Chapter 8
Rehabilitating Autistic Reasoning

Having outlined what are the deficiencies of autistic reasoning on one hand, and what kinds of reasoning and learning is required to control the behavior on the other hand, we proceed to how the issues of autistic reasoning can be cured. We will dive into a broad range of technique improving autistic reasoning, both computer training-based and human training-based. These techniques are the conjecture of the reasoning deficiencies we defined formally or computationally in the previous chapters. The goal of reasoning rehabilitation is twofold: teach CwA to *think soundly* and judge righteously about various aspects of life, and properly chose and control *behavior* based on reasoning and rationality (Fig. 8.1).

8.1 Training Environment

A few versions of the web-based user interface for NL_MAMS have been developed for a number of environments, including describing of mental states of scene characters. A variety of interface components were designed for specifying mental states, including natural language and drop-down box-based.

The one-to-one rehabilitation strategy (NL_MAMS – independent), conducted by a member of rehabilitation stuff, includes the following components:

- direct introduction of the basic mental entities *want-know-believe* using real-world examples;
- explanation of derived mental entities using the basis *want-know-believe*;
- introduction of the derived mental entities by means of real-world examples;
- conversations that heavily rely on a discourse with mental focus;
- conversations that are based on a pictorial representation of interaction scenarios (Figs. 8.3 and 8.6);
- involving the trainees into actual interactions with other children and asking them to verbally represent these interactions;

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Fig. 8.1 Therapy should leverage available skills such as tolerance to height and fast motion

- encouraging the parents and rehabilitation personnel to demonstrate a special awareness of mental entities in the real world (Galitsky 2000; Galitsky 2001)
- "picture-in-the-head" and "thought-bubbles" techniques, using "physical" representation of mental attitudes (Swettenham et al. 1996, Fig. 8.3).

NL_MAMS-based training is intended to assist in all of the above components. Initially a trainer shows how to represent mental states from the above components via NL_MAMS, and discusses yielded scenarios with a trainee. The plausibility and appropriateness of actions yielded by NL_MAMS require special attention from trainees. Then the trainer specifies other initial mental states and asks a trainee to come up with plausible scenarios originating from these mental states.

After a certain number of demonstrations, the trainees are encouraged to use NL_MAMS independently, applying it to real-world mental states the trainees have experienced, as well as abstract mental states. Trainees are presented with both natural language and structured input and output of NL_MAMS, and they are free to choose their favourite way of user interface.

Trainees are children with high-functioning autism 6–10 years old, selected so that they are capable of reading simple phrases and communicating mental states in one or another way.

An exercise introducing the mental action of *offending* and *forgiving* is depicted at Fig. 8.2. This is a partial case of NL_MAMS training of yielding a scenario given an initial mental state: it is adjusted to the definition of *offending*. Expected resultant scenario is just the actions of *offending* or *forgiving* with appropriate parameters for agents and subjects of these actions. These parameters are specified via drop-down boxes; their instances are expected to show the trainees how to generalize the instances of *offending* or *forgiving* towards different agents. Also, multiple ways to express these generalizations are shown: *friend, parent, brother/sister, they/them,*

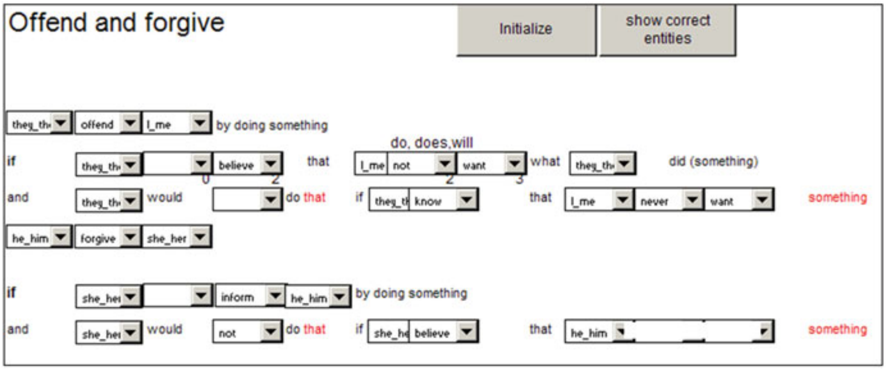

Fig. 8.2 The form to introduce a mental entity (here, to offend and to forgive). After an entity is explained via examples and verbal definition is told, a trainee is suggested to choose the proper basic entities with negations when necessary to build a definition

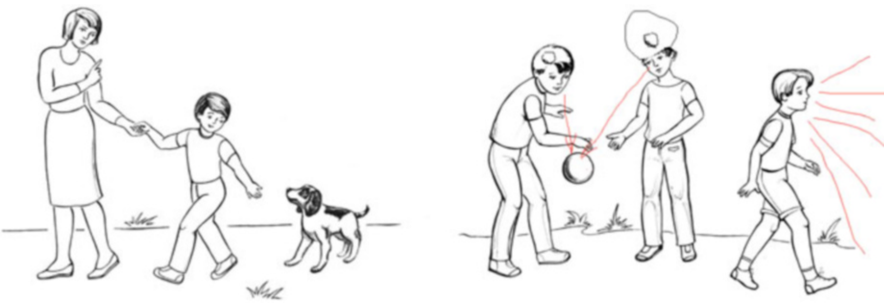

Fig. 8.3 A visualization of interaction scenario: a situation with conflicting goals (on the left). The children are asked the questions about who is hiding where, who wants to find them, and about their other mental states. On the right: "picture-in-the-head" and "thought-bubbles" techniques are used, based on "physical" representation of mental attitudes

he/she, him/her etc. After the trainees learn how to derive a single-step scenario for a fixed mental action, they are given tasks to compose a scenario with two or more mental actions they have already learned (Fig. 8.3).

8.1.1 Short-Term and Long-Term Training Settings

We performed the NL_MAMS-assisted training and its evaluation at two levels: short-term and long-term. The *short-term approach* includes the theory of mind training with and without NL_MAMS for two groups of 12 autistic children of similar mental age and IQ. The evaluation is based on passing the set of tests including the seeing-leads-to-knowing (first-order) and Sally-Anne false belief

Fig. 8.4 Developing such complex skills as using a photo-camera and doing a performance require integral rehabilitation strategy and a substantial support

(second-order) ones so that a uniform coverage of mental states and actions (up to the order three) is evaluated. In the short-term approach we performed a limited evaluation of the skills transfer from artificial situations to real life ones, but did not analyze how the training affected the socials skills of trainees. The short-term approach is utilized for the purpose of evaluation of theory of mind teaching efficiency, and the control group is subject to the NL_MAMS-assisted rehabilitation after the evaluation. The advantage of the short-term approach is that it is possible to ignore other factors affecting the theory of mind performance of both groups.

The *long-term approach* is applied over 3 years, where manual and NL_MAMS-assisted teaching of the theory of mind is combined with rehabilitation strategies of various natures. The goal of our long-term approach is to teach theory of mind reasoning not just for the reasoning skills per se, but also for improvement of social behavior (Figs. 8.4 and 8.5). Therefore, the evaluation criteria are based on tests of decision-making in the real world as well as tests of reasoning and choosing actions in artificial situations (below we include the quantitative results for the latter).

When our training occurs over a relatively long period, it is important to verify whether performance improvement is simply due to natural development and other rehabilitation procedures over that time. For this reason a control group with neither one-to-one nor NL_MAMS-based training, matched for mental age, IQ and severity of autism, was subject to examinations at the beginning and the end of the set long-term training period. The control group was selected from another autistic rehabilitation center, where there is a lack of human resources to provide a focused theory of mind training by rehabilitation personnel.

