

Decoding Social Situations in Adolescents with Asperger through a Serious Game

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Abstract

This work focuses on the development of social skills in adolescents with Asperger Syndrome. In this context, several multimedia tools to support learning have been developed. These tools have the advantage of being flexible and fun for some. However, they generally lack interaction and realism. Thus, in some cases, it is difficult for people with Asperger to transpose the skills acquired through these tools in real situations. Our goal was to develop a serious game that facilitates immersion of Asperger adolescents in the game through real situations in order to facilitate the transfer of skills. The game we have developed was designed and tested in the context of a project in partnership with experts and Asperger adolescents.

Key words: Serious Game; Disabilities; Asperger syndrome; participative design; evaluation.

1. Introduction

Asperger syndrome is an autism spectrum disorder that is characterized by significant difficulties in social language, communication and interaction with others. Asperger people have difficulties to understand the mind, feelings or intentions of others [1]. Gesture and gaze are poorly integrated with communication and interaction behaviors. It is difficult for Asperger people to identify feelings and intentions of other people from their facial expressions, gestures, visual contact or body position. While the language and cognitive development are relatively preserved compared to other autism spectrum disorders, these difficulties, particularly severe in adolescence, lead to isolation and loss of self-esteem or to anxiety and depressive disorders.

With their intellect, people with Asperger are capable of learning several of social skills. For this, various media and techniques are used [2], including books, virtual films, role-playing game, etc. These tools encourage Asperger people to experiment and develop appropriate behavior according to social situations presented by small virtual images or movies. However, these tools lack interactivity and realism. Therefore, it is in some cases difficult to transfer skills acquired through these tools in real situations.

To fill this gap, we propose to enhance learning social skills through a serious game in order to support the immersion of people Asperger in real social situations. The game should allow the Asperger adolescent to be confronted with a social situation in which he or she may decide to adopt a behavior and to receive feedback on the consequences of his or her behavior. The objective is to help the Asperger adolescent to identify the important clues to take into account to make decisions in a given situation. This game is based on small video scenes with several possible outcomes. Depending on the choice made by the person, the game engine adapts the scenario by selecting the most appropriate skits with more interesting consequences.

In addition to the realism of the situations in the game, we targeted four properties:

- Dynamic adaptability of the scenario: the path in the game scenario is defined as the set of stages of a game session allowing the learner to achieve one or more learning objectives. The progress in the game scenario is dynamically generated taking into account the specificities and the behavior of the learner.
- Feedback: the ability of the game to collect interaction traces in order to present them to the learner (for a reflexive learning [3]) or for experts (to track the progress of learners).
- Guidance and prompting: the interfaces design and interactions with the system integrates the specific needs related to Asperger syndrome. These learners, needing especially structuring reasoning, are guided by a companion; elements that can affect the concentration can be adjusted.
- Openness and upgradeability: In order to allow game designers to add, delete or modify one or more situations on different social skills.

The work presented in this article is part of a project in partnership with “Saint-Jean de Dieu” Hospital. The objective of this project is to develop a serious game to facilitate learning about social situations in adolescents with Asperger's syndrome. The project focuses in particular on three skills:

- Identifying and decoding emotions;
- Adapting his or her behavior to situations depending on the context;
- Conversing and joining a group.

This article is organized as follows: the next section presents a state of the art of methods and tools learning for people with Asperger. Section 3 is dedicated to the presentation of the project in which this work is included. Then, Section 4 details the principle of the game that we have developed. Section 5 describes the architecture and models of the game. Evaluations of the game are presented in Section 6. Section 7 presents a conclusion and perspectives.

2. State of the art

Asperger syndrome is an autism spectrum disorder. The World Health Organization defines it as a "significant difficulties in social interaction and nonverbal communication, alongside restricted and repetitive patterns of behavior and interests. It differs from other autism spectrum disorders by its relative preservation of linguistic and cognitive development". In France, Asperger's syndrome affects about 400,000 in France; most of them are not even diagnosed [4].

