to pass out, trouble breathing or choking sensation.
S5-5_7
Thank you for answering.
S5-5_10
I comprehend
S5-5_11
P5-5_2
Yes.
No.
Some of them.
Can't quite remember.
Have you ever experienced something like that?
S5-5_8
Yes.
No.
I'm still not sure.
P5-5_4
S5-5_2
Where you alone?
Very well, we can move on.
S5-5_9
P5-5_3
Yes.
No.
Some of them.
Can't remember
Check Goals
S5-5_3
I see.
Positive Rapport
Negative Rapport
S4
S5-5_4
If you're having one of this attacks, it can be helpful to have someone with you, reassuring you that it will pass and the symptoms are nothing to worry about.
S5-5_5
It's important to seek help if you're starting to avoid certain situations because you're afraid of having a anxiety attack.
Next question
miro


S4-1_1
With whom do you live?
S4_2
Parents
Family
Friends
Share a Flat
Partner
Alone
No share
P4-1_1
That's nice. I hear that living with your family is quite comforting.
S4-1_1
Do you like living with them?
S4-1_2
That's quite adventurous.
S4-1_9
Do you like living with them?
S4-1_10
Do you like living with them?
S4-1_12
Do you like to live alone?
S4-1_19
Yes, I really like it
I Guess
It could be better
Not really
I prefer not to answer
P4-1_2
P4-1_5
P4-1_6
P4-1_9
That's good. You're lucky to be able to spend time with them.
S4-1_3
Do you feel like you have a good relationship with them?
S4-1_4
I see
S4-1_6
How long have you been living together?
S4-1_13
Is everything alright between you two?
S4-1_15
Do you get lonely on occasion?
S4-1_20
Yes
Sometimes
No
P4-1_10
Yes
More or less
No
P4-1_3
Less than a year
1-3 years
More than 3 years
P4-1_7
Then are you unsatisfied because you want more freedom and independence? (open
S4-1_5
Thank your for sharing.
S4-1_7
Yes
More or less
No, it's for other reasons
P4-1_4
Ok, we can move to other topic..
S4-1_8
That's nice. It's always good to share our lives with somebody special
S4-1_14
Yes
I Guess
No
I prefer not to answer
P4-1_8
It's quite normal for relationships to have their ups and downs.
S4-1_16
But you should actively try to solve the problems that appear.
S4-1_17
Be it talking about it with your partner or looking for counselling.
S4-1_18
Check Goals
Positive Rapport
Negative Rapport
S5 or S6
Next Question

