Virtual Reality Assessment of Social Anxiety Disorder: The Role of the Serious Game 'Secret Agent's Mission' in Measuring Avoidance Behaviours

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Abstract. Social Anxiety Disorder (SAD) is a prevalent condition characterised by a tendency to avoid social interactions, posing challenges for real-life assessment. Virtual Reality (VR) provides an immersive platform to collect diverse data for evaluating this disorder. This paper introduces the serious VR game "Secret Agent's Mission" as a tool to assess social anxiety levels by observing various avoidance behaviours exhibited by players during gameplay. Furthermore, the game allows to practice social behaviours. The player assume the role of a secret agent tasked with interacting with characters of varying personalities, necessitating the establishment of trust to accomplish the mission. The game facilitates natural speech interactions, resembling real-life conversations, overcoming the limitations of traditional lab assessments and offering a generalizable capture of SAD behaviours. Early findings indicate that "Secret Agent's Mission" serves as a valid measurement tool for assessing SAD behaviours, encompassing active and passive avoidance, as well as latency. As a result, this serious game holds promise as a supplementary diagnostic tool for SAD.

Keywords: Social Anxiety Disorder · Virtual Reality · Serious Game · Assessment · Avoidance Behaviours · "Secret Agent's Mission" · Immersive Simulation · Natural Speech Interactions · Diagnostic Tool · Preliminary Study · SAD Behaviours · Trust Building · Real-life Evaluation · Personality Variances · Active Avoidance · Passive Avoidance · Latency Measurement · Supplementary Diagnosis

1 Introduction

Imagine feeling too afraid to attend a job interview or even go out to do grocery shopping. Your worries are caused by the fear of scrutiny and embarrassment. Not only are you frightened, but you also experience various somatic symptoms, such as blushing, sweating, an increased heart rate, and muscular tension. As unbelievably as it sounds for people who are neither practitioners nor patient, this is the everyday experience of individuals with Social Anxiety Disorder (SAD), sometimes referred to as Social Phobia [14]. Approximately 7% of Europeans

will experience this disorder in their lifetimes, and a staggering 80% will experience at least one symptom of SAD [11] . These poignant statistics manifest in lower job performance, and in some cases, unemployment, as well as an increased burden on healthcare systems [11]. Nevertheless, the disorder often remains undiagnosed and undertreated [20][10]. In addition to well-known reasons common to all psychiatric disorders, such as the social stigma associated with psychiatric conditions and the lack of access to psychiatric healthcare, many existing diagnostic tools are suboptimal in their sensitivity [18]. The lack of assessment of avoidance, time consumption, and limited usability are also highlighted in the literature [13]. Maladaptive avoidance is the hallmark of anxiety disorders [12] and a specific symptom of SAD [3]. Finally, conventional laboratory tests do not mirror real-life settings and are heavily influenced by the patients' feelings and attitudes on the day of the test [8][18]. At least 10 different diagnostic instruments have been developed since 1969, but is has not lead to significant breakthroughs [6][13]. This led us to state the following research questions:

How can avoidance in Social Anxiety Disorder be measured in a generalizable way in a laboratory setting?

How can a measurement tool for Social Anxiety Disorder simultaneously facilitate practising social behaviours?

To answer these questions we propose a Virtual Reality (VR) serious game "Secret Agent's Mission". Our intention is not to replace other tools but to address two specific problems: the difficulty of modelling SAD in a laboratory settings and the lack of well-designed tools to measure avoidance. Thus, our instrument serves as a complement to the existing arsenal of SAD diagnostic tools, allowing practitioners to choose any other tools for further diagnosis without the concern of how to measure avoidance, particularly in laboratory settings. In addition, it allows to practice the desired behaviours. The only existing instrument designed to fulfil a similar role – Role Playing – is cumbersome to use and hardly generalizable [6]. In our design, we have avoided mentioned issues. In comparison to other solutions, this game is accessible due to low technical requirements, it allows for easy measurement of avoidance with a high degree of internal validity, is user-friendly, and does not require specific skills besides assessing avoidance itself. To our knowledge, this is the only example of a VR serious game used to measure symptoms of SAD and one of few examples of such games used for practising social behaviours.