In order to support these difficulties, specific methods have been developed, such as TEACCH¹ and ABA². TEACCH is a method that offers teaching according to children and adolescents with Asperger's syndrome needs. This method is applied in the classical school, home or specialized centers. It advocates:

- Structuring tasks and, spatial and temporal organization of the environment in order to make clear and explicit the environment of the child with Asperger's syndrome and to facilitate its visual integration.
- Evaluation process in order to determine the specific difficulties that children with Asperger syndrome have, and then to develop tailored responses to the specificities of each.
- Collaboration with parents, the method considers parents as partners in the work undertaken with children.

The ABA method, inspired by behaviorism, is an analysis of the behavior associated with intensive intervention on the person (30-40 hours per week) to provide better integration into society. This method should be conducted by an educational team, involving parents in individualized programs.

Although these methods have proven effective to some people, they require specific and expensive educational structures. In addition, as pointed out [5], it is difficult to design one method to suit all profiles.

¹ Treatment and Education of Autistic and related Communication handicapped CHildren

² Applied Behavioral Analysis

With the advance of computers, numerical solutions have been developed to support learning for Asperger people. In this context, [6] provides a serious game environment based on fun exercises. The game Tom O'Connor [7] is a serious game for evaluation and rehabilitation cognitive. The scenario of the game is dynamically generated based on the user profile.



Figure 1: Interface of Tom O’connor game.

In [8], the authors present a software generating exercises for learning dialogue using different modalities: text, images 2D-3Dn synthetic voice, etc.

JeStimule is a game designed to improve social skills of children and adolescents with autism or PDD (Pervasive Developmental Disorders). This game allows improving emotion recognition skills from facial expressions and gestures while taking into account the context. The game begins with a learning phase, where the user must assign a color to a particular emotion. After this introduction, the player chooses an avatar and can begin to navigate in the virtual world.

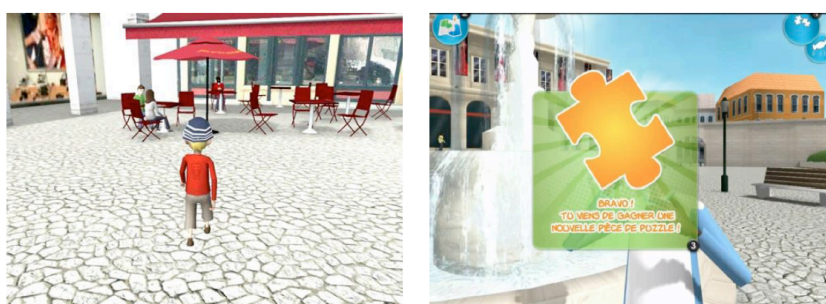


Figure 2: Interface of JeStimule game.

These games lack interaction, realism and relevance in the selection of situations, especially for adolescents for whom the social context is important. Thus, our objective is to design a serious game that facilitates immersion of adolescents in the game through real life situations.

3. Project Description

The project is the result of collaboration between researchers from LIRIS laboratory and child psychiatry at “Saint-Jean de Dieu” Hospital. To compensate for the lack of realism of the

methods used to teach the rules of social life, the goal is to design an educational serious game that facilitates immersion of Asperger teens in real situations enabling them to develop skills in social situations. The identified needs of the project are:

- Targeted skills: decoding the feelings and emotions of others, adapting his or her behavior to a situation depending on the context, starting a conversation, being part of a group, managing stress, seeking help and responding to criticism.

- Game world: in order to increase the effectiveness of the game, the world should take place in a familiar environment that affects all of the target population and that will facilitate transfer to real situations.

- Pedagogical principles: the learning social skills must be done through decision-making. The learners must understand the consequences of their decisions. These decisions will determine the course of the rest of the scenario. The scenario will be articulated by a gradual increase of the difficulty of situations by complex elements in environment or by the broached theme.