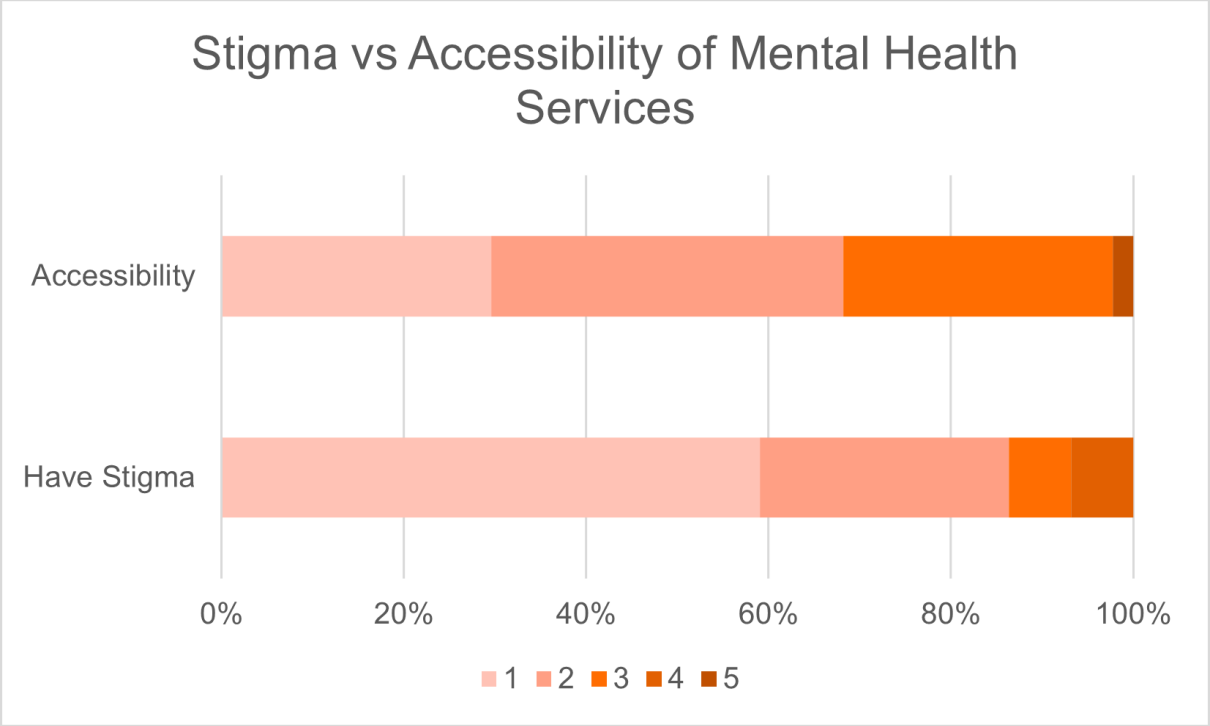

S4-2_1
What course are you currently enrolled in?
S4_2
P4-2_1
Course
I prefer not to answer
S4-2_1
And are you enjoying the course?
P4-2_2
Yes I really like it
I think so
More or less
Not really
I prefer not to answer
S4-2_2
Do you go to all the classes?
S4-2_13
Are you having trouble keeping up?
S4-2_8
It's alright, lets move on.
P4-2_3
Yes.
Most of them
I miss a lot of them
I prefer not to answer
Yes.
At some subjects.
No.
I prefer not to answer
P4-2_8
S4-2_3
That's good.
S4-2_5
Might I ask why?
S4-2_4
And do you see yourself working in the subject your studying?
Have you tried asking for help from friends or getting some tutoring?
S4-2_14
Would you rather have physical or virtual classes?
S4-2_7
P4-2_4
Yes.
Perhaps.
No.
I prefer not to answer
It's alright, lets move on.
S4-2_8
P4-2_5
I don't learn a lot through them.
I prefer to study from other sources.
I don't have the time.
I don't like classes.
Other reason.
I prefer not to answer
P4-2_9
Yes.
No.
I prefer not to answer
You should try to... Sometimes help is what we need.
S4-2_15
S4-2_9
Can you name it?
And do you see yourself working in the subject your studying?
S4-2_4
P4-2_7
Open answer.
S4-2_10
Thank you.
S4-2_6
I see.
S4-2_8
It's alright, lets move on.
S4-2_7
And would you rather have physical or virtual classes?
P4-2_6
Physical.
I don't have a preference
Virtual.
S4-2_6
I see.
I understand your preference, they do have their advantages.
S4-2_11
Namely the comfort and time saved in transportation.
S4-2_12
Check Goals
Positive Support
Negative Support
S5 or S6
Next Question
miro