Fig. 8.5 Assisted discovery of unknown objects

8.2 Exercising Scenarios

There are two children, A and B, who are subject to detection and/or training of the corrupted reasoning about mental states and actions. Correct answers follow the question, wrong answers are enumerated in the parenthesis, where presented (Fig. 8.6).

8.2.1 Mental State of Another Person

There is a table in a room with two boxes on it. The experimenter (E) is keeping a token in his hands. Child A is in the room, and child B is outside the room. E is asking A:

1) *You see the token in my hands. Do you know which box I am going to put the token to?*
   A: I don't know that box/nobody knows. (A is confused: I don't know the answer).
2) *E: As you see, I put the token into the left box. Do you know, where B will look for the token: in the right box, in the left one or in both boxes?*
   A: In both boxes. (In the left box, where the token actually is).
3) *E: And do you know where the token is?*
   A: I know where is the token.

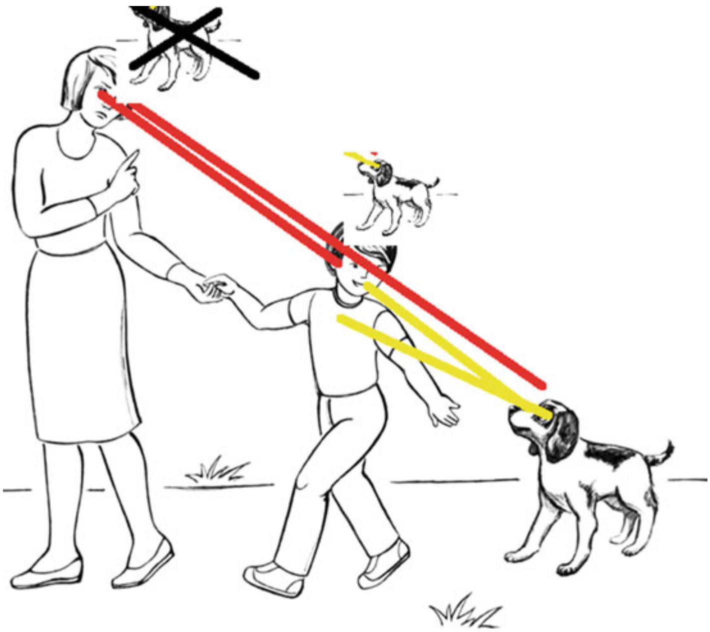

Fig. 8.6 A bubble-thought approach to introduction of mental states

4) *E: Does B know where the token is? If we ask him, what would he respond:*
   A: I don't know where the token is. (I know where it is. I know it is in the left box).
5) *E: If we ask B about his opinion, do you (A) know whether B knows where the token is?*
   A: B knows that I know that he does not know where the token is. (B knows where the token is, B does not know where the token is, B knows that I know where the token is, B knows that I know that B knows where the token is.)
6) *E: Can we achieve a situation, when B will know where the token is?*
   A: Yes, we can tell him or show him (A is confused: I don't know).
   B enters the room. Now all the questions are repeated; B's responses, predicted by A, are actually evaluated.
7) *E, After A showed (or told) B the location of the token: How do you (B) think, did A know whether you knew the location of the token while out of this room?*
   B: A knew that I did not know where the token is.
8) *E, interrupting B: what do you (A) think, what will B say?*
   A: B will say that B knew that I knew that he B did not know where the token was.
9) *E: Now you (B) know where the token is, because A have shown you. Do you think he (A) wanted you to know where the token was?*
   B: Yes, A wanted myself (B) to know where the token is.
10) *E: Do you (A) know whether B knows that you (A) wanted him (B) to know where the token was?*
   B : Yes, I know that I wanted B to know where the token was.

8.2.2 A Wrong Mental State

1) *E: Now I want to tell you the following. I believe, that B still does not know where the token is. Who is wrong: myself (E) or B?*
   A: You are wrong telling us that B still does not know where the token is. (B is wrong, now he does know where the token is).

8.2.3 Mental State Transmission

This is a mirror test to the *mental state of the other person* one.

E keeps the blank piece of paper. A is next to E, and B is in the other room.

1) *E: I am going to plot a geometric sketch on a piece of paper. I'm about to start the drawing. Do you know what I am going to draw; do I know, if myself knows what will be drawn?*
   A: I don't know, and you do.
   E finishes the picture.
2) *E: Now you know, what I've drawn. Does B know that?*
   A: B does not know what is drawn.
3) *E: How can you let him know what is drawn?*
   A: Either show him or tell him (describe the picture).
4) *E: You mentioned two ways of letting B know about this picture. Do both these ways require your knowledge of what is actually drawn?*
   A: No, to show him, I do not necessarily have to know (have seen) the picture. To describe the picture, I have to know its content. (Yes, I have to know the picture content for both telling and showing).
5) *E: If we call B into the room and ask him if he knows what is on the paper, what would he (B) respond? What would he respond if we ask him after we show him the picture?*
   A: Before we show him (B) the picture, he will tell that he does not know what it is about. After we show or tell him (B) about the picture, he will tell he knows it.
6) *E: if we ask B concerning his opinion, do you (A) know that he (B) does not know what this picture is about right now, before we informed him about the picture?*
   A: B knows that I know that he does not know the drawing. (A is confused: I don't know. B does not know that I know that he does not know. B does not know that I don't know that he knows).
7) *E: I guess, I want your friend to know what is on the picture. Is it true? If so, does B know that you wanted to let him know about the picture? Does B know that you want him to know the picture?*
   A: I'm not sure. After I informed him about the picture, he would know that I wanted him to know what is on the picture. I don't know if he (B) knows that I want him to know the picture.

Thereafter E calls B in and asks A to actually inform B about the picture. All the questions above are posed for B as B's prediction of mental state of A.

8.2.4 Temporal Relationships Over the Mental States. To Forget and to Recall

There are the toys on the table: a bear, a fox and a rabbit. Experimenter is asking the child about his/her mental states.

1) *E: As you see, the bear is watching the rabbit. Does the bear know that the rabbit is on the table?*
   A: Yes, The bear knows that the rabbit is on the table.
2) *E: Now the rabbit leaves the table. The bear knows that the rabbit is not on the table any more. Does the bear know that the rabbit was on the table before?*
   A: Yes, he knows that he was on the table before.
3) *E: Then, after a while, when the fox asks the bear if the rabbit had been on the table, the bear is saying that the rabbit has not been there. Trusting the bear, what do you think, does the bear know that the rabbit was on the table?*
   A: The bear does not know that the rabbit was on the table.
4) *E: OK, the bear forgot that the rabbit was on the table. Does the rabbit know that he earlier knew that the rabbit had been on the table?*
   A: No, the rabbit does not know that he earlier knew that the rabbit had been on the table.
5) *E: Now the fox wants the bear to recall that the rabbit has been on the table. What will she do?*
   A: She (the fox) will tell the bear that the rabbit was on the table, and that the bear has seen him there.
6) *E: Then, assuming, that the bear trusts the fox, what is the knowledge of the bear?*
   A: Now the bear knows that the rabbit was on the table.
7) *E: OK, so the bear recalls that the rabbit was on the table. Does the bear know that before the recollection he did not know that the rabbit had been on the table? Analogously, does the bear know that he(bear) knew that the rabbit had been on the table, while (bear) was watching the rabbit?*
   A: Yes, the bear knows that he did not know that the rabbit has been on the table, as well as the bear knows that he knew that the rabbit has been on the table while watching the rabbit.

8.2.5 Pretending

There is a table, and a book on it. The experimenter teaches the child A to pretend that it is soap.

1) *E: As you see, there is a book on the table. Do both of us know that it is a book?*
   A: Yes, both of us know that it is a book.
2) *E: Now let us pretend that it is soap. Both of us will still know, that it is the book. However, if I ask you, what that is, what will I respond?*
   A: You respond that it is soup.
3) *E: If you ask me, what is on the table, what will I respond?*
   A: That there is soap on the table.