- Game design: it is important to give learners the opportunity to relive situations so they can appropriate or try other options. A history of activities will allow them to compare their answers and be aware of their evolution.

- Tutor tool: in order to maximize the benefits of the game, the system must also include a tool for monitoring and analysis for tutors. These can then visualize the path of learning of each student or group of students and adjust their instructional choices.

Specifically, the prototype of the game was designed and developed as part of a collaborative project by 4th year students of the Industrial Engineering Department of INSA-Lyon. Students were able to adopt a participatory design approach all throughout the project. A group of teenagers, being part of a group of social skills training weekly in child psychiatry at St. “Saint-Jean de Dieu” Hospital, and their supervisors have participated in the selection of scenes of the game, and the adolescents have tested the implemented prototype.

4. The game principle

4.1 Organization and operating of the game

The game environment is a high school in which the learner can move and act in different situations of everyday life. The main task of the learner in the game is to help one of his friend(s) to find lost pictures of an album. To do this, he must visit 12 places in the school to retrieve the pictures and complete the album. In each place, the learner can visualize a scene to work one or more social skills, depending on the complexity of the situation.

As shown in Figure 3, a scene is composed of three stages, which are linked in a logical manner. Each step includes a film that describes a situation, and a question followed by four possible answers:

1) Social response: is an ideal response allowing the learner to socialize. This kind of response would be given, in most cases, by a person without Asperger Syndrome.

2) Awkward answer: This response shows an interesting initiative, but not the right way.

3) Escape response: This is a fairly neutral response, enabling the learner to not put himself in an embarrassing situation. This answer does not allow socialization.

4) Excessive response: This is not suitable response to the situation. It can be aggressive and puts the person in embarrassment, confusion, pain or irritation.

Each response triggers a video associated therewith accordingly. At the end of the stage, a feedback in the guise of an explanation is presented to the student to help him better understand and decode the situation. Then the game puts him between 1 (corresponding to the excessive response) to 4 pictures (corresponding to the social response), depending on its answers.

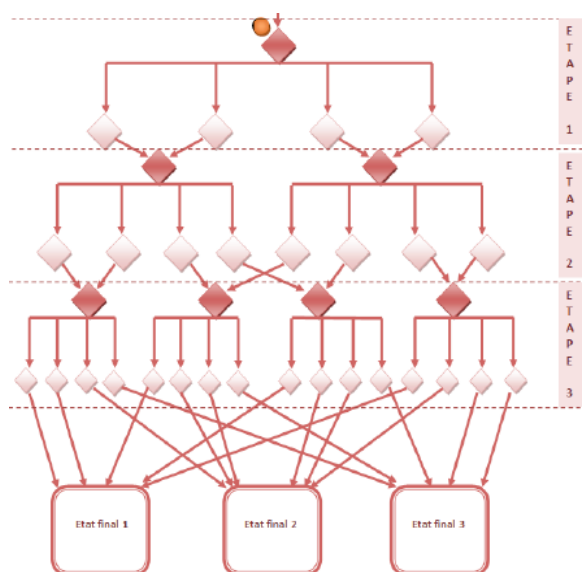


Figure 3: Scene organization.

Legend: The red diamond represents a film of a situation. The vertical arrows represent the phase of decision-making in the form of a question posed to the learner, followed by four proposed answers. The pink diamond is a specific video chosen in function of the learner response.

In addition to the steps associated to the different places in the school, the learner can choose to relax going to the students' hall where short mini-games can be played. These mini-games allow to introduce implicit learning based on game mechanisms only.

During all stages of the game, the learner may use a personalized companion to help him. This assistance can occur in two ways: at the request of the student or the automatically in function of the context.

4.2. Step example

To illustrate our approach, we present an example of a step which focuses on social competence "conversation and integration in a group".

1) Description of the situation:

The learner is in the queue to eat at the lunch room. He looks at the displayed weekly menu. Behind him, his three classmates wondering what is the menu the same day.