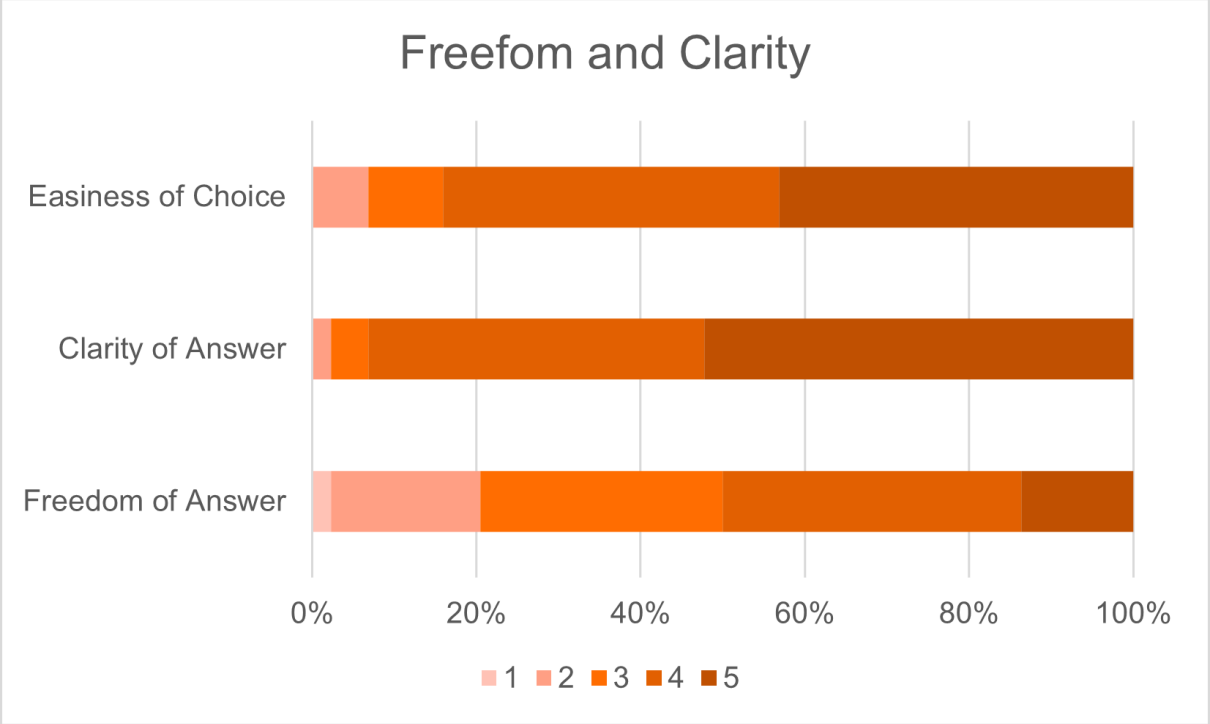

S4-3_1
miro

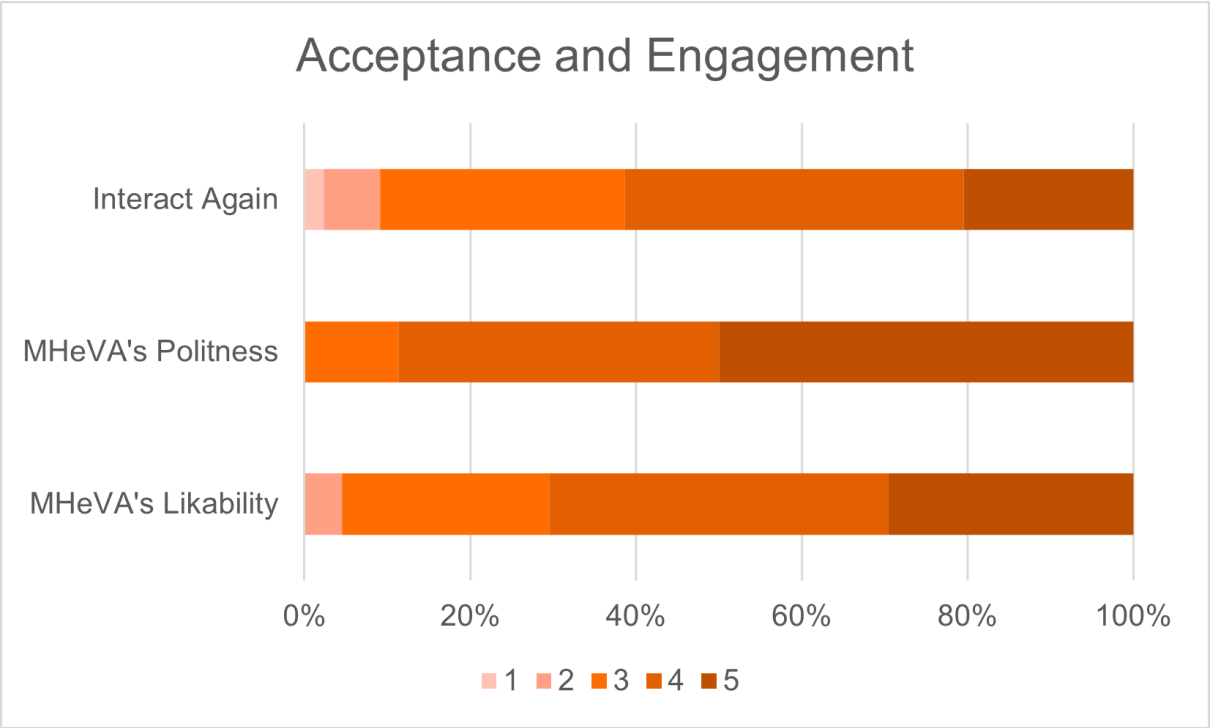