4) *E: When one asks you if you know what is on the table, what will you respond?*
   A: I do know what is on the table.
5) *E: Now let us stop pretending. Both of us still know that this is actually a book. If one asks me what is on the table, what will I respond?*
   A: You will respond that it is the book.

8.2.6 Exercising Results

Twenty autistic children of the age 4–18 participated in the testing and training and 20 control children of the age 8 participated in the testing.

Note that the questions above cover the majority of mental formulas complexity 1–4, involving *want* and *know* (*believe* is identified with know for simplicity). The manifold of tested mental state achieves the real world complexity. Therefore, the trained children are expected to behave properly in the real conditions, if they are able to transfer artificial mental states to the real ones.

Each question with the mental formula complexity below three was successfully answered by every control child.

– Each question of complexity 4 was failed by at least one autistic kid.
– For each question the autistic child failed, it was possible to perform training such that the question is successfully answered after fifth attempt.
– If to replace the mental states by physical states, the questions will be easier answered by the autistic children, than the questions above. It will not make a significant difference with the control children.

8.3 Construction of Mental Formulas

Teaching the exhaustive set of mental formulas in a labor-intensive yet efficient way towards a proper reasoning about mental world. Starting from the simplest formulas for intention, a caregiver proceeds to complex mental states involving contradicting beliefs (Table 8.1). The codes for mental formulas are in seven columns on the left.

Once the totality of mental formulas is acquired by a trainee, he can proceed to formalizing a scenario. Given a story (essay, anecdote), he is expected to formalize it via mental formulas and feed into NL_MAMS (Fig. 8.7).

Once the totality of mental formulas is explored and CwA is capable of formalizing some simple scenarios, the trainer can proceed to more complex mental entities (Figs. 8.7 and 8.8). The definitions of more complex mental concepts: *to offend*, *to forgive* and *to reconcile* are as follows.

Table 8.1 Encoding for the approach of building the mental formular for the exaustive set of mental formulas

Not	Want	Not	Know	Not	Believe	Embed	Definitions of the constructed expressions	Semantic comments
	1					1	want (Agent, do(Agent, Action))	Agent wants to commit an action
	1					2	want (Agent, do(DAgent, Action))	Agent wants another agent to commit an action
	1		2			2	want(Agemt, know (Agent, What)):- (believe(Agent, know (KAgent, What)), ask(Agent, KAgent, What))	Agent wants (himself) to know
	2		3		1	3	believe (Agent, want(WAgent, know (Wagent, What))):- prefer(Agent, tell(Agent, Wagent, What), Other Action)	Believe that other agent wants to know
	2		3		1	3	believe (Agent, inform(WAgent, KAgent, What)). believe(Agent, want(WAgent, know (KAgent, What))):- not know (KAgent, want(WAgent, know (KAgent, What))), inform(Agent, KAgent, ask(KAgent, WAgent, What))	Believe that someone wants to know - > inform believe that someone else wants the third person to know
	2,4		3		1	4	believe(Agent, want(WAgent, know (KAgent, want(Agent, What))):- believe(Agent, inform(WAgent,KAgent, want(Agent, What)))	Believe that someone else wants the third person to know what I want

8.4 The Literature Search System

Once a trainee is familiar with mental formulas and is capable of forming simple scenarios from it, he should proceed to formulating questions in the mental world. A rich and extensive domain in the mental world is the one of the fictional characters in a narrative work of art (such as a novel, play, television series or film). In this section we propose a reasoning exercise based on formulating queries and searching

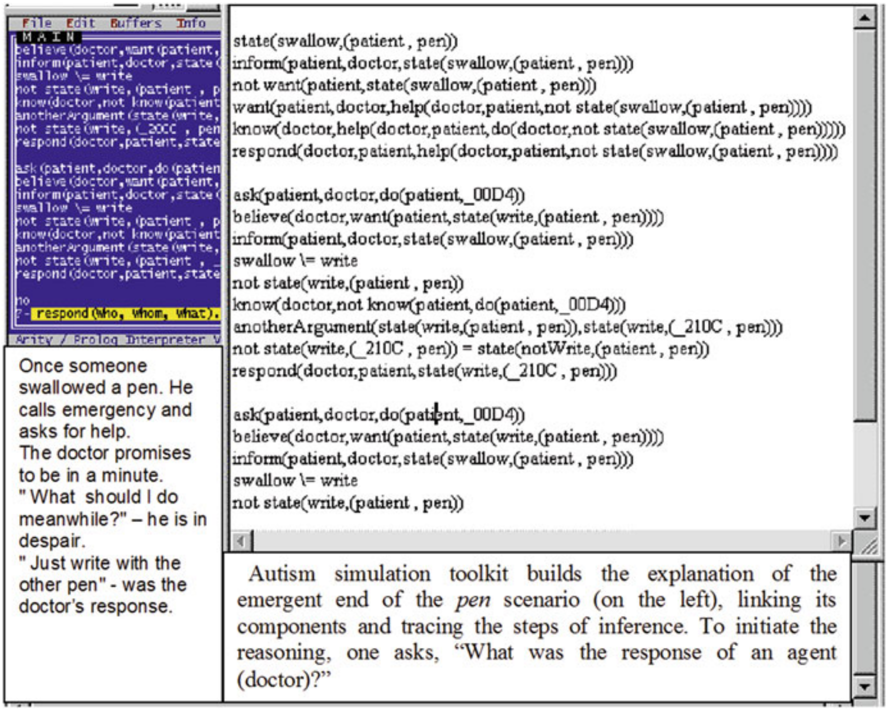

Fig. 8.7 NL_MAMS processing a joke, formalized by a trainee

for works of literature (WOL). This is the most computational intelligence-intensive application in HCI domain among other assistive technologies, along with NL_MAMS.

The methodology and abstraction of such search are very different from those for database querying, keyword-based search of relevant portions of text, and search for the data of various modalities (speech, image, video etc.). Clearly, the search that is based on mental attributes is expected to be semantically accented: using just the author or title name is trivial. Also, using temporal (historical) and geographical circumstances of the characters reduces WOL search to the relatively simple querying against the relational database of WOL parameters.

Focusing on the mental component of WOL plots is rewarding from the prospective of building the compact and closed (in terms of reasoning) vertical natural language question-answering (Q/A) domain. It is important that a user is aware of the lexical units and knowledge that is encoded in a domain to ensure the robust and accurate Q/A system. Division of the commonsense knowledge into mental and non-mental (physical) components introduces a strict and explicit boundary between the "allowed" and "not allowed" questions, that is a key to success of NL Q/A application in the field of education (Galitsky 2000).

Unintentional offend is based on the lack of knowledge that the offending action *do(Who, Action)* is unwanted:

offend(Who, Whom, Action) :- want(Who, Action),
not want(Whom, Action),
not know(Who, not want(Whom, Action)),
do(Who, Action).

To be forgiven, the offender has to demonstrate that the offense is indeed unintentional. It is necessary for the offender *Who* to inform *Whom* that *Who* would not *do* that *Action* if *Who* knew *Whom* did not like (*want*) it.

forgive(Whom, Who, Action) :-
offend(Who, Whom, Action),
inform(WhoElse, Whom,
not know(Who, not want(Whom, Action))),
believe(Whom, (know(Who, not want(Whom, Action))→
not do(Who, Action))).

If *Who* is unable to convince *Whom* (to make him believe) that the *offend* was unintentional, the other agent *Counselor* is required to *explain* the actual situation to *Whom*:

reconcile(Counselor, Who, Whom, Action) :-
offend(Who, Whom, Action),
not forgive(Whom, Who, Action),
explain(Counselor, Whom,
believe(Whom, (know(Who, not want(Whom, Action))→
not do(Who, Action))).