2) Questions

Once the video showing the step is completed, a voiceover asks the learner, "You just hear the conversation of the group, what are you doing? "And she invites him to choose an answer from four options.



Figure 4: example of a step.

3) Possible answers

- I inform them that the menu is displayed and asks them if they like the daily menu;
- I tell them the daily menu;
- I take my tray;
- I tell them the whole week menu;

Depending on the response of the learner, a video is triggered accordingly. For example, if the student chooses the answer one, he eats with his friends, but if he chooses answer 3, he will eat alone. For each of these cases, the game proposes adapted steps according to a predefined scenario by the designer / expert.

4) Feedback

After the completion of the three stages of a given scene, the learner receives feedback. During this phase, the game reminds the learner with the different situations in which it happened, his answers in relation to different issues and the consequences of its decisions.

Depending on the answers of the learner, the game gives him from 1 to 4 photographs. Indeed, whatever the performance of the learner, he will collect at least one photo.

5. General architecture and models

In this section, we formalize the different elements presented previously. We present the global architecture and the different models used to design and implement the game.

5.1 Game play and scenes sequencing

Twelve scenes have been designed to cover the entire set of social skills and to insure a certain educative impact. To do so, each situation covers at least two social skills and each skill is treated at least three times. We based this design on the three step pedagogical model for skills acquisition: discovery, understanding and acquisition of a skill. In an indirect way, the aim of the game will be to encourage the learner to visit all the high school places so that he can assimilate the social skills associated to each place.

Each scene represents a particular time in school life (getting the bus, being in class with classmates, going to the lunch room, going out for break, etc.).

At the beginning of the game, only one place is accessible. Crossing this place, never mind the score obtained, release one or two other places with higher level of complexity.

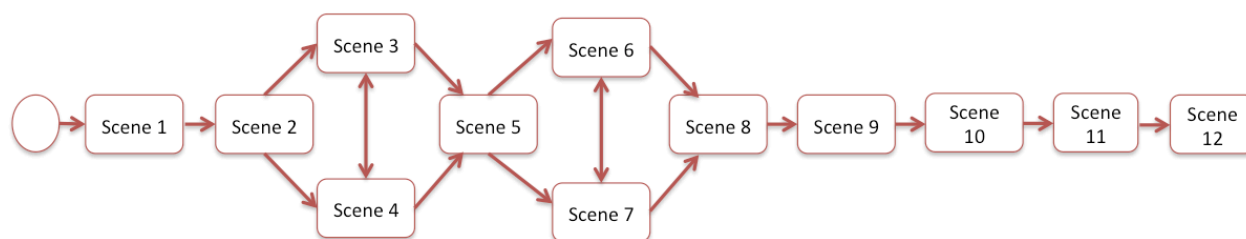


Figure 5. Scene sequencing in the scenario

For equivalent scenes, in terms of complexity, the learner is free to choose the order in which he/she wants to complete some scenes, defining his own path (see figure 6).

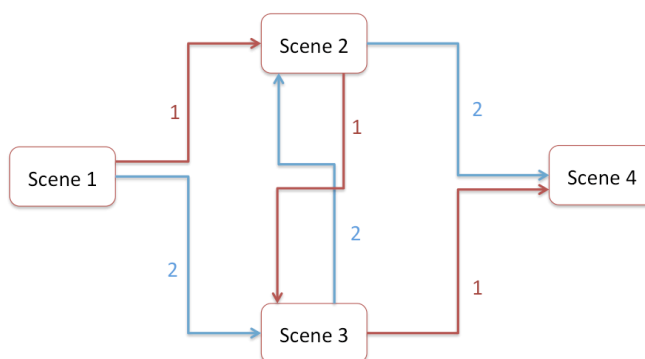


Figure 6. Possible paths in the scenario

In the same way, releasing a mini-game in the students' hall depends on the completion of a scene (crossing a place). Mini-games are selected randomly.