2 Related work

Virtual Reality exposure therapy has been successfully employed in various psychological conditions related to anxiety. The realistic and immersive simulation can serve as a beneficial therapeutic tool [15][2]. Although there are conflicting results regarding the use of VR tools to practice social behaviours, on average, they exhibit slightly higher success rates than conventional tools [7]. VR exposure tends to be more advantageous than merely imaginary situations, at least in the context of hypothetical violent situations [19]. Virtual reality is advantageous

in psychological applications due to its high standardisation and experimental control. It also provides generalizable benefits for the patient [17]. Finally, virtual reality is suitable for measuring and treating avoidance [1].

Exposure to social anxiety stimuli in virtual reality tends to be translatable into conventional scales. Avatar identification (how it relates to me), interpersonal distance, and emotions exhibited by NPCs have been identified as important elements of such simulations [4]. Considering these results, a game with a first-person view would fully immerse a player in the portrayed reality and the issue of avatar identification would be minimised. Furthermore, Virtual reality gaze exposure has been proven to improve the symptoms of patients with anxiety[5]. Patients with SAD also exhibit an unusual gazing pattern [16]. Finally, the latency to approach an NPC (vigilance) is strongly correlated with avoidance behaviour, making it a viable proxy [9].

2.1 Medical tools and metrics

Relevant existing tools and methods can be broadly categorised into two major groups: professional measuring instruments designed to diagnose SAD and VR tools intended to assist patients in practising social interactions. As mentioned previously, various tools and metrics described in the literature are utilized by practitioners for diagnosing SAD. Two of them are administered by practitioners during the screening or diagnosis process, while the rest are self-administered and later assessed by specialists. The Liebovitz Social Anxiety Scale is the most commonly used assessment in the first category. Consisting of 24 items, it is solely employed to screen patients in clinical settings. Its strength lies in its validation, but its weakness is the fact that some items are not empirically proven [13]. The second scale in this category is the Brief Social Phobia Scale, originally designed to assess treatment progress. Similar to the Liebovitz scale, its limitations are associated with the fact that not all items have been empirically proven. The significant drawback of these instruments is their time consumption [13].

Self-administered scales address the issue of time consumption; however, they are often cumbersome to use and may not effectively measure avoidance. When they do measure avoidance, the results often have limited generalizability as they can hardly be translated to real-life settings [13]. Finally, Role-Playing is a method used to diagnose avoidance in clinical settings. It enables the simulation of real-life situations in a laboratory setting, providing an immersive experience with promising results [6]. However, it requires special training, is time consuming, and is more expensive than conventional instruments.

2.2 Tools designed to help patients to practice social behaviours

Simli – Simli is a Swedish company that claims to design software allowing the generation of AI-based NPCs for practising social interactions with completely unscripted dialogues. However, the software has not been released yet,

and there are no published studies. It is not specifically designed for patients with SAD but rather for practising interactions in general.

CleVR – This software is designed by a Dutch company, providing Cognitive Behavioural Therapy (CBT) for various psychological conditions in virtual reality settings (VR-CBT). The software is continually developed and validated in the Dutch setting. It is highly extensive and customisable, and has been commercialised [1].

Flair– This game requires the player to interact with NPCs in "chat rooms" to complete tasks and overcome anxiety. Players can make decisions to become more "likeable" or choose more pragmatic options. The game is designed as a complement to CBT[2].

Other related products *SAD RPG: A Social Anxiety Role Playing Game* – the indie game marketed on Steam platform to demonstrate how SAD patients perceive world [3].

Sym – a puzzle game on Steam. According to the authors, the game allows to better understand SAD by assuming the role of two alter-egos of the same character – the constantly afraid and withdrawn one and one who wants to overcome their fears [4].