B

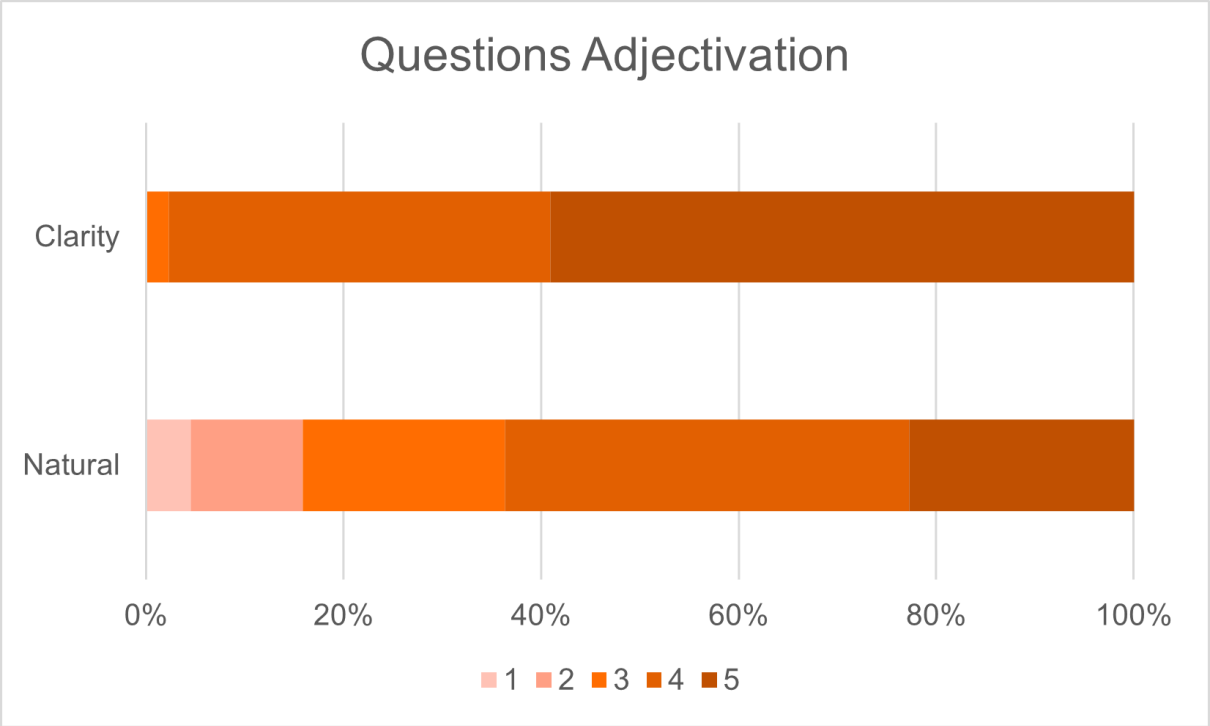
Survey Answers

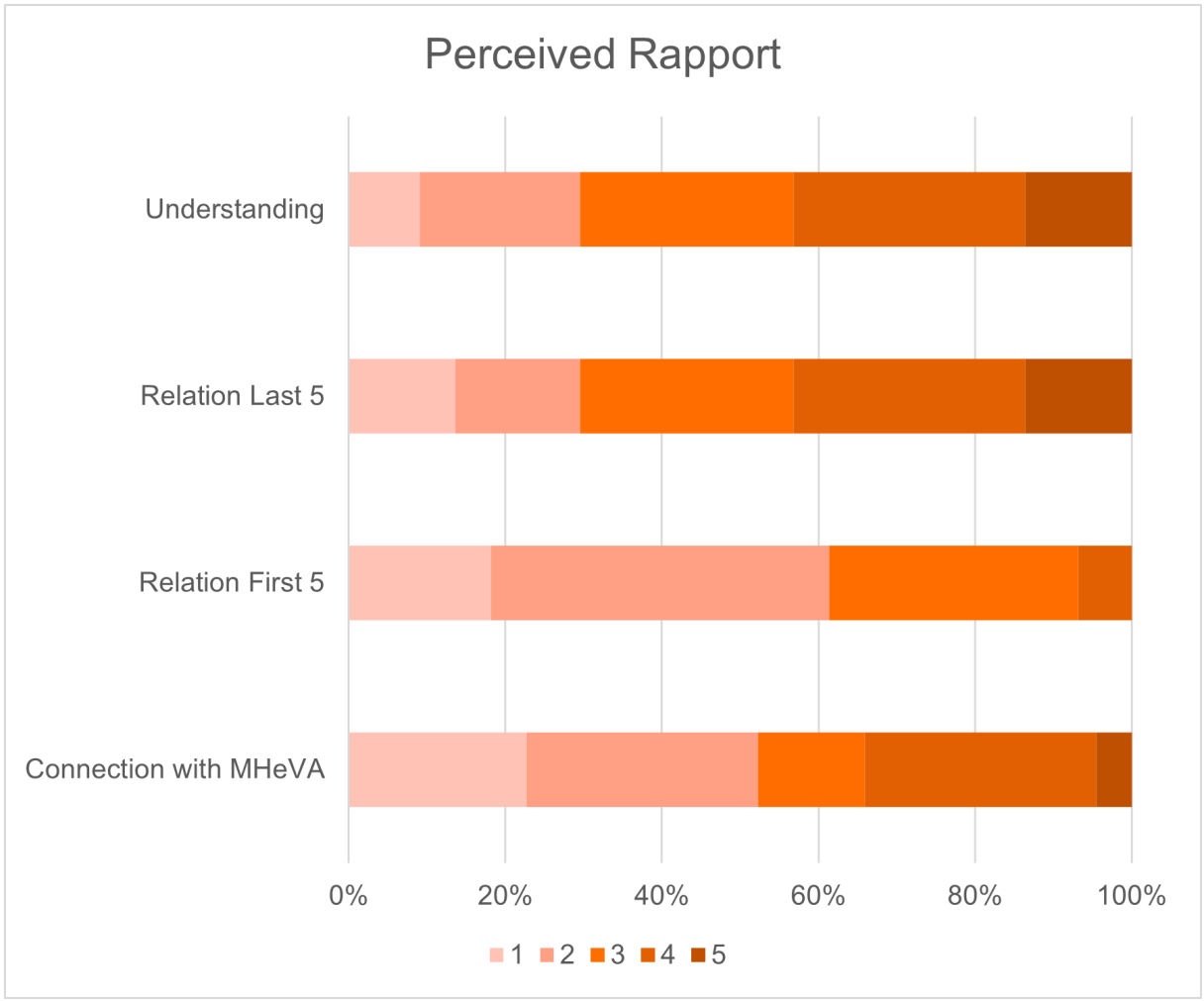
Here we share in more detail the answers to the survey we conducted.