In each scene (or place), the learner has to answer to 3 questions that will fix his progress in the scene until a final state (there are 3 different final states per scene, cf. figure 3). In this way, several sequencing and paths are possible. They depend on the learner's actions. Crossing a place is conditioned according the final state achieved.

During a scene, the learner doesn't have the possibility to get back to a previous state and change one answer. If he is not satisfied by the choices made, he has to complete the whole scene again. Therefore, at the end of a scene, the learner can choose to play again the scene that he has just crossed or to continue the game.

5.2 Guidance and prompting module

The adolescent with Asperger needs more rigor than others adolescents, so it is essential to express the rules and the instructions of the game in a clear and simple way, avoiding tacit knowledge.

The instructions are presented within the game, using an adapted vocabulary. This guidance is carried out by a "virtual friend", called a companion. This companion, who can be personalized for better appropriation, will be presenting the instructions to the learner. As this companion is speaking, the instructions are given thanks to the audio modality (voiceover) but also to the textual representation (words balloon). The multimodality used here insures a good comprehension of the instructions by the learner. To increase this understanding, some elements associated to particular aspects of the instructions have a dynamic behavior in the user interface. Each time the companion is talking about an element in the game, this one appears on the screen.

Guidance and prompting are also present during the active phases of the game thanks to an assistance module. The friend chosen by the learner at the beginning of the game will help him if needed. The module is accessible via an icon representing an interrogation point. The learner can trigger this assistance when needed (solicited assistance) or the system can decide to guide the learner in order to avoid too long inactive periods (unsolicited assistance).

Nature of the assistance	Triggering
Unsolicited assistance	This assistance is automatically triggered when the system judges that the learner is blocked or doesn't understand something (time indicator).
Solicited assistance	The learner decides to launch the assistance by clicking on the

	related icon (friend or interrogation point).
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Table 1. The different assistances

The assistance module has been designed to be generic. Table 2 presents some examples of assistance during the game.

Nature	When	Issue and implementation
SA2 (solicited assistance)	After 30 sec of inactivity on the game map	Make the learner understand that he/she has to go in some places Possible sentence: « Hey! Don't forget that I'm counting on you to get back my pictures! They are scattered in the high school. What if you'd go into one of these places to have a look? If you want to have a break, you can go to the students' hall to play to mini-games! »
UA3 (unsolicited assistance)	When the learner must make a choice in a particular scene and he didn't see all the possible answers.	Make him react and guide him giving him some clues. Possible sentence: « Now you have to choose what to do next! Pass over you mouse on the elements around you to see the possible answers. »

Table 2. Examples of assistance content

5.3 Feedback module

When a scene is over, a summary of the learner progress is launched. For each question, a debriefing is presented to highlight the learner's choices and their consequences so he can perceive his mistakes or strengthen his knowledge. This feedback looks like an interactive photo album. Two photos are selected for each step, one for the presentation of the initial situation (corresponding to the video) and the question, and one for the illustration of the consequences of the learner's choice. A complementary photo is also added to illustrate the final state of the scene.

For each situation presented and answer given by the learner, an explanation and advices are provided according to the relevance of the answer. Table 3 presents the model of sentences that are used to construct the feedback according to the relevance of the answer.

Situations	Voiceover sentences
Initial situation	The situation presented was this one... You've made different choices during this situation. Let's see how it went. At the beginning...
Social responses	Well done! Indeed in this case (<i>characterization of the situation from a</i>

	<i>global perspective</i>), it is recommended to... You chose to...It's a good way to do that.
Awkward or escape responses	Good ! But you could have... In this kind of situation, it would be wiser to...You escaped from the situation doing...
Excessive responses	Here you've done... This reaction can appear excessive for others. Maybe you could have done... You have hurt ... by... Be careful

Table 3. Examples of voiceover sentences for the construction of the feedback

6. Game evaluation

We adopted a participatory design approach to design and implement the game. At different steps of the process, experimentations with end-users (Asperger adolescents) and validation with Asperger experts and ergonomics experts have been conducted. The goal was first to validate the pedagogical content of the game and its relevance for the target end-users, and then to measure the user experience and the quality of the user interfaces and interactivities during the game. Two different data gathering have been defined: questionnaires for learners and Asperger and ergonomics experts, and an observation of learners during the interaction with the game to identify the potential difficulties encountered and to identify improvements for the game.