In conclusion, VR exposure therapy has shown promise in addressing social anxiety, offering a realistic and immersive therapeutic approach. While conflicting results exist, VR tools generally exhibit slightly higher success rates than conventional methods. Factors such as avatar identification, interpersonal distance, and gaze exposure are crucial in designing effective VR simulations. Existing diagnostic tools vary in their utility, with self-administered scales addressing time concerns but lacking in generalizability. Among tools to aid social behaviour practice, CleVR, Simli, and Flair offer innovative solutions, each with its unique approach. Other related products, such as SAD RPG and Sym, provide alternative perspectives on social anxiety through gaming experiences. CleVR appears to be the most comprehensive option currently available for addressing SAD through VR technology.

3 Game Design

The goal of this game is to measure avoidance in generalizable setting and to allow players to practice desired social behaviours, for this purpose we have identified three essential requirements:

1. The game should provide an immersive experience to the player. The more the player is immersed in the game environment and interactions, the more likely they will show SAD symptoms.

[1] clevr.net
[2] Flair
[3] sadrpg.com
[4] Sym on Steam

2. The game should have balanced difficulty, providing various hints to ensure that the player does not get stuck due to the game's complexity. Simultaneously, the game should not be too easy to maintain the player's interest.
3. The player must engage with NPCs extensively to advance in the game. Only through this interaction can the player's SAD behaviour be induced and measured.

Based on these requirements, we have designed a serious VR game.

3.1 General Description

The game enables practitioners to measure avoidance triggered by an unfamiliar environment and the range of emotions and behaviours exhibited by NPCs in an immersive, generalizable setting. To successfully complete the game, a player must approach and "talk" with all NPCs **??**. Avoidance is measured by the latency of approaching any NPCs. To finish the game, a player also needs to refrain from exhibiting active avoidance. This is in contrast to the avoidance measured elsewhere in the game, during which a player would simply refrain from initiating a social interaction or delay it. For a simple example (courtesy of ChatGPT), imagine that the player is invited to a party. If they reject the invitation, e.g., by using an excuse, it would be a case of *active avoidance*. However, if, for whatever reason, e.g., being too anxious to decline the invitation, they attend the party and just stand in the corner, as in the popular meme [5], then it would be an example of *passive avoidance*. To enhance immersion, NPCs will provide dynamically generated responses. To ensure generalizability and avoid increased latency when entering rooms caused by curiosity, all rooms look approximately the same. An additional advantage of the game is the measurement of the player's gazing (gaze height direction), which in patients with SAD has an unusual pattern [16]. The game is played from the first person perspective. Since there is no avatar in our game, the player is fully immersed in reality to overcome the limitation of avatar (dis)similarity [4]. Furthermore, the game can be utilised to practice social behaviours. The entire game takes around 20 minutes to complete. The technical requirements are modest, thus any modern VR headset and computer with a dedicated graphics card should be able to run the game.

3.2 Game story and loop

The player's alter ego is a secret agent whose goal is to steal bomb's plans from the enemy agency's office. To achieve this, the player must communicate with the agency's employees to earn their trust. Only by gaining their trust can the player obtain crucial information and advance to the next level's employees. The agency consists of a total of 5 employees and the agency's head, with the difficulty of gaining trust gradually increasing. The player will only have the opportunity to steal the bomb plans once they gain the trust of the agency's head.

[5] This one.