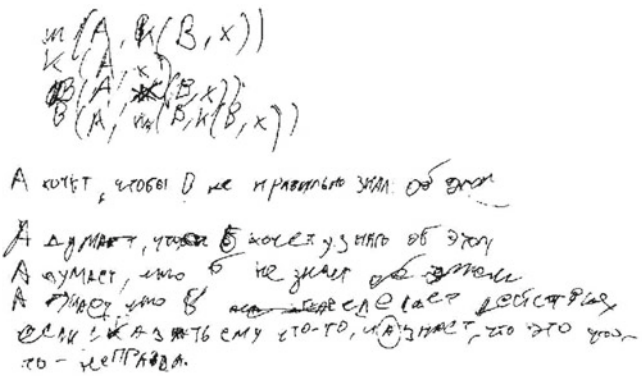

Fig. 8.8 A trainee writes a formal definition for *cheating* followed by its definition in plain words (Russian)

What is the role of mental states of fictional characters in the classification and schematization of the works of literature? We have built the dataset of WOLs, which includes the manually extracted mental states of their characters. We collected as many WOLs as it was necessary to represent the totality of mental states, encoded by logical formulas of the certain complexity (Galitsky 2002). Below are the features of this dataset:

1. As a rule, the main plot of a WOL deals with the development of human emotions, expressible via the basic (*want-know-believe*) and derived (*pretend, deceive*, etc.) mental predicates. A single mental state expresses the very essence of a particular WOL for the small forms (a verse, a story, a sketch, etc.). When one considers a novel, a poem, a drama, etc., which has a more complex nature, then a set of individual plots can be revealed. Each of these plots is depicting its own structure of mental states that is not necessarily unique. Taken all together, they have the highly complex forms, appropriate to identify the WOL.
2. Extraction of the mental states from a WOL allows us to clarify psychological, social and philosophical problems, encoded by this work. The mental components, in contrast to the "physical" ones are frequently expressed implicitly and contain some forms of ambiguity.
3. The same mental formula may be a part of different WOLs, written by the distinguishing authors. Therefore, it is impossible to identify a certain WOL or author when we take into consideration just a single mental formula. However, the frequency of repetition of certain mental formulas shows us the importance of the problem raised by a WOL.
4. The sets of mental formulas are sufficient to identify a WOL. The possibility to recognize a certain author according to a collection of mental states of his or her WOLs is beyond our current considerations.

8.4.1 Architecture and Implementation

We enumerate the tasks that have to be implemented for the literature search system based on the scenario reasoning settings

1. Understanding a natural language query or statement (Galitsky 2003). This unit converts a NL expression in a formalized one (mental formula), using mental metapredicates and generic predicates for physical states and actions.
2. Domain representation in the form of semantic headers (Galitsky 2000), where mental formulas are assigned to the textual representation (abstract) of WOLs.
3. NL_MAMS-supported reasoning that builds the hypothetical mental states, which follow the mental state, mentioned in the query. These generated hypothetical mental states will be searched against WOL knowledge base together with the query representation (in unit 5).
4. Synthesis of all well-written mental formulas in the given vocabulary of basic and derived mental entities.
5. Matching the mental formula, obtained for a query against mental formulas, associated with WOLs. We use the approximate match in case of failure of the direct match.
6. Synthesis of canonical NL sentence based on mental formula to verify if the query was properly understood.

Figure 8.9 presents the chart for interaction between the respective components (1)-(6) of the WOL search system. Suggested system architecture allows two functioning options: WOL search and extension of WOL dataset. When a user wishes to add a new WOL to the current dataset, mental formulas associated with text are automatically build by unit 1 and are multiplied for semantically different phrasings by Unit 3.

Rather complex semantic analysis (unit 1) is required for exact representation of input query: all the logical connectives have to be properly handled. Unit 3 provides the better coverage of the WOL domain, deductively linking mental formula for a query with mental formulas for WOLs. Unit 4 is based on NL_MAMS to handle the totality of all mental formulas, representing the real-life situations.

We rely on NL_MAMS to extract the plausible mental formula from the totality of all well-written mental formulas, represented via metapredicates. In addition, introduction of the classes of equality of mental formulas are required for the approximate match of mental formulas (Unit 5) that is also inconsistent with the traditional formalizations of reasoning about knowledge and belief. NL synthesis of mental expression (Unit 6) is helpful for the verification of the system's deduction. A trainee needs this component to verify that she is understood by the system correctly before starting to evaluate the answer. NL synthesis in such

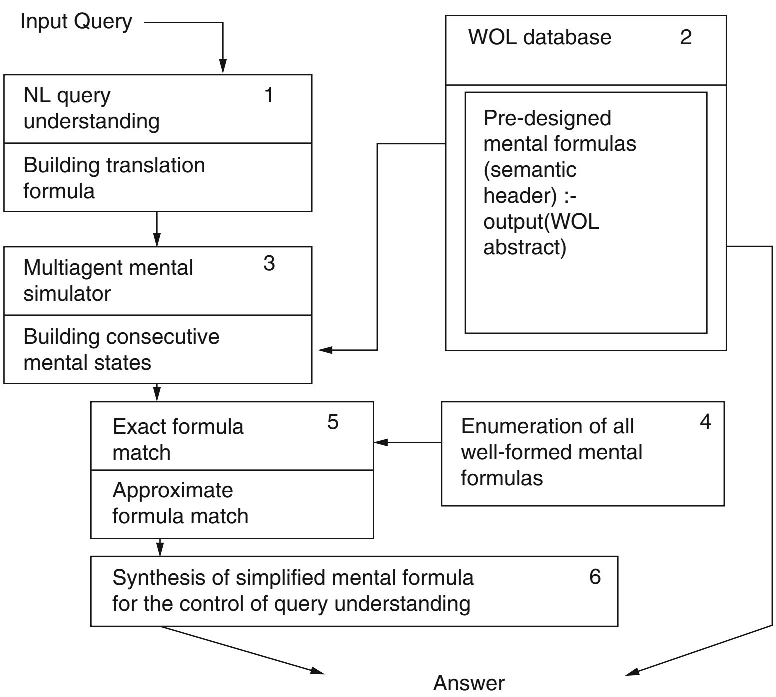

Fig. 8.9 The chart of the WOL search and mental reasoning system

strictly limited domain as mental expression is straightforward and does not require special considerations. Note that semantic rules for the analysis of mental formulas require specific (more advanced) machinery for complex embedded expressions and metapredicate substitutions.

The special question-answering technique for the weakly structured domains has been developed to link the formal representation of a question with the formal expression of the essential idea of an answer. These expressions, enumerating the key mental states and actions of the WOL characters, are called *semantic headers of answers* (Galitsky 2000). The mode of knowledge base extension (automatic annotation), where a customer introduces an abstract of a plot and the system prepares it as an answer for the other customers, takes advantage of the flexibility properties of the semantic header technique.

The mode of knowledge base extension (automatic annotation), where a trainee or a caregiver introduces an abstract of a plot and the system prepares it as an answer for the other trainees, takes advantage of the flexibility properties of the semantic header technique.

To summarize, The WOL architecture is as follows. NL query that includes mental states and action of WOL characters is converted into mental formula (1). Multiagent mental simulator (3) yields the set of mental formulas, associated with the query to extend the knowledge base search. Obtained formulas are matched (5) against the totality of prepared semantic headers (mental formulas) from the WOL database (2). If there is no semantic header (mental formula attached to text) in the dataset component that satisfies the mental formula for a query, the approximate match is initiated. Using the enumeration of all well-formed mental formulas (4), the system finds the best approximation of the mental formula for a query that matches at least single semantic header (mental formula for an answer) (Fig. 8.10).

How would a person pretend to another person that she does not want that person to know something?

When would a person want another person not to pretend that he does not know something?

When would a character pretend about his intention to know something?

Why would a person want another person to pretend about what this other person want?

How can a person pretend that he does not understand that other person does not want?

Is it easy for a person to believe that another person does not pretend what she wants?

How can a person believe that another person might pretend that he wants something?

She wanted to believe that he pretended that he was not a prince.

Can she believe that he does not pretend that he committed the murderer of her spouse because of his love to her?

A person believes that the husband does not want him to love his wife.

A wife wishes not to confess to her husband that she was not faithful.

Fig. 8.10 Sample questions for the literature search

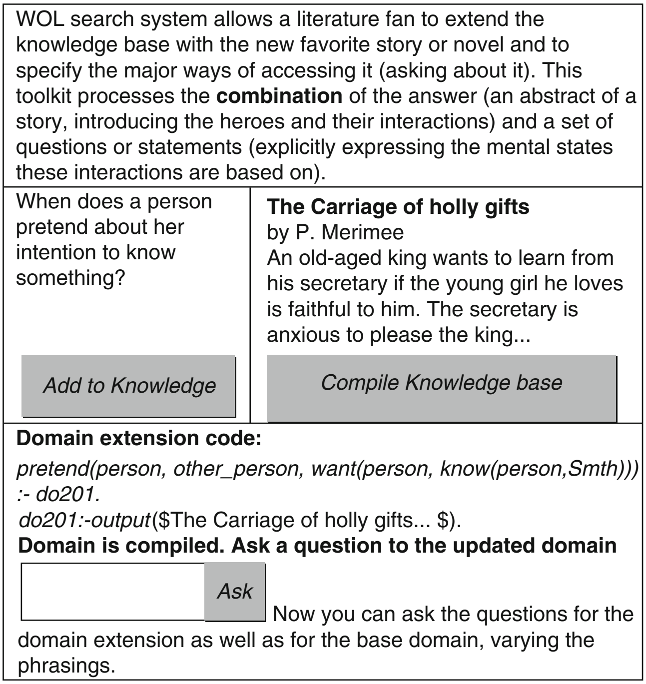

Fig. 8.11 Autistic child learns the mental interaction with the characters (participants of the scene), using suggested system

8.4.2 HCI Aspects and Query Examples

Interaction with the literature characters is demonstrated to be a novel educational and entertainment area, appealing to adults as well as to children, interacting with the characters of the scenes in NL (Fig. 8.11). Since the players are suggested to both ask questions and share the literature knowledge, the system encourages the cooperation among the members of the players' community. In the demo we have built, the system only recognizes the questions and statements, involving the terms for mental states and actions. This way we encourage the players to stay within a "pure" mental world and to increase the complexity of queries and statements we expect the system to handle properly. Observing the game players, we discovered that they frequently try to obtain the exhaustive list of WOLs, memorize the querying results and enjoy sharing WOL plots with the others.

The demo encourages the users (players, students) to demonstrate their knowledge of classical literature, from medieval to modern, asking questions about the mental states of the characters and compare the system results with their own imagination. The system stimulates the trainees to extract the mental entities, which can be formalized, from the totality of features of literature characters. After an

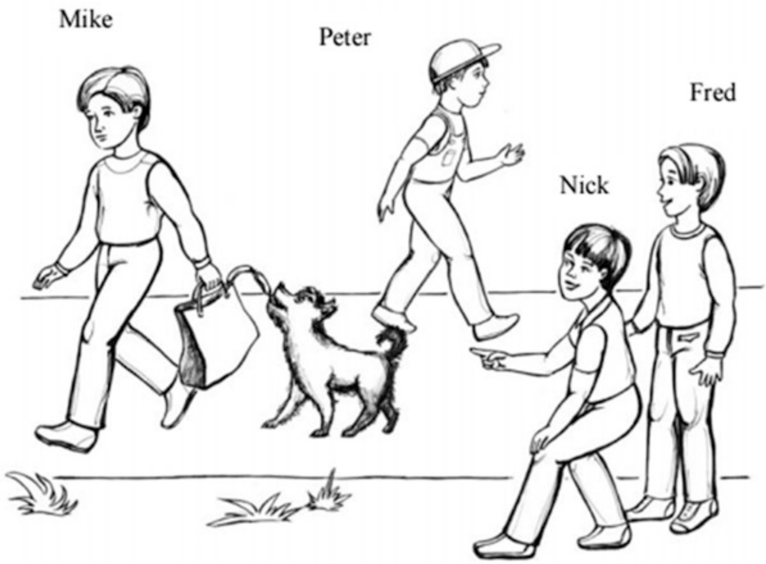

Fig. 8.12 A scene that is a subjects of questions about mental states

answer is obtained, it takes some efforts to verify its relevancy to the question. It takes a little variation in the mental expression to switch from one WOL to another. More advanced users are offered the option of adding new WOL. For mental intervention (particularly, autistic children) certain visualization aids are useful in addition to the WOL search system (Fig. 8.12, Galitsky 2000).

Examples of questions the children may ask the system about, while watching the scene, are shown in Fig. 8.10. Involving more and more complex mental states helps the playing children to develop creativity and imagination of thinking, as well as the communication skills of understanding other's mental states.

1. Does Mike see that the dog is eating the sausages?
2. Does Peter see what is happening with Mike and the dog?
3. Does Nick know what is happening with Mike and the dog?
4. Which way does Nick express his emotions?
5. Does Fred know whether Peter knows what is happening with sausages?
6. Does Nick want to keep the dog from eating the sausages?
7. What would Fred do if he wants to let Peter know what is happening?

8.5 The Action Adjustor Training System

Having acquired various reasoning patterns, regrettably, CwA experience difficulties transferring these patterns from one domain to another, from home to street environment, from behavior while on holiday or in the class etc. Therefore, although the default reasoning patterns per se are formulated as domain-independent, the same patterns have to be repetitively introduced in each domain.

Adjustment of action can be initiated in a pre-verbal age. It is important to give meanings to CwA actions. Some CwA do not yet use their behavior for communication with others, but a parent or trainee can respond to CwA behavior as if it were a communication. It teaches her that her actions have meanings. For example, if CwA makes sounds without an intent to communicate anything, a parent should respond as if the sounds have a goal, such as a request for some objects. The caregiver should then pronounce "here it is, the toy" and give it to CwA. Also, if CwA reaches up in the air without any intent or associated meaning, react as if he wants to be picked up. Attach a meaning to CwA's play even if she handles a toy in an unusual or odd way. If a child arranged toy animals in a row, a trainer can say "You arranged your animals in a Zoo".

Teaching children with autism proper reasoning patterns concerning selection of actions in a context should be conducted in *all* domains one would expect to make children's behavior more adequate. Hence a separate component for each behavioral domain is required, including home, school, outdoor, sports and other activity. We build a sample interactive form for the "going to school" domain, keeping in mind that similar forms are required for different domains. In the future we expect such forms will be developed (possibly, built by automated tools) by a number of educational content providers.

The generic interactive form that includes two exercises is shown at Fig. 8.13. The form specifies the initial conditions and default actions (drop-down boxes on the left) and also current circumstances with adjusted actions (drop-down boxes on the right); actions are chosen by trainees. Selecting the items on the left, trainees imitate respective sequence of (changing) circumstances/contexts, and the appropriate action adjustment (correct action) should be selected on the right. The link between the selections on the left and those on the right is implemented via default rules.

In Fig. 8.14 we present two interactive forms for organizing a party (on the top) and a route to school (on the bottom). The initial state is randomly set. Then

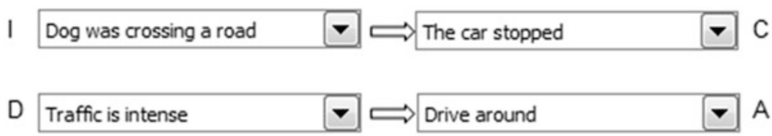

Fig. 8.13 Interactive form to train the adjustment of action to representation change

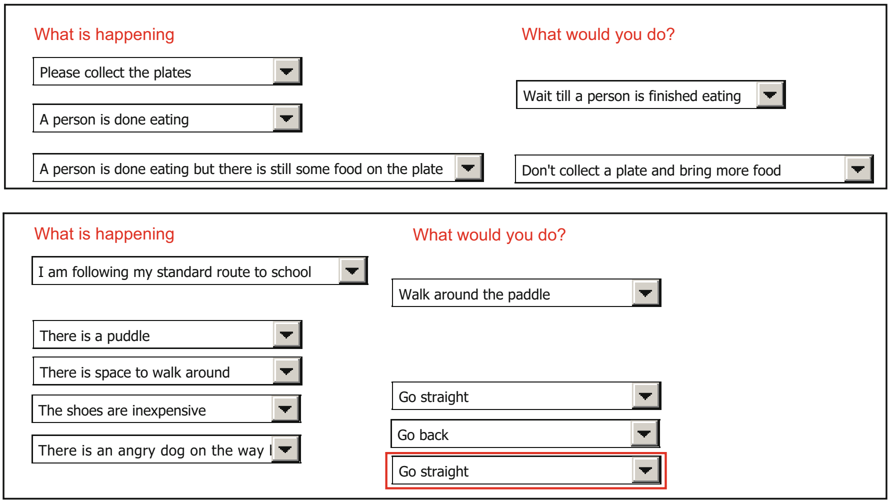

Fig. 8.14 Two interactive forms for training selection of actions

the trainee needs to select an appropriate action in response to the auto-selected circumstances. Alternatively, the trainee can select these circumstances herself to browse through all possibilities. Once the choice is done, the system corrects the selection if the choice was erroneous.

8.6 Emotional Remediation

It is hard for CwA to recognize facial expressions of different emotions. Children who have trouble interpreting the emotional expressions of others are taught about emotional expressions by looking at pictures of people with different facial expressions or through identifying emotional expressions of others in structured exercises. CwA are missing an intuitive, almost automatic sense of another person's affect (Fig. 8.15). This is the feature people rely on to appreciate an emotional state of a peer. In other words, understanding of emotions of other people is supposed to happen very rapidly through a personal, non-logical, emotional reaction. One can often respond to the person's affect before it even consciously accepted. Thus, we flirt back, look embarrasses, puzzled or display anger as part of our intuitive, affective response. Once we have experienced, at the intuitive level, the other person's emotional signal, we can also reflect on it in a conscious and deliberate manner. People may determine that other people are unhappy angry, or puzzled and to do that they are relying on their own affective response, not just on facial expression of an opponent (Fig. 8.16).

Fig. 8.15 Attempting to cause positive emotions without scaring

Fig. 8.16 Classes of emotions (Hergott 2016)

During a regular course of events, such as attending a cocktail party or trying to establish relationships with other children at a birthday party, there is a high volume of affect signals being exchanged. If a child or adult consciously tries to figure out each separate one, they will be doomed to failure and confusion.

Therefore, the way to help CwA to recognizing and learn affect signals is to provide him or her extra practice in experiencing and reading those signals. A trainee should start in rather simpler social situations involving lots of reciprocal, affective interactions, initially with one-on-one caregiver and other children. After that CwA should gradually proceed towards more complex situations with other people.

It is not enough to teach child recognize emotions on a computer game. A trainee must proceed talking about emotions in real-world interactions (Fig. 8.15). Since CwA cannot learn this affect on their own; they must be guided. The "practice" needs to involve the personal inner experiences of someone else's affect, as well as one's own, in a series of reciprocal interactions. Similarly, children who have theory of mind problems are often provided with cognitive exercises involving figuring out other people's perspectives, rather than working at the primary level of affective signaling, which is often compromised and at the core of these children's problems.

Our experience in rehabilitation tells that children with autism or Asperger's Syndrome are not able to learn to feel their own and someone else's affect and, therefore, can only learn to read facial expressions through pictures or perform theory of mind tasks in a conscious, deliberate manner (Fig. 8.15).

Although a number of research suggests the opposite, with a program focusing on relating and affect cueing, the majority of children made progress in understanding and showing emotions (Greenspan and Wieder 1998). In general, the missing piece in many intervention programs is a lack of understanding of the developmental steps involved in acquiring certain cognitive, social, and emotional skills (Fig. 8.17). By understanding these steps, which often involve transformations of affect, intervention strategies can help the child master the critical foundations for cognitive and social skills.

Fig. 8.17 Children express distinct emotions observing something that causes a surprise

Greenspan (1997) worked with children on their skills to interact by means of affective gestures. The first step was simple interaction scenarios including back and forth negotiations (Rosenschein and Zlotkin 1994) such as put a book on the table or get a hat. The author found that CwA can mostly achieve a continuous flow of affective interaction. As children are involved in interactions, their repetitive, idiosyncratic, un-reciprocal and stereotypical forms of behavior were altered. They begin using their gestures, available language and thinking skills in a more purposeful, creative and abstract manner.

For children who start this training at age eight, they need a number of years to develop the basic capability for reciprocal affective gesturing since this skill was omitted at the appropriate age. When this training starts at earlier age, CwA develop these skills more quickly and fully (Greenspan and Wieder 1998). Many children benefit from a balanced intervention program which involves both spontaneous reciprocal affective interchanges and problem solving training with certain structure. When goals are posed in a semi-structured way, the training needs to be offered in a way that initiates enthusiastic affect and a continuous flow of back and forth interaction while solving a problem. An example of such semi-structured problem would be teaching a child to "open" in the context of his trying to open the door to get his favorite toy that has been deliberately placed behind the door.

8.6.1 Emotions in Conversational Agents

Computers need to be programmed emotions from scratch to display affect in response to some stimuli. The area of affective computing (Picard 1997) is the design of computational devices proposed to exhibit either innate emotional capabilities or that are capable of convincingly simulating emotions. With CwA, we target both these directions, giving them rules to reason about emotions as a part of the mental world on one hand, and teach them direct rule when it is appropriate to express a given emotion.

A more practical approach for the case of computers, based on current technological capabilities, is the simulation of emotions in conversational agents in order to enrich and facilitate interactivity between human and machine. While human emotions are often associated with surges in hormones and other neuropeptides, emotions in machines and CwA should be associated with states associated with progress (or lack of progress) in autonomous learning systems, or cognitive development. In this view, affective emotional states correspond to time-derivatives (perturbations) in the achieved recognition accuracies of an arbitrary learning system. Both computer scientists and CwA teachers pose the question on how far can their subjects go in terms of doing a good job handling people's emotions and knowing when it is appropriate to show emotions without actually having the feelings.

Marvin Minsky, one of the pioneering computer scientists in AI, relates emotions to the broader issues of machine intelligence, stating in his book "The Emotion

Machine" that emotion is "not especially different from the processes that we call 'thinking' (Minsky 2007). He explains that the distinction between emotions and other kinds of thinking is rather vague. His main argument is that emotions are "ways to think" for different "problem types" that exist in the world. The brain has rule-based mechanisms, implemented as switches or selectors, that initiate emotions to tackle various tasks. Minsky's approach backs up our intervention strategy based on the rule-based assistance with understanding and reproducing emotions.

In his book "Descartes' Error" (Damasio 2004) argued that, thanks to the interplay of the brain's frontal lobe and limbic systems, our ability to reason depends in part on our ability to feel emotion. Too little like too much of this system would cause bad decisions. The simplest example: It is an emotion – fear – that controls one's decision not to go into a forest in the dark at night to avoid wolves. Most AI experts aren't interested in the role of emotion, preferring to build systems that rely solely on rules. Another AI pioneer John McCarthy believes that we should avoid affect in computational models, arguing that it isn't essential to intelligence and, in fact, can get in the way. Others, like Aaron Sloman, think it's unnecessary to build in emotions for their own sake. According to Sloman, feeling will arise as a "side effect" of interactions between components required for other purposes. In terms of our model of the mental world, once mental states are properly trained, emotions will follow since they obey similar definition framework.

Picard (1997) believes that computers should be designed to take into account, express and influence users' feelings. From scheduling an appointment to picking a spouse, humans follow their intuition and listen to their gut feelings. According to Picard, computers that are not capable of understanding and generating emotion are like an autistic ski resort service guy who says, "I remember you! You're the dude who gave me a bad tip."

The pragmatics of autistic intervention of emotional development helps to resolve the disagreement between Picard and her opponents. On one hand, *interactional approach* to affective computing adopts a notion of emotion as constituted in social interaction. This is not to neglect the fact that emotions have neural aspects, but it is to confirm that emotion is "culturally grounded, dynamically experienced, and to some degree constructed in action and interaction". When a CwA is taught to choose an action, once it affects other people or a feeling of himself, a rule needs to be introduced for an associated emotion. When you either step into a puddle or go around, in addition to physical results of either action CwA needs to be explained the feeling of the mother once she observes the pair of wet shoes.

Also, the interactional approach does not seek to enhance the affect-processing capacities of computer systems. Rather, it seeks to help people to understand and experience their own emotions, which is important for CwA. Furthermore, the interactional approach accordingly adopts different design and evaluation strategies than those described by the Picardian research program. Interactional affective design supports open-ended, inter-individual processes of affect interpretation. It recognizes the context-sensitive, subjective, changing and possibly ambiguous character of affect interpretation. Interactional approach considers these efforts to make sense of emotions and that it may be difficult to formalize affect.

Fig. 8.18 A training to properly express emotions

Picard and her followers pursue a *cognitivist measuring approach* to users' affect, while the interactional followers prefer a pragmatic approach that views (emotional) experience as inherently referring to social interaction (Boehner et al. 2007). While the Picardian approach focuses on human-machine relations, the goal of the interactional affective computing approach is to facilitate computer-mediated inter-personal communication. And while the Picardian approach is concerned with the measurement and modeling of the neural component of the emotional processing system, interactional affective computing considers emotions as complex subjective interpretations of affect, arguing that emotions instead of not affect are at stake, from the point of view of technology users.

Picard uses the state transition diagram to simulate transitions between emotions. The state (here: *interest (I), distress (D)*, or *joy(J)*) of a person cannot be observed directly, but observations which depend on a state can be made (Fig. 8.19). The Hidden Markov Model shown here characterizes the probabilities of transitions among three "hidden" states, (I,D,J), as well as probabilities of observations (measurable eccentric forms, such as features of voice inflection, V) given a state. Given a series of observations over time, an algorithm such as (Viterbi's 1967) can be used to computer the sequence of states which provide the best explanation for observations. These diagrams should be used as an educational aid for trainers to explain how one emotion can grow into another (Fig. 8.18).

For example, if one is *interested* in something, but is denied access or information, she transitions into *distress.* Once the access is granted or information is obtained, she can further transition to *joy*. These transitions can also be illustrated by modifying an schematic image of an agent, an animal or a human (Sect. 8.6.5).

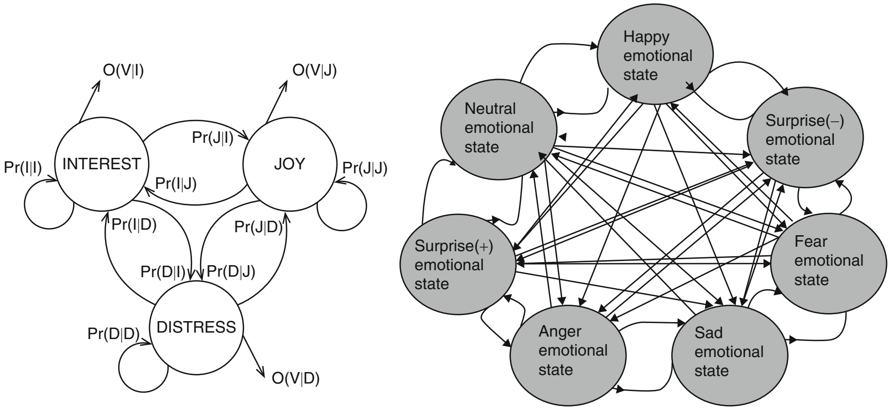

Fig. 8.19 State transition diagram to simulate transitions between emotions (from Jain and Asawa 2015)

This probabilistic algorithm is good to teach a machine to recognize emotions, but for a teaching a CwA a deterministic rule-based approach is necessary, like *always* show a joy once you satisfied your interest, not randomly. In general, random, probabilistic behavior, as observed by others, as associated with autism and therefore needs to be cured. Even if deterministic system does not behave as close to a natural emotional system as a probabilistic one, it is still a step forward in terms of teaching CwA.

Although most computer models for imitating mental activity do not explicitly consider the limbic response, a surprisingly large number implicitly consider it. (Werbos 1994) explains that his original idea of the backpropagation learning algorithm, extensively used in training artificial neural networks, was inspired by trying to mathematically translate an idea of Freud. Freud's model began with the idea that human behavior is governed by emotions, and people attach emotional energy to things Freud called "objects."

According to Freud's theory, people first of all learn cause-and-effect associations; for example, they may learn that "object" A is associated with "object" B at a later time. And his theory was that there is a backwards flow of emotional energy. If A causes B, and B has emotional energy, then some of this energy flows back to A. If A causes B to an extent W, then the backwards flow of emotional energy from B back to A will be proportional to the forwards rate. That really is backpropagation.... If A causes B, then you have to find a way to credit A for B, directly. ... If you want to build a powerful system, you need a backwards flow."

What are the cases that arise in affective computing, and how might we proceed, given the scenarios above? Table 8.2 presents four cases:

I. Most computers and some CwA fall in this category, having rather limited affect recognition and expression. Such computers and humans are neither personal nor friendly.

Table 8.2 Four categories of affective computing, focusing on expression and recognition. Another question can be posed whether a system can act based on emotion, having a capability to express it (on the bottom)

Computer	Cannot express affect	Can express affect
Cannot perceive affect	I.	II.
Can perceive affect	III.	IV.
Can act based on emot. | …		

II. This category aims to develop computer voices with natural intonation and computer faces (perhaps on agent interfaces) with natural expressions. When a disk is put into a laptop and its disk-face smiles, users and peers may share its momentary pleasure. Of the three categories employing affect, this one is the most advanced technologically, although it is still in its infancy. This case is also represented by CwA which need to be trained to perceive affect and emotions.
III. This category enables a computer or a CwA to perceive your affective state, enabling it to adjust its response in ways that might, for example, make it a better teacher and more useful assistant. It allays the fears of those who are uneasy with the thought of emotional computers, in particular, if they do not see the difference between a computer expressing affect, and being driven by emotion.
IV. This category maximizes the meaningful communication between human and computer, potentially providing truly "personal" and "user-friendly" computing. It does not imply that the computer would be driven by its emotions. This is the goal of emotional rehabilitation of CwA.