These experimental studies were conducted with experts and Asperger adolescents from the hospital "Saint-Jean de Dieu". They mobilized 2 Asperger experts, 11 learners and 1 ergonomics expert.

6.1 Validation of pedagogical content

1) Relevance of the scenes

This evaluation aimed to insure the relevance of each scene designed in the game. The relevance was measured according to the complexity or the problematical aspects of the situation covered in the scene for Asperger adolescents. For each of the twelve scenes, we asked to two Asperger experts, via open-ended questions, to evaluate the scene relevance et to collect suggestions about the scene specification and sequencing (initial step, possible answers leading to the next step and the final states). The twelve scenes have been validated and the improvements suggested have been integrated in the pedagogical scenario.

2) Choice of the scene that has been implemented

The scenes have been presented to a group of 7 Asperger adolescents and 2 of their tutors to measure the relevance in terms of game mechanisms, complexity and difficulty of the situation and identification. The scene selected, the one taking place in the school restaurant, obtained the majority of votes for the whole participants.

6.3 Ergonomics evaluation and user experience measure

1) Ergonomics evaluation

In order to evaluate the user interfaces of the game, we conducted study with an expert in HCI. All the interfaces have been evaluated using Bastien and Scapin criteria [9]. These criteria are usually used to design, improve or evaluate interactive systems. The set of criteria consists of eight main criteria: guidance, workload, explicit control, adaptability, error management, consistency, significance of codes and compatibility. Some of these criteria are subdivided into sub-criteria, or elementary criteria. We asked the expert to analyze each user interface according to the set of elementary criteria with a Likert scaled questionnaire. The prototype obtained good results and the suggestions and comments of the expert have been integrated to the improvements of the game.

2) User experience

We measured the user experience on the observation of four Asperger adolescent playing the game. We used questionnaires also to collect their opinion after using the system. During the playing phases, we observed the learners' interactions with the system. In particular, mistakes and hesitations have been collected, pointing out for each one the cause (guidance problem, or codes significance for instance) and the part of the game where the mistake was made (connection, companion personalization, game map, scene number, feedback or mini-games). After the game, learners had to answer to a closed-ended questionnaire to measure their level of game play understanding regarding the access to the scenes and mini-games, the game map and the scene sequencing, and finally the feedback. A second questionnaire with both close-ended and open-ended questions collected the learners' opinion regarding the game design, the esthetic quality, the content of helping messages during decision-making phases and feedback, elements that they liked or disliked and the suggestions regarding game improvement.

These observations revealed some understanding problems regarding the rules and game play, and regarding the guidance during decision-making phases. These observations allowed the improvement of scenes design. These evaluations are encouraging and positive, learners show a real interest in playing the game and they manifest a certain satisfaction regarding the game esthetics and realism.

7. Conclusion and future work

We presented in this paper the design of an educational serious game for the development of social skills for adolescents with Asperger Syndrome. The issues of this project were to script difficult situations in an realistic way but also to introduce games mechanics in order to improve immersion, motivation and knowledge transfer. Using a participative design approach, we

integrated in the very first steps of the design process suggestions of end-users (Asperger adolescents) and their tutors (Asperger experts).

The first data collection and user experience measure are encouraging for next iterations in the game design and development. Obviously the validation of the game should be done at a larger scale to measure the real impacts of the serious game on the acquisition of social skills and emotions decoding.

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