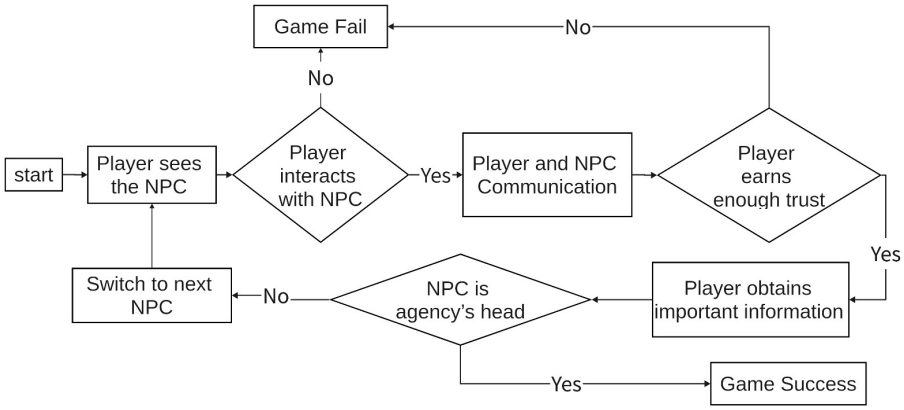

Fig. 1. Detailed game loop

3.3 Core Mechanics

The core mechanics of the game consist of three essential elements: the design of NPCs, the trust scoring system, and the dialogues. Together, these elements lead to a consistent gaming experience and generalizable results.

1. Design of NPCs
   - **Exhibition of various emotions and grimaces:** Individuals with SAD struggle with social interactions, both positive and negative ones. By designing NPCs in the game with a variety of expressions and personalities, we were able to more realistically simulate the diversity of social scenarios. This ensures that the social situations players face in the game are complex enough to fully reflect the variety of social challenges players may encounter in real life.
   - **Induction of avoidance behaviour:** Individuals with SAD often exhibit avoidance behaviour in response to criticism or praise. Therefore, setting the game in such a way that some NPCs display negative emotions such as anger or impatience, while others display positive attitudes, can more effectively simulate the different reactions that SAD patients may encounter in real social situations. This design decision helps the game to provide comprehensive and accurate data on social behaviour to better assess players' behavioural patterns.
2. Trust-scoring system
   - **Simulation of the trust-building process:** The trust scoring system is designed to simulate the complexity of building trust in social interactions. Individuals with social phobia find the process of building trust

in social interactions challenging, so the inclusion of this mechanic in the game helps to more fully assess player performance in building trust. This allows the game to reflect the trust-building challenges that may be faced in social situations, thus providing targeted data for evaluation.

- **Trust building:** The level of trust in the game is determined by the effectiveness of player-NPC interactions and reactions to events. Points of trust are earned through dialogues with NPCs. Initiating dialogues increases the likelihood of gaining all trust points. Once a threshold is reached, NPCs reveal important information. Player responses are recorded in the trust system. For example, a certain NPC offers 4 trust points. Talking based on clues can yield 2 or 3 trust points. If the player's trust score meets the threshold (e.g., 3), the NPC helps access the next setting to progress.
- **Quantification of social interactions' effectiveness:** The trust scoring system focuses not only on the number of effective player-NPC interactions but also on how players react positively or negatively to particular events e.g., by exhibiting avoidance. This helps to quantify the actual effects of social interactions, including whether the player succeeded in building trust, experienced frustration, or exhibited other symptoms of social anxiety. Through this system, the game provides detailed insight into the different ways in which individuals with social phobia behave during the trust-building process.

3. Dialog interaction
   - **Hints:** While guiding players through social interactions, the hints mechanic helps to ensure smooth gameplay. Players can progress by starting dialogues based on tips in the UI, ensuring that dynamically generated responses are related to the storyline.
   - **Keyword triggering:** The dialogues start when the player pronounces selected keywords, shown in the UI. This triggers the NPC's narration of the corresponding storyline information.

4 Game Implementation

For the implementation of our game, we focused on maximising player immersion and achieving as close to natural real-life behaviour to accurately asses SAD behaviour. To achieve these goals we used the following components: NPC's AI, NPC interaction and game data analysis.

4.1 AI NPC asset

To create immersive experience, we utilised the Inworld.ai asset, an AI NPC resource pack that enhances the lifelike qualities of in-game characters. These NPCs respond dynamically to player input, displaying facial expressions, body language, and can change moods during communication. Moreover, specific triggers, such as keywords or trust level thresholds, enable NPCs to convey crucial

information related to the storyline. This approach ensures a seamless storyline progression while providing players with the freedom of communication.

4.2 Interaction method and UI

We used speech recognition built in Inworld.AI for player-NPC interaction, enabling natural communication. Game dialogues are presented in text to ensure smooth gameplay. We designed hints for multiple choices that will appear in the user interface (UI), as well as the trust level. When the game progresses and the trust level increases, the corresponding hints change. When all available trust levels are reached, the trust level bar turns green. An example of the UI is shown in Fig‘2.