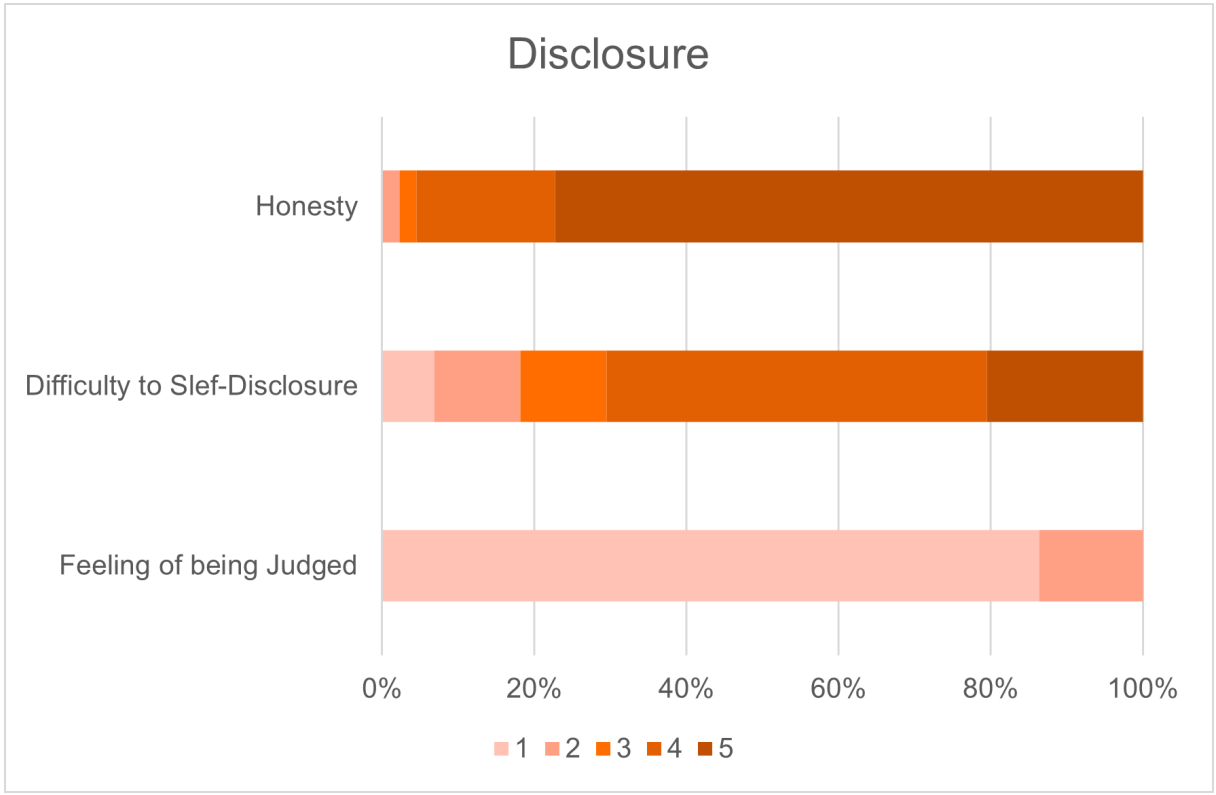

Stigma vs Accessibility of Mental Health Services
Accessibility
Have Stigma
0%
20%
40%
60%
80%
100%
1
2
3
4
5

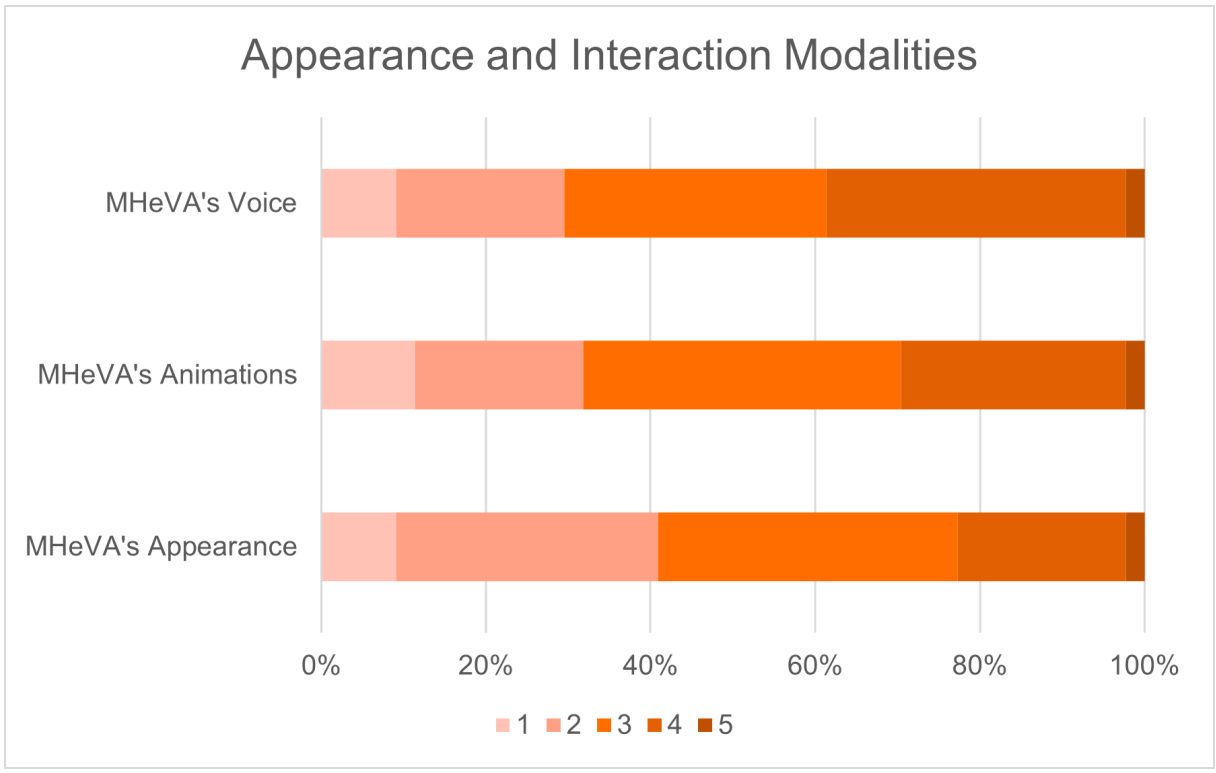

Freefom and Clarity
Easiness of Choice
Clarity of Answer
Freedom of Answer
0%
20%
40%
60%
80%
100%
1
2
3
4
5

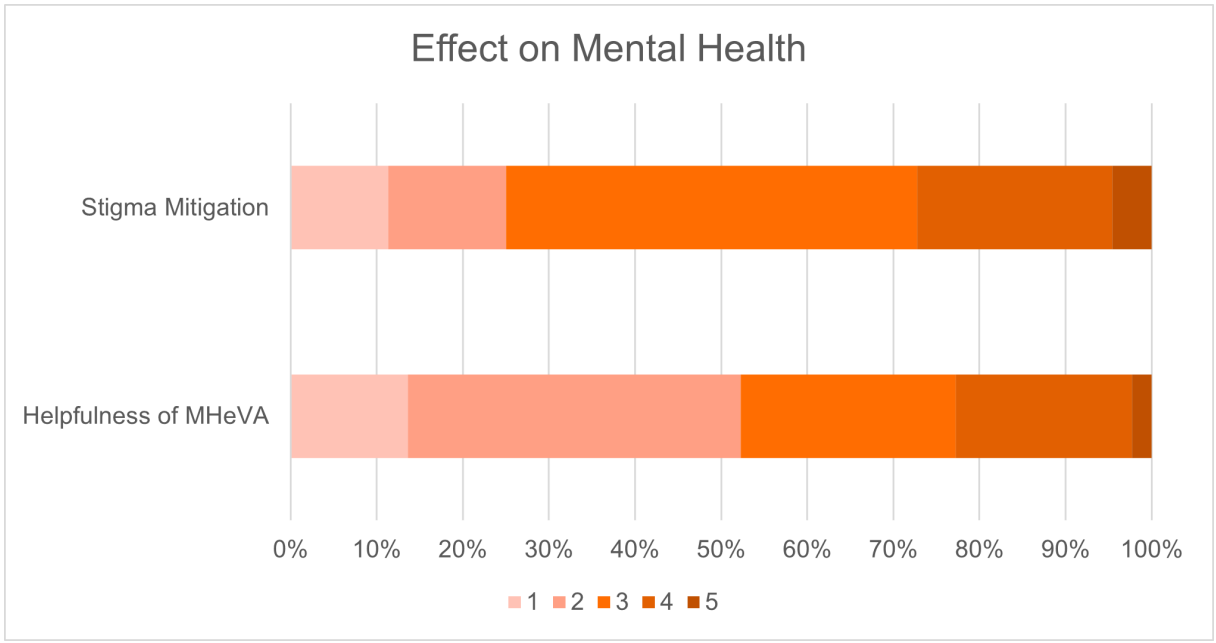

Acceptance and Engagement
Interact Again
MHeVA's Politness
MHeVA's Likability
0%
20%
40%
60%
80%
100%
1
2
3
4
5


Questions Adjectivation
Clarity
Natural
0%
20%
40%
60%
80%
100%
1
2
3
4
5


Perceived Rapport
Understanding
Relation Last 5
Relation First 5
Connection with MHeVA
0%
20%
40%
60%
80%
100%
1
2
3
4
5


Disclosure
Honesty
Difficulty to Slef-Disclosure
Feeling of being Judged
0%
20%
40%
60%
80%
100%
1
2
3
4
5


Appearance and Interaction Modalities
MHeVA's Voice
MHeVA's Animations
MHeVA's Appearance
0%
20%
40%
60%
80%
100%
1
2
3
4
5


Effect on Mental Health
Stigma Mitigation
Helpfulness of MHeVA
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
1
2
3
4
5