Abstract. The work carried out in the Social Simulator Project focused on development of the social simulator tool. Methods for making use of the tool were also examined. The tool consists of two computer software programs, one for viewing social scenarios and one for the creation and editing of the scenarios. Within the framework of the project, series with interviews, mock workplace interviews as well as demonstrations, lectures and seminars about the software were also carried out. The project began in 2000, supported in the initial phase by the Swedish Handicap Institute. The Vardal Foundation for Health Care Sciences and Allergy Research supported the second phase, the results of which are reported here.
Background
Autism and Asperger syndrome are psychiatric diagnoses that have far reaching consequences for the social comprehension and interaction of the individuals affected. According to one theory, a person with autism is *mindblind* (Baron-Cohen, 1995). This means they have difficulties in *mind reading*, i.e., intuitively being able to interpret other’s intentions and motives from external clues such as facial expressions, body language and other nonverbal signals. People with autism learn to understand most everything that has to do with what others think, suppose or know through painstaking mental training rather than intuition. In the long run, a deficiency in *mind-reading* abilities leads to a *deficient theory of mind*, i.e., the inability or reduced ability to create inner models of external reality, particularly of the reality to be found in human social interaction (Frith, 1995; Hobson, 1995; Kristiansen, 2000).

The foundation of the rules of social interaction can be found in a set of innate abilities consisting of signals that we humans spontaneously send out and interpret. Direct learning of the actual signal system never really occurs since it is an innate and universal ability of the human race (Ekman, 1999). We have this ability in common, moreover, with other mammals. Training of the signal system’s usage in social interaction starts normally at a very early point in life – long before language develops – and that is why most people know instinctively and naturally how they should act in relation to others. Normally developing infants begin practicing such things as eye contact, turn-taking, interaction initiation, expectations of others reactions and perspective-taking soon after birth. In the first four months of life, the infant is entirely engaged in training social interaction (Stern, 1985; Happé, 1994; Hobson, 1995). Insufficient spontaneous training in early social interaction results in the characteristic difficulties with mutual communication and social interaction that are seen in people with autism. Insufficient training in perspective-taking results in thought patterns where “the other” as an inner dialogue partner is missing; it also results in a more egocentric way of understanding and relating to the world (Mandre, 2002).

It is not until someone obviously does not understand the rules of social interaction, which usually are invisible and taken for granted, that they become apparent. Faulty body language, eye contact that lasts too long or is avoided in the wrong situation can give entirely misleading signals in the complicated social interaction between people. Without “the other” as an internal conversational partner, a world of thought develops that is solely based on the individual’s own perspective. In social situations, you need to have the ability to change perspectives, which is why people with autism, instead of using intuition, have to consciously and logically try to understand the motives and actions of other people. People with autism generally want to understand the rules of social interaction and to participate. The reason that many of them are isolated is not because they do not want to be involved with others but rather because they do not know how. They lack the elementary knowledge of how people’s minds work.

There are more people nowadays who are being given the autism diagnosis (Nylander, 1999). For a long time, many of these adults were inexplicable cases seeking help from psychiatry, the social insurance system or employment centres. Professionals in these systems have not been aware of the reason why these people, in spite of high scores on intelligence tests, are unable to manage everyday life or to
hold down a job. Many times they have been advised to “use their own good resources” even though they lack the ability to do so. The interaction with the client can easily run amok if the professional/caregiver does not understand that all people do not go through the same stages of psychological development (Mandre, 2000).

**The Social Simulator Project**

It was with this in mind that the social simulator was developed. It consists of a computer program that enables people with autism to train understanding of the complexities of social interaction in a game format in which they choose alternative actions and receive explicit feedback on their choices. The training was intended not only for those who have difficulties in understanding social interaction themselves, but was equally constructed to increase case workers and psychiatric personnel’s knowledge of the special way in which their clients/patients comprehend the world around them.

The Social Simulator Project has focused on developing a tool of the same name. Methods for making use of the tool were also examined. The tool consists of two software programs, one for viewing social scenarios and one for the creation and editing of the scenarios. Within the framework of the project, series of interviews, mock work place interviews, as well as demonstrations, lectures and seminars concerning the program software have also been carried out. The social simulator scenarios have primarily been developed in interaction with eight persons who have autism, based on situations that they find enigmatic or unfathomable in the world of social relations in which they live. This has resulted in a number of scenarios that serve as examples for people with normal social abilities as well as those whose abilities to understand social interaction are impaired. In the process, different applications of the existing software have been identified as well.

The project began in 2000 and the Swedish Handicap Institute supported the initial phase. The second phase, the results of which are reported here, have been supported by the Vardal Foundation for Health Care Sciences and Allergy Research.