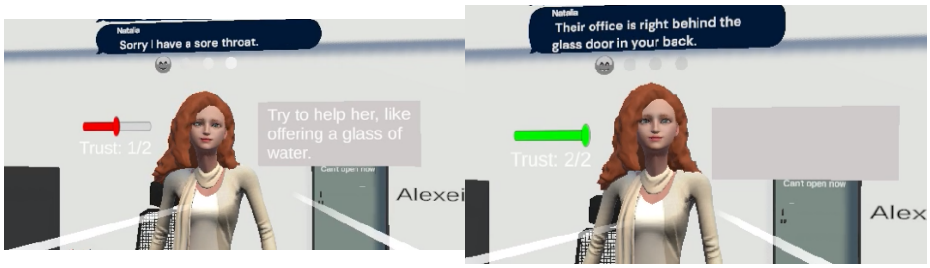

Fig. 2. An example of the in-game UI

4.3 Game data analysis

”Secret Agent’s Mission” is a serious game to assess the SAD behaviour of its players. The game captures and analyse three types of data: active avoidance, passive avoidance, and latency assessment.

- Active Avoidance Data:
  - Derived from in-game storyline events.
  - Recorded when a player remains silent or rejects NPC invitations during communication.
  - Captured as trigger signals, measuring active avoidance behaviours.
- Passive Avoidance Data:
  - Extracted from two primary sources: player-NPC distance and eye-gaze data.
  - Real-time recording of distances between the player and NPCs.
  - Eye-gaze data includes gaze duration and direction during player-NPC interactions, helping assess hesitancy and eye contact avoidance.
- Latency Assessment as proxy for passive avoidance:
  - Time it takes for a player to approach an NPC upon entering a room/office.

- Time it takes for the player to respond to in-game dialogue.
- Longer latency indicates passive avoidance.

5 Evaluation

The assessment of effectiveness of "Secret Agent's Mission" as a tool for measuring SAD behaviour will be conducted by experimental psychologists. However, we conducted a test to evaluate whether "Secret Agent's Mission" is able to measure the required data and to assess the players' experience. The evaluation consisted of a game experiment and a questionnaire.

5.1 Game experimental Settings

In total, three players participated in the evaluation, all of them were students. We did not require players to have prior knowledge of VR. Before the experiment started, without revealing the purpose of the experiment, we briefly instructed them on how to walk around and talk in the VR game. After completing the game, players were asked to fill in a questionnaire containing 4 questions about their experience: enjoyment, engagement, difficulty, and perception of variety of NPC personalities. The scale with range 1-10 was used. All participants were informed and consented to the use of their data.

5.2 Results

Player data analysis In the game, we mainly measured the data listed in subsection4.3: active avoidance, passive avoidance, and latency. The latter is also a proxy for the passive avoidance. The exemplary results are shown in Figure 3.

As can be observed, the passive avoidance and latency data of the players were recorded, including the real-time distances between the player and different NPCs as well as the time spent approaching the NPCs, and the gaze pattern (gaze height) when the player is talking to the NPCs. Since none of the players displayed significant passive or active avoidance behaviours to our knowledge, i.e. long periods of silence or rejecting invitations, these trigger signals were not recorded.

Questionnaire results The results of the questionnaire are shown in Figure 4.

Players can clearly feel the difference in the personality of the NPCs in the game and on average feel engaged. Players found the game quite enjoyable. In terms of difficulty, one player found the game to be very easy, while others found it to be moderately difficult.