Also it is worth adding the rows "Computer can/can't induce the user's emotions" as it is clear that computers already influence our emotions, the open questions are how deliberately, directly, and for what purpose.

It has to be clearly explained to a CwA what is the difference between feeling, emotion and affect. Feelings are *personal* and *biographical*, emotions are *social*, and affects are *pre-personal* (Shouse 2005).

We can define a feeling as a *sensation that can be recognized* given the previously accumulated training set (of feelings). It is personal and biographical because every person has a distinct training set of previous sensations. An infant does not experience feelings because he lacks such training set. At the same time, parents are confident that their children have feelings (which are indeed affects) and express them regularly.

An emotion is a *display* of a feeling, a means to show feeling to the public. Unlike feelings, the display of emotion can be either genuine or fake (Oatley and Johnson-Laird 1987). We broadcast emotions to the world:

1. an expression of our internal state;
2. in order to fulfill social expectations.

Infants do display emotions although they do not have a training set to experience feelings. The emotions of the infant are direct expressions of affect.

CwA need to be explained that for a given feeling, there are multiple way to express respective emotion. When *feeling* = *'upset'* the emotion ∈ {'yell', 'throw object', 'tantrum', 'being quiet', 'drop into tears', 'complain'}. A caregiver should give an example first and then make a trainee display one emotion after another, given a particular feeling. Also, CwA needs to be capable of recognizing genuine (sincere, real) emotions versus fake (*cheating, pretending*, trying to *impress* someone with her specific feeling to achieve a goal).

Affect can be defined as the *body's way of preparing itself for action* in a given circumstance by adding a quantitative dimension of intensity to the quality of an experience.

An affect is a non-conscious experience of intensity; it is a moment of unformed and unstructured potential. Affect cannot be fully realized in language, and it is outside of consciousness). The body has a grammar of its own. CwA need to be trained to imitate affect by their bodies, and differentiate it from emotions. According to (Massumi 2002), affects include coordinated responses involving the facial muscles, the viscera, the respiratory system, the skeleton, autonomic blood flow changes, and vocalizations that together produce an analogue of the particular gradient or intensity of stimulation influencing the person's body.

8.6.2 Tuning Emotional Response

Children should be capable of defining emotions and telling a caregiver about a time they feel, experience this emotion. A definition of a particular emotion needs to be provided if a child is unable to produce an appropriate explanation. A trainer must ensure that the children are aware of the meaning of each term referencing emotion as they are asked to discuss their personal experience.

An important class of exercises targeting reasoning that supports understanding and expressing emotions is recalling a prior personal experience. High-functioning individuals with autism also seem able to discuss experiences with simple emotions but usually have trouble with more complex or self-conscious emotions such as *pride* and *embarrassment.* The form-based approach where a child picks a combination of himself or his proponent or opponent in the mental state, is fruitful (Fig. 8.20, Galitsky and Shpitsberg 2015). In the rightmost column the trainees are to give example of cases from their personal experience.

Whereas simple emotions are associated with distinct facial expressions, exhibit little cultural variation in antecedents or expression, and are typically recognized and understood relatively early in development, self-conscious emotions necessarily involve complex attribution processes relying on later developmental achievements, such as the capacity for reflecting upon experiences and evaluating them in relation to sociocultural norms and expectations, as well as the appraisals of others (Lewis et al. 2010, Fig. 8.21). According to Cooley 1902)

proud	I		person
	you		person's action
	he		person A's action towards person B
	they	with	myself
embarrassed	I		my action
	you		my action towards person B
	he		
	they		

Fig. 8.20 A form for being proud and being embarrassed

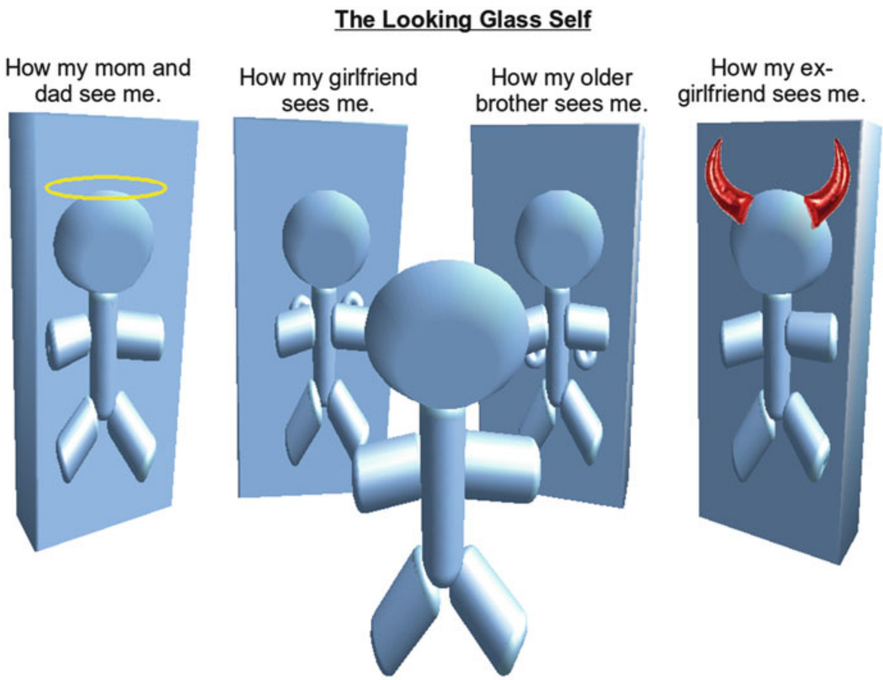

Fig. 8.21 This drawing depicts the looking-glass self. The person at the front of the image is looking into four mirrors, each of which reflects someone else's image of this person

> the thing that moves us to pride and shame is not merely mechanical reflection of ourselves, but an imputed sentiment, the imagined effect of this reflection upon another's mind.

When the children are unable to recall a personal experience, a trainer describes a scripted personal experience of her own involving the term in question, followed by the prompt "Have you ever felt that way?" Once children began their accounts, however, such advising should be limited to requests for elaboration and clarification in response to children's excessive pauses, trailing off, and incoherent remarks.

There are two kinds of issues in understanding and expressing emotions while children recount their emotional experience:

1. Involving inappropriate contexts, actions and events that, without further explanation, would not typically elicit the emotion/or non-emotion in question (e.g., "I was embarrassed once time when I was asked to assist with carrying a bag").
2. Involving episodes that would tend to elicit feelings of appropriate sentiment polarity but did not contain sufficient details or explanation for distinguishing the specific emotion/non-emotion from the feeling expressed in language by a verb of the same class (feelings with the similar patterns). (e.g., "I was proud when I received an acceptance letter in the mail").

These issues are cured by learning correct, concise definitions of emotional entities.

Only describing unambiguously evocative contexts (e.g., "I was not happy when my parents took my brother instead of me to watch a movie") and/or that include explanations clarifying the reasons the particular actions or events were associated with the feeling in question (e.g., "I felt proud when I earned an award for running fast") can be considered as successful understanding of emotion.

8.6.3 Autism and CwA Expression of Feelings

Despite many difficulties, CwA can acquire social skills over a period of time, given appropriate intervention. Attempting to teach people with autism about emotions using conventional strategies, such as trying to make them understand a viewpoint of another person, is rarely successful. A more concrete approach is required.

In this chapter we present a method to teach CwA to understand and acknowledge the thoughts and feeling of others via *social stories*. These short stories describe scenarios that enable individuals to improve their understanding of themselves and others. These stories prompt both children and adults to ask questions about other people and attempt to recognize that different people may think differently.

If one distinguish a child's capacity for deep, joyful relating from the capacity for affective, reciprocal interchanges, one can observe that CwA are capable of the full range of warmth, love, and closeness. This intimacy is relