A Serious Game for Early Detection and Assessment of Social Apathy: A Pilot Study

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Abstract: With increasing life expectancy, the prevalence of age-related disorders such as dementia, often preceded by mild cognitive impairment (MCI), has risen significantly. Among the early signs of cognitive decline, social apathy stands out as a key indicator, associated with an increased risk of progression to dementia. In this context, we present ApathySEED, a serious game developed to assess social apathy in individuals with MCI. The game uses decision-making in social scenarios to evaluate apathy across initiative, interest, and emotion subdomains. A pilot study involving 33 healthy participants was conducted to validate the game's usability and effectiveness as a tool for assessing social apathy. Standardized questionnaires, including SUS, NASA-TLX, and AMI, were used to measure game performance, cognitive load, and apathy levels. Results suggest that ApathySEED is a promising tool for apathy assessment, with low cognitive load and high usability, making it suitable for future clinical utilization.

1 INTRODUCTION

Mild cognitive impairment (MCI) is a common condition among the elderly, bridging normal aging and more severe cognitive decline, such as Alzheimer's disease (AD). It involves memory and attention deficits without major impact on daily life. With no cure for AD or dementia, early detection is vital (Etgen et al., 2011). Social apathy, marked by reduced interest and engagement in interactions, is a key MCI indicator and linked to a higher risk of progression to AD (Kazui et al., 2017). Early detection of social apathy could help delay or prevent severe cognitive decline.

Traditional methods for assessing apathy, like clinical interviews and paper-based questionnaires, often struggle to capture real-life social engagement and can introduce bias through subjective reporting. Digital and gamified approaches offer a more interactive and objective alternative, allowing for scalable, user-driven assessments without needing trained personnel. This improves accessibility and engagement, leading to more accurate and ecologically valid results compared to traditional methods (Tong et al., 2014).

In this work, we introduce ApathySEED (SErious game for Early Detection), a novel serious game developed to assess social apathy in patients with MCI. Serious games, designed for purposes beyond entertainment, have gained traction in healthcare for diagnosis, rehabilitation, and cognitive training (Chessa et al., 2024). Effective serious games in healthcare must integrate more than just biomedical content—they must also prioritize usability, accessibility, and aesthetic appeal to engage users, particularly older adults (Khalili-Mahani et al., 2019).

The contributions of our study are multi-faceted. First, ApathySEED provides an innovative alternative to paper-based assessments for social apathy in MCI, with a design tailored for elderly users. A pilot study demonstrated its effectiveness and correlation with traditional tools, showcasing its potential for reliable, complementary data. The game also enables early detection, supporting timely interventions to prevent further cognitive decline. Finally, its intuitive design and visually appealing elements enhance user engagement, improving both the user experience and the efficacy of cognitive evaluations in healthcare.

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2 RELATED WORKS

Currently, there are several tests available for screening MCI (Tsoi et al., 2015), with the choice of test largely depending on various factors such as the administering expert's familiarity with the tool, time constraints, or the test's perceived accuracy. Despite this variety, there is a notable lack of standardization in terms of accepted tests and scoring criteria, which can affect the reliability of the results.

Several tests specifically designed for MCI diagnosis, such as the Memory Alteration Test (M@T) (Rami et al., 2007) and Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), are widely used in psycho-geriatric settings for initial cognitive evaluations (Chen et al., 2021b). While they assess broad cognitive domains, they require professional administration and may not fully capture specific deficits like social apathy.

Apathy often coexists with other clinical syndromes, such as depression, fatigue, and anhedonia. Recently, the diagnostic criteria for apathy in brain disorders have been updated (Robert et al., 2018; Miller et al., 2021). These new criteria refine the domains of apathy, indicating that a reduction in goal-directed activity can manifest in behavioral, cognitive, emotional, or social dimensions. Furthermore, apathy is also observed to varying degrees in healthy individuals (Ang et al., 2017), making its assessment important for early identification and prevention of future cognitive decline.

Integrating information and communication technologies into medical evaluation can offer valuable diagnostic insights (Zeghari et al., 2020). However, developing serious games for users with cognitive impairments is challenging, as it requires addressing their needs, emotional responses, and overall comfort. Since most affected individuals are elderly and may have limited technological familiarity, usability adaptations and a well-designed interface are crucial for maintaining focus and immersion (Chen et al., 2021a).

Several serious games for MCI assessment have been developed. Kitchen and Cooking (Manera et al., 2015) evaluates planning, attention, and object recognition through cooking tasks, tracking performance over time to monitor cognitive decline. In (Chessa et al., 2019), a non-immersive exergame and an immersive VR environment were tested, showing strong correlation with standard clinical tests. SynapseToLife (Costa et al., 2017) assesses problem-solving skills through virtual real-life scenarios, while SkillLab (Pedersen et al., 2023) uses six mini-games to assess cognitive abilities like reaction time and memory. Despite these advancements, there remains a significant gap in games designed specifically to assess apathy in MCI populations.

3 THE PROPOSED SERIOUS GAME

The ApathySEED serious game for social apathy assessment has been designed in alignment with the diagnostic criteria for apathy outlined by (Robert et al., 2018), ensuring the game's relevance for clinical evaluation. The game's narrative centers on decision-making within social contexts. Participants are scored based on their choices, which are mapped to the apathy dimensions specified in the updated diagnostic criteria. Figure 1 illustrates the various elements of the developed game, including the avatars, 3D environments, and user interface.

3.1 Narrative/Storytelling

The development of the narrative was closely supervised by an expert in the field, who is among the authors, ensuring that both the storyline and decision points are clinically relevant and effectively contribute to the evaluation of apathy. The storyline was designed as a linear structure to enhance immersion and to provide a smooth and continuous progression. This seamless flow supports accurate assessments by reflecting the patient's social engagement or detachment through their decision-making. To accommodate older adults' limited tech experience, a brief tutorial was incorporated at the beginning of the game to introduce the game mechanics.

The narrative unfolds across three distinct scenarios (see below) and involves three characters: the protagonist, representing the player; the protagonist's neighbor; and the protagonist's daughter. User decisions guide the player through various narrative paths that intertwine and diverge throughout the game, ensuring a coherent evaluation regardless of the chosen route.

3.1.1 First Scenario: Living Room

The narrative begins with the player relaxing at home when the doorbell rings amidst heavy rainfall. Upon opening the door, the player encounters their neighbor, who is soaked and distressed. The neighbor explains they've forgotten their keys and asks to stay until the storm passes or their spouse arrives. The evaluation in this scene focuses on the player's willingness to let the neighbor in and engage in conversation.

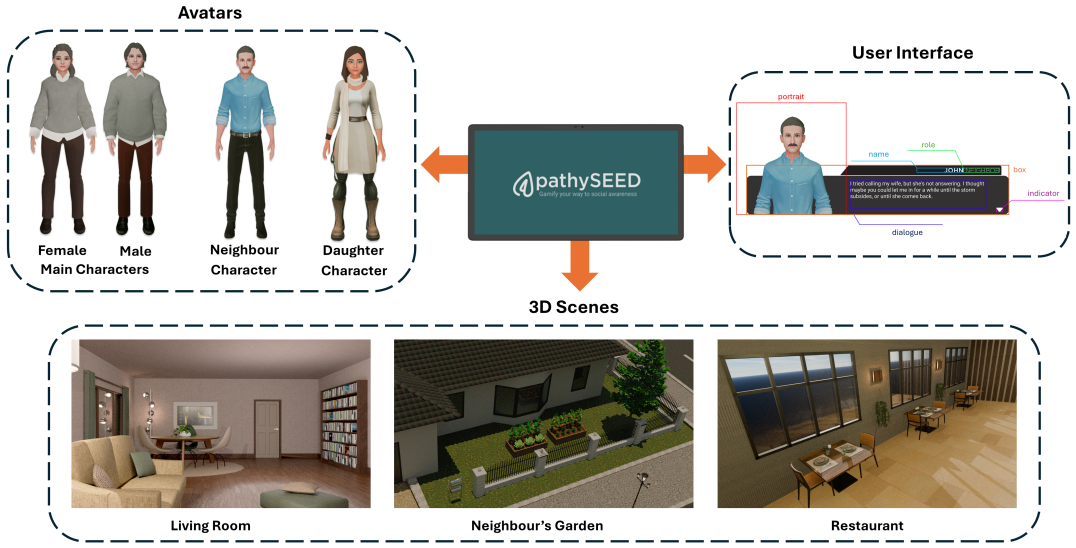

Figure 1: Various elements of the ApathySEED game.