**The Social Simulator today**

The Social Simulator in its current state is a tool that enables the user to easily construct interactive scenarios making use of images, sound and text. In addition, there is a freestanding program that is used exclusively for viewing the scenarios. The editing program, SimulatorEdit, has been redesigned to function better as a tool that can be directly utilized in an interview situation. The current version has its starting point in the narration of a course of events. The only information that is initially needed as input includes texts that describe the segments in the course of events as well as how they are related to one another. The structure of SimulatorEdit is based on a succession of actions and responses. This structure was chosen because it fits well with the normal flow in narratives about social situations – “First I said this, and then he said that, and then I did this and then he said that . . .”
Figure 1. SimulatorEdit interface for editing structure. This interface is designed to work in an interview situation. It is possible to directly enter text in the boxes. You make connections by dragging the cursor from one box to another – the design is based on as few steps as necessary when setting up the first version of a scenario. Later in the process, the user can add pictures, sound and animations by using the special dialogue boxes that appear when you click on a box in the structure.

Figure 2. SimulatorEdit interface for real time editing. The interface works exactly as in SimulatorPlay (see Figure 3) with the exception that it is possible to make changes. All text can be changed. By right clicking on different parts of the screen, dialogue boxes will appear that allow you to edit images and sound. It is also possible to add new actions in the field to the right. When you choose an action that does not progress any further, a new subordinate “box” is automatically created (see Figure 1) connected to the action.

There are two different ways to edit a scenario in the SimulatorEdit: structure editing (Figure 1) and real time editing (Figure 2). In structure editing, you see a scenario flow chart presented as a tree structure.
The work with the Social Simulator can be described as an iterative process in which the software has been continually tested and further developed. The current project was based on the software initially developed with funding from the Swedish Handicap Institute (Magnusson, 2001). That software consisted of two parts – an editing program (AgentEdit) and a playback program (Simulator).

The software was quite advanced and allowed the implementation of scenarios with preset choices and ones in which the user could type, in free text, what he or she wanted to do. By making use of different conditions and actions that the computer could generate automatically after a given time interval in the playback mode, relatively complex scenarios could be created (Figure 4).
Figure 4. AgentEdit. A structure with scenes (S), actions (A), responses (R) and conditions (C). TIMEOUT specifies an action that the computer generates after a given time when the scenario is running. The flow of the scenario is indicated with arrows; each scene, action, response and condition has a name that specifies its contents. The contents are edited by double clicking on a box and then filling in the different choices in the dialogue box.

The scenarios thus created could be played back in the AgentEdit software (it was not possible, however, in this earlier version to edit during playback) or by using the separate viewing program (Figure 5).
Figure 5. Simulator. At the bottom, the user types in what he or she wants to do. If the scene contains preset choices, the row at the bottom is exchanged for a list of action alternatives. Information about the scene is at the top, speech and actions are viewed in the square on the left, thoughts are displayed as thought bubbles to the right and under them is the help window to be used when a user gets stuck. In the help window, the actions are displayed that are available for that particular scene.

The AgentEdit program was tested by two people diagnosed as having Asperger syndrome as well as a project member who was not a technician (Eve Mandre). Outside of the project framework, Helena Salmonsson also tested the program and, using the Simulator and AgentEdit, examined the possibility of utilizing the scenario program as an aid for social training for people with psychoses. At the same time, a series of interviews were carried out aimed at generating new scenarios and testing how the Simulator and AgentEdit programs worked in an interview situation. Three fictional workplace interviews were also carried out and documented. The test results were positive in so far as the Simulator software proved to be easy to use and worked well as a basis for discussion in demonstration and seminar situations. Helena Salmonsson’s study (Salmonsson, 2002) also demonstrated that the Simulator was easy for people with limited computer skills to use.

Two features that were implemented in the software proved to be of particular significance. Our assumption that it was critical to be able to include photographs was confirmed and the ability to control the time flow (since it was possible to create actions that the computer then generated after a predetermined time interval) also proved to be essential. Being able to control time is useful in making a scenario more lifelike, but also because it enables the implementation of certain aspects of time in social interaction. Helena Salmonsson did not use the time control function, but she commented that usage of real photographs seemed to get the persons using the program to associate with similar situations they had experienced.