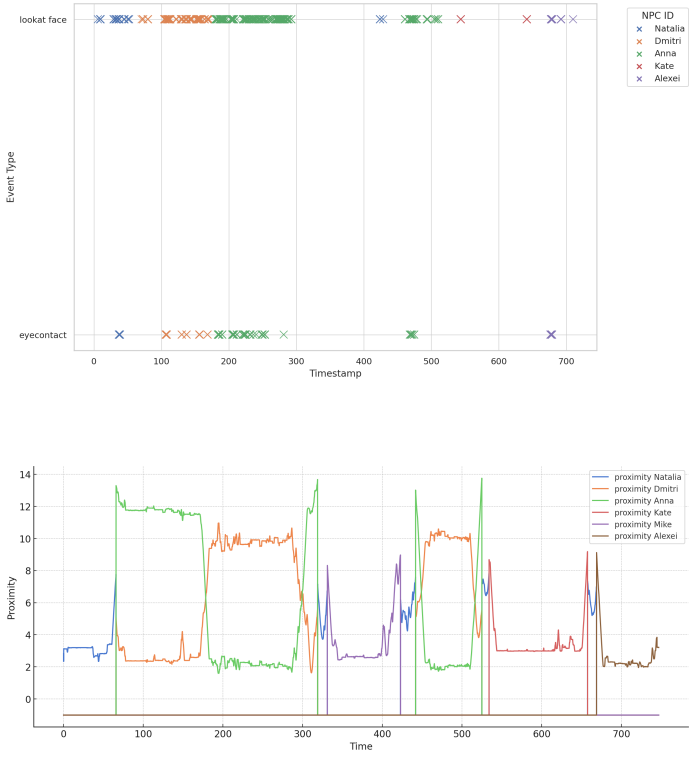

Fig. 3. Player's data

5.3 Discussion

From the evaluation, it can be concluded that "Secret Agent's Mission" can measure data for assessment of SAD. Considering a very small sample of testers, any definitive conclusions can be hardly drawn, except for the fact that the game collects data related to SAD behaviour. Furthermore, the players' opinion on the difficulty of the game were divided, and more data are needed to make definitive conclusions. A solution for low difficulty could be to incorporate setting different difficulty levels. The settings could influence the amount of hints available affecting the difficulty of the level. However, lower number of hints could result in inability to complete the game. Additional tests on a big sample would be required to assess this.

"Secret Agent's Mission" will be further evaluated by an experimental psychologist. The game will be evaluated first with healthy individuals, albeit with high social anxiety scores to determine whether there is a correlation between game results and results of conventional tests. If this part of evaluation turns out to be successful, the game will be tested on real patients.

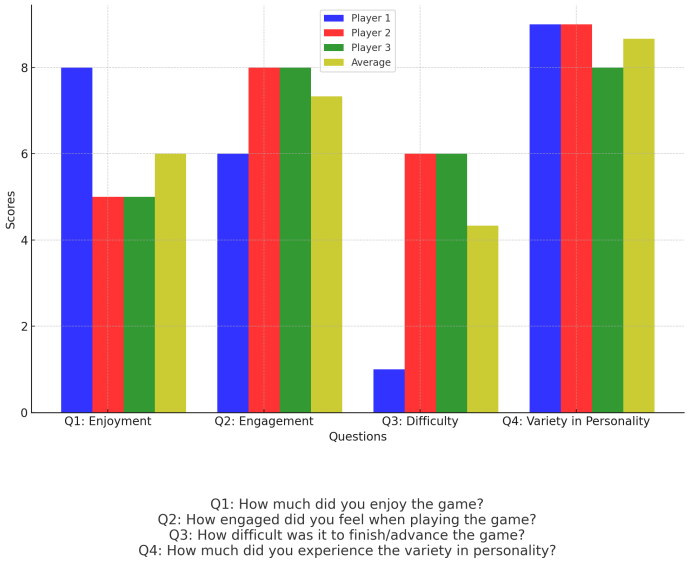

Fig. 4. Questionnaire results

6 Conclusion

The game 'Secret Agent's Mission' is a novel VR instrument designed to assess symptoms of SAD and simultaneously practice social behaviours. Our evaluation suggests that the game effectively measures both active and passive avoidance. Additionally, thanks to the application of AI assets, the game allows for adjustments to NPC personality and dialogue styles, thereby boosting its versatility for diverse requirements. In collaboration with an experimental psychologist, a thorough clinical evaluation will be undertaken, and the results will be reported elsewhere.

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