3.1.2 Second Scenario: Neighbor's Garden

After the storm subsides, the neighbor, expressing gratitude for the hospitality extended, offers the player fresh vegetables from their garden. This offer leads to two potential narrative pathways: accepting or declining the offer, which assesses the player's willingness to leave the house.

- **Accepting the Offer.** The scene transitions to the neighbor's garden, where a conversation ensues. The player's responses to the neighbor's emotions and life events are assessed, alongside their initiative to participate in activities like helping with the vegetable harvest. Afterwards, the player returns home and receives a phone call from their daughter, who reminds them of a dinner reservation at a restaurant. The decisions made during this call set the stage for the third part of the narrative.
- **Declining the Offer.** The player remains in the living room, resting, and receives a phone call from their daughter, reminding them of the dinner reservation at the restaurant. On the way to the restaurant, the player encounters the neighbor again in their garden, leading to a conversation that follows a similar pattern to that of the "accepting the offer" narrative pathway, providing another opportunity for assessing social engagement.

3.1.3 Third Scenario: Restaurant

The final scene takes place in a restaurant where the daughter had made a reservation for dinner. In this setting, the player and their daughter reconnect after a period of separation. This conversation serves to evaluate the player's interest in their daughter's life and concerns, as well as their willingness to discuss personal matters. This scene is used to assess emotional engagement and social apathy, as it involves intimate family interaction.

To conclude the narrative, the player returns home and is presented with a final decision that summarizes their overall experience and engagement throughout the game.

3.2 Scoring System

The final narrative framework encompasses twenty key decisions, each offering three distinct options. Depending on the player's choice, a scoring system is applied, awarding 0, 1, or 2 points per decision, resulting in a maximum achievable score of 40 points. These decisions are structured within social dimension of apathy outlined in the diagnostic criteria (Robert et al., 2018). In particular, 6 decisions correspond to the emotion subdomain, 6 to the initiative subdomain, and 6 to the interest subdomain, while the remaining 2 decisions are intentionally left ambiguous. To ensure a focused and reliable evaluation, the five most definitive decisions from each subdomain were selected for scoring, with each subdomain carrying a maximum potential score of 10 points. Higher scores indicate lower levels of social apathy, reflecting greater emotional engagement, initiative, and interest in social interactions, while lower scores suggest higher levels of apathy.

3.3 Game Design

The game's style and interface were designed to ensure accessibility for older users while meeting the game's needs. A stylized approach was chosen, blending cartoonish and realistic elements to leverage the benefits of both styles (Korre, 2023) while user-centered guidelines informed the creation of simplified, high-contrast interface elements for intuitive and accessible navigation (Gerling et al., 2012).

Character design was developed using the ReadyPlayerMe[1] platform. Each character was crafted with specific aesthetic and color criteria in mind, ensuring alignment with the narrative requirements of the characters. Simultaneously, Blender[2] was utilized for the development of various 3D scenarios, combining internally created materials and models with pre-existing elements sourced from BlenderKit[3], Sketchfab[4], and the Unity Asset Store[5].

The user interface design was inspired by visual concepts commonly found in existing video games, aiming to create an engaging 3D background. To enhance immersion and narrative flow, dialogue boxes featuring character portraits were integrated. Graphic elements were developed using Illustrator[6] and Photoshop[7], while Figma[8] facilitated the integration and overall design of the user interfaces. The design process involved selecting a color palette and typography that aligned with established design guidelines.

The game was developed using the Unity[9] game engine. Three distinct scenes were created, utilizing Blender models imported in FBX format with textures and UV maps. A lighting system combining real-time and pre-computed techniques was implemented, using directional, spot, and point lights, along with skyboxes, to create an immersive atmosphere.

Game mechanics were managed with custom scripts and the Fungus[10] tool to streamline interactive storytelling. Cameras were strategically positioned to support the narrative, and characters were animated using Mixamo[11] animations and custom ones from Blender. Sound, visual effects, and post-processing techniques were added to enhance immersion.