Unfortunately, the results of the editing software tests were not as positive. It was true that the people who tested the editing software constructed scenarios of varying size and complexity, but it was clearly apparent that the software did not work in an interview situation. This was because it contained too many steps. It simply took too much time to construct a scenario that the program could use directly in an interview situation. It was also the case that the flexible scenarios in which the user could type in actions in free text required quite a lot of work to be satisfactory – which in turn resulted in the intended users who were building the scenarios (with the exception of Helena Salmonsson) keeping entirely to predetermined choices. There was also a built-in contradiction between flexibility and the required level of detail that gradually became more apparent. Great flexibility allowing the user to freely choose actions requires that the situation be greatly limited so that the number of possible actions in the system will not be too great. This results in difficulties in dealing with more sophisticated nuances in the social interaction and more open types of social situations. With set choices, you can in principle handle any situation and it is also possible to go into more detail in the social interaction. On the other hand, there is a risk that the user will be controlled by the choices that are presented. Even though the editing program described here was too slow, the preliminary results indicated that
joint scenario construction (i.e., two or more people constructing a scenario together) was an interesting way to use the program.

Since one of the fundamental principles of the project was that the user would be able to construct his or her own scenarios, and since we had also come to see the importance of joint, interactive scenario construction, we realized at this point that a considerable reworking of the editing software was necessary. The new version would be easy to use and primarily adapted to joint scenario construction. The requests and suggestions we brought to this effort are summarized in the following list:

- Construct the scenarios as before with text, images and sound.
- The basic editing program should have as few steps as possible and be based on text information (images and sound take time to generate and most likely have to be added afterwards).
- It should be possible to edit a scenario at the same time as it is played back (a suggestion from one of our test users diagnosed with Asperger syndrome).
- More editing functions for colour and text size are needed.
- Remove the free text scenarios – use preset choices.
- Keep the function for actions that are generated by the computer (i.e., allow easy control of the time flow in a scenario). This is important, in part, because timing is critical in social interaction, but even because it is a way of generating simple animations.
- The spatial ordering in the playback interface should be made more evident (less important, but the speech and thought bubbles interfered with the pictures in some situations).

The revisions resulted in two entirely new programs. From the beginning, they looked, in general, liked the Social Simulator just described. In the first prototype version, however, all three fields were displayed in the playback interface at the same time on the screen. Initial user testing showed that this could be experienced as confusing, and a version in which the actions on the right were displayed with a time delay was developed. A follow-up user test was carried out and the new version fulfilled the requirement.

Additional user testing, primarily with joint scenario construction, was carried out and the new version functioned well. It was even fully possible during a discussion group meeting for people with the Asperger diagnosis to type in different action alternatives while the discussion was in progress. Having the program there also resulted in an interesting and lively discussion and the constraints of focusing the entire time on “what he/she/you said” in contrast to “what he/she/you did” contributed to keeping the discussion on a concrete level. Supplementary tests have also provided good results so far – of course, there are minor errors that should be rectified, but the fundamental functionality currently meets the demands placed on the desired user situations.
Application

In conjunction with the development of the software, a number of scenarios have been constructed in cooperation with eight primary users diagnosed with Asperger syndrome. These scenarios comprise a sample collection that can be used primarily as a basis for discussion for people with normal social abilities and for those who have reduced abilities to understand social interaction. In the process, different applications of the existing software have been identified as well. These have to a certain degree already been touched upon, but are more clearly and concisely summarized here.

The software that only plays back different scenarios can be used for:
- Individual training/illustrating. A user goes through existing scenarios and can thus increase his or her understanding of the actual situation.
- Training/illustrating in groups. Several persons go through an existing scenario together, discussing what happens. This method is also used for demonstrations/lectures/seminars. What occurs in the simulator and what happens in the resulting discussion can work together constructively and contribute to increased understanding and new insights.

The editing software can also be used in different ways:
- Simple scenario construction. One user constructs a scenario on his own. This is a way of constructing new scenarios (for a person with autism/Asperger syndrome or for a special education teacher, occupational therapists, support person, personal assistant, etc.), but also a means of reflecting. The constructed scenarios can even be used to understand the person’s way of thinking, cognitive abilities, etc.
- Joint scenario construction. An interviewer and the person/s to be interviewed jointly construct a scenario. This is, in part, a way of creating new scenarios but also a means of reflecting on a specific situation, thus increasing understanding of the different action alternatives and their consequences.

Good, lifelike scenarios require real situations. In our trials involving both people with and without autism/Asperger syndrome, the scenarios that we constructed based on more general knowledge had a tendency to be relatively limited, while those that we built together with the users and that were based on concrete, real situations were more lifelike and interesting. It has also proven to be important to have concrete, real-life situations as a basis, rather than scenarios that contain a large amount of action alternatives. At the same time, it has been demonstrated that extensive information was required to construct a scenario. If the person constructing the scenario is not basing it on his or her experiences, an ordinary interview is not sufficient; it has to be supplemented with observations and follow-up interviews. The documentation of a situation achieved in this manner is very detailed.
Figure 6. Two scenarios constructed by two different people. Both of them have an Asperger diagnosis. Note the difference in structure and complexity.

Of course, it is possible to build good scenarios that illustrate general knowledge, which can be of great help in the construction of other scenarios, but for them to be instructive and useful, observations made in real-life situations are required.

The person who constructs a scenario based on his own experiences very clearly displays his pattern of thinking in the process. Tests with eight users with an Asperger’s diagnosis have revealed great differences in structure (see Figure 6). As already mentioned, this can be used for describing a person’s thought processes and as a starting point for discussion.

Joint scenario construction has proven to be a worthwhile process that not only gives rise to a scenario but also provides the people involved in the construction process with increased insight into different action alternatives and the consequences thereof. This is how a situation can be worked through and new insights gained. One example was a scenario construction based on a conflict situation in which the person involved in the conflict said after completion: “Now I understand him a lot better. . .!”

An educational tool for social knowledge

The Social Simulator can be called an educational tool for social knowledge. The construction of social scenarios using the Social Simulator articulates aspects of social knowledge. Just as in the construction of expert systems in previous projects (Magnusson, Svensk, 1993; Magnusson, Larsson, 1994; Magnusson, Svensk, 1997; Magnusson, 1998; Magnusson, Foisack, 2000; Foisack, Magnusson, 2000) or the creation of argumentation trees (Rolf, Magnusson, 2002), the building of scenarios enables reflection and exploration. The reason for this can be briefly summarized in two key terms:

- limitations
- articulation (visualization)

The reason these two terms are so central has to do with the reflection in action and the reflection on action (Schön, 1983) that are essential in the construction of this type of program. Because the “action” that is to somehow be reshaped and implemented in the program structure is precisely the expression of the tacit or unarticulated knowledge you want to get at, working with the program results in the exposition and
exploration of the underlying knowledge structure. And it is this, in connection with reflection, which results in positive effects in the form of learning/increased understanding.

Why then are “limitations” and “articulation” such key concepts? “Limitations” may sound negative, but in fact they are often a necessary condition for much of the activity we humans engage in. Well-selected content limitations constitute a support not only in problem solving but in such things as creative/artistic activities as well (Gedenryd, 1998). In order to deal with problems, we simply have to limit ourselves. External limitations can be an added value in this situation because we need not put energy into keeping track of them and instead can focus on what is important in the current context.

But limitations here do not only concern content. When it comes to implementing the consequences of a knowledge structure in a computer program, it also includes setting limits in the structural design. In all the projects we have been involved in so far, these particular limitations have not proven to be a primary obstacle, but have instead constituted a powerful tool for reflection. Since the existing knowledge in a problem area usually is not structured in the desired form, adaptation to the desired structure requires a very detailed reflection over the knowledge material before it is possible to organize/structure it in the prescribed form. In this way, you are forced to reflect over the details as well as the structure of the knowledge. The effect of the structural limitations is similar to the one that “surprise” has with Schön (1987). The discrepancy that arises between expected and actual outcome, quite simply, compels reflection.

A slightly paradoxical consequence of this is that the farther the original knowledge structure is from the prescribed, the more the knowledge has to be re-worked and the greater the positive effects. Of course, this assumes that it is at all possible to organize knowledge according to a prescribed structure.

As early as the 1950s, Polanyi (1958) wrote that articulation or visualization offers people the opportunity to reflect and explore. In our case, it involves two different types of exploration. One is the software’s capability to articulate unexplored “blind spots” which then, of course, have to be further revised. The other is that the system makes it possible to investigate the concrete results of a given knowledge structure. There is, naturally, a link between the two. In the exploration of unknown territories of knowledge, it may be necessary to test what kind of results different ways of designing the knowledge structure produce. And the natural way of doing this in the development of this type of system is by means of the current program software. It is interesting to note that the learning process that best fits the description just presented is what Marton and Booth (1997) call “deep learning”.

**Summary**

In conclusion, the Social Simulator can be said to have preliminarily shown itself to function as an educational tool, even if several more extensive scenarios are needed for evaluation of different educational effects. It has also preliminarily been demonstrated that it is possible to gain insight into the thought structures/thought
patterns of different people, and even in some cases, compare them. On the whole, however, the unforeseen significant changes that have come out of the user testing have resulted in prioritizing program development in this project. We are now in the position of having a revised and functional software application as well as promising preliminary results.

The next step will be to go in and with the help of in-depth field studies, interviews and perhaps above all, joint scenario construction followed by further feedback in the form of individual and group illustrations, create actual scenarios and eventually compare these.

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