[1]https://readyplayer.me/
[2]https://www.blender.org/
[3]https://www.blenderkit.com/
[4]https://sketchfab.com/
[5]https://assetstore.unity.com/
[6]https://www.adobe.com/products/illustrator.html
[7]https://www.adobe.com/products/photoshop.html
[8]https://www.figma.com/
[9]https://unity.com/
[10]https://fungusgames.com/
[11]https://www.mixamo.com/

Figure 2 shows gameplay screenshots highlighting key user interactions, including dialogues, decision-making, and the user interface. These images illustrate how players engage with the narrative and make choices that assess social apathy by simulating real-life interactions, reflecting their social initiative and emotional connection.

4 GAME VALIDATION

To prepare for clinical use, it was essential to evaluate the game's effectiveness, usability, and overall feasibility as a tool for assessing social apathy. This validation process was necessary to ensure the game not only aligns with clinical diagnostic standards but also remains functional, engaging, and accessible for diverse user groups.

Therefore, a pilot study was conducted aimed to gather data on technical performance and user interaction, focusing on ease of use, narrative immersion, and clarity in decision-making. The study also provided preliminary insights into the game's potential for detecting social apathy by simulating real-world interactions. The user study was conducted after approval from the university ethics research committee of the University of Genoa (n. 2024/59).

4.1 Study Participants

A total of 33 participants were recruited from the students and researchers community. The overall demographics of the participants can be found in Table 1. All participants were volunteers and received no compensation.

Table 1: Demographics of the participants. Gaming and serious games experience is self-rated out of 10.

Total Participants	33
Male Participants	18
Female Participants	15
Age	26 ± 8.2
Video Gaming Experience	6.4 ± 2.6
Serious Games Experience	4.2 ± 2.7

All participants were presumed to be healthy, as the primary objective of this pilot study was to evaluate the game's usability, user experience, and general acceptance, rather than to assess its diagnostic accuracy in clinical populations. This approach allowed the study to focus on refining the game mechanics and interface, ensuring that the design would be intuitive and engaging for a broader audience, including individuals with cognitive impairments in future studies.

Figure 2: Examples of various dialogues and decision making scenarios from the game.

4.2 Experimental Procedure

The game was installed on an Android tablet, specifically the Samsung Galaxy Tab S7 FE, which features a 12.4-inch display with a resolution of 2560x1600 and runs on Android 13. This device was selected for its large screen and high resolution, which facilitated a more immersive and accessible gaming experience.

The experiments were conducted in a controlled room at our institute, designed to provide a neutral, distraction-free environment conducive to consistent testing conditions for all participants. Each session lasted approximately 20 minutes.

Prior to commencing the study, participants received a thorough briefing on the project's objectives, including the ethical handling and confidentiality of their personal data. After reviewing this information, participants voluntarily signed a consent form, confirming their willingness to take part in the study. The participants were further informed of their right to withdraw from the study at any time without prejudice. A thorough explanation of the experimental tasks and procedures was also provided to them.

At the start of each session, participants completed a brief demographic questionnaire, which included questions about their prior experience with video games and serious games. They then engaged with the ApathySEED game, navigating the narrative and making decisions independently. Upon completing the game, participants were asked to complete several post-interaction questionnaires, which served to assess their experience and evaluate key aspects of the game's usability, workload, and alignment with its apathy detection objectives. These questionnaires included:

- **System Usability Scale (SUS).** The SUS (Brooke, 1996) consists of 10 items, each rated on a five-point Likert scale. It provides a global usability score out of 100, reflecting the game's user-friendliness.
- **NASA Task Load Index (NASA-TLX).** The NASA-TLX (Hart and Staveland, 1988) measures perceived workload across six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration. Participants rated each dimension on a scale from 0 to 20. The raw version of the questionnaire was used and the scores are scaled out of 100.
- **Apathy Motivation Index (AMI).** The AMI (Ang et al., 2017) evaluates apathy across three dimensions (behavioral, social, and emotional) using 18 items, rated from 0 to 4. A standardized range from 0 to 4 is used, where 0 represents no apathy, and 4 indicates high apathy levels for each dimension as well as the total score.

Throughout the process, participants were encouraged to respond honestly and were given the opportunity to ask questions for clarification at any point, ensuring they fully understood the tasks and questionnaires.

4.3 Data Analysis

A boxplot for the mean game scores can be seen in the left image in Figure 3. The mean scores (General: 32.58; Initiative: 7.55; Interest: 7.45; Emotion: 9.18) suggest that participants displayed low levels of social apathy, which aligns with expectations given that all participants were presumably healthy individuals.

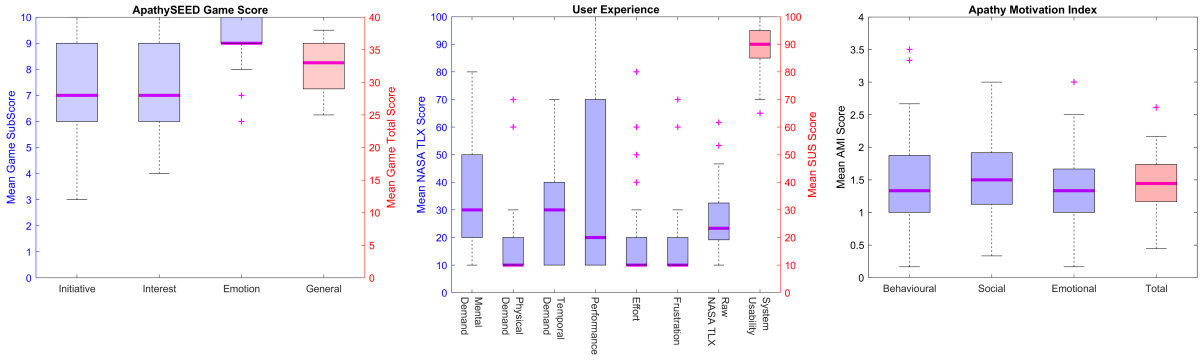

Figure 3: Questionnaire responses. (left) ApathySEED game scores. (middle) User experience questionnaires, i.e., NASA Task Load Index and System Usability Scale (rightmost column). (right) Apathy Motivation Index.

Among the subdomains, the emotion subdomain exhibited both a higher mean score and a lower standard deviation compared to the interest and initiative subdomains. This could imply that participants demonstrated greater emotional responsiveness. Alternatively, this result may reflect limitations in how the emotional content of the game is currently framed, as the narrative and decision-making process might be influenced by socially acceptable norms rather than authentic emotional engagement.

The middle image in Figure 3 illustrates participants' responses to the user experience questionnaires. In terms of system usability, low variability was observed in participant responses, indicating a general consensus regarding the ease of use and functionality of the game. Users found the system intuitive, accessible, and easy to learn, even without prior experience, reflecting well on the design's effectiveness. Most participants felt confident in using the game, and the overall SUS score of 88.64 reflects a strong perception of the system's usability, though some variation in individual user experiences was observed.

Cognitive load responses showed low to moderate variability, with the performance sub-scale exhibiting the highest variability, indicating mixed perceptions of success. The physical demand, effort, and frustration sub-scales were rated consistently low, suggesting minimal strain. Mental and temporal demands were seen as low to moderate, indicating some cognitive challenge and time pressure, but not excessive. The highest perceived workload was related to performance, reflecting differing views on success. The average NASA-TLX score of 26.16 suggests moderate cognitive engagement without significant burden.

The right image in Figure 3 presents the scores for the apathy questionnaire. The average scores across the various dimensions (Behavioural: 1.49; Social: 1.53, Emotional: 1.39; Total: 1.47) are notably similar, suggesting that participants exhibited a generally low level of apathy across all dimensions. This finding aligns with expectations, given the healthy status of the participants. Furthermore, the standard deviations for each dimension demonstrate moderate variability in participants' responses, which reinforces the overall perception of low levels of apathy.

An analysis was conducted to explore the relationship between participants' scores in the game and their scores in the social dimension of the AMI. The Shapiro-Wilk test revealed non-normal data distribution($p < 0.05$). Consequently, Spearman correlation coefficients were computed to examine the associations (see Figure 4). The results showed a negative trend due to inverse scoring scales. The initiative dimension had the strongest correlation, highlighting its reliability as an indicator of social apathy, while the interest dimension showed the weakest correlation. In general, the consistent trend across the AMI scores mirrors the game scores, providing additional validation for the effectiveness of the serious game in assessing social apathy.

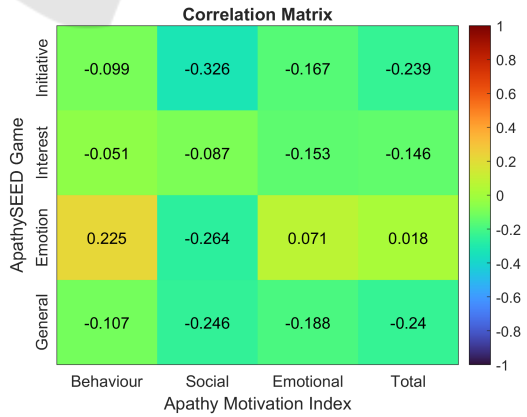

Figure 4: Spearman correlation coefficients between game scores and AMI scores.

To further investigate this relationship, participants were divided into two groups based on their so-

cial apathy levels: low social apathy and high social apathy. This classification facilitated a comparative analysis of game performance in relation to the participants' social apathy levels. A cutoff of 1.5, corresponding to the median AMI social dimension score, was used, i.e., scores below 1.5 were categorized as low, and scores above 1.5 as high. A Mann-Whitney U-test assessed statistical differences between groups, with results summarized in Table 2.

Table 2: Mann-Whitney U-test.

	Statistics	p-value
Initiative	76.5	0.038
Interest	110.0	0.405
Emotion	86.5	0.070
General	93.5	0.153

The comparison between the low and high social apathy groups revealed no statistically significant differences in the general score or in the dimension of interest, indicating a lack of clear distinction between the groups in these areas. Although the dimension of emotion did not achieve statistical significance, the p-value was close to the conventional threshold of 0.05, suggesting a potential trend towards a difference between the groups. Notably, the dimension of initiative displayed statistically significant differences between the groups. This suggests that variations in participants' willingness to take initiative in social situations are closely associated with their levels of social apathy, making this dimension a valuable focus for future assessments and interventions.

4.4 Discussion

This pilot study aimed to evaluate the usability and effectiveness of the ApathySEED serious game in assessing social apathy. The high SUS score suggests that participants found the game user-friendly and intuitive, meeting the design goal of easy adoption for a wide audience, including potential clinical users. The NASA-TLX results reflected a low to moderate cognitive load, indicating the game was challenging yet manageable for participants, with minimal frustration or physical demand.

The game scores were consistent with AMI scores, reflecting similar patterns across self-reported and game-based measures. The game scores indicated low levels of apathy among healthy participants, reinforcing the game's validity as an apathy assessment tool. The initiative subdomain, in particular, demonstrated the strongest correlation with AMI scores, suggesting that this aspect of the game aligns well with traditional measures of social apathy. This dimension also revealed statistically significant differences between participants with low and high social apathy, underscoring its sensitivity in detecting varying levels of initiative in social contexts.

Although the study yielded promising results, several limitations should be acknowledged. First, the sample consisted exclusively of healthy participants, limiting the generalizability of the findings to clinical populations with cognitive impairments or apathy-related disorders. Future studies will involve patients with known apathy or cognitive impairment to evaluate the game's effectiveness in a more clinically relevant context.

Moreover, the emotional domain of the developed game showed potential for improvement, as the current narrative may not fully engage or evaluate emotional apathy as intended. Revisiting the design and content of the emotional scenarios could enhance the game's ability to assess this dimension more accurately.

5 CONCLUSIONS

This work introduced ApathySEED, a serious game designed for the assessment of social apathy, particularly targeting individuals with cognitive impairment. The game design focused on simulating decision-making in social contexts to evaluate apathy across various dimensions by paying attention to the effectiveness and easiness of interactions. A pilot user study was conducted with 33 healthy participants to evaluate the game's validity, usability, and cognitive demand using standardized tools such as the SUS, NASA-TLX, and AMI questionnaires. The findings show the game's potential as an effective tool for assessing apathy, with promising usability and low cognitive load. Future work will expand the study to clinical environments, involving patients with mild cognitive impairment to further validate the game's effectiveness in clinical settings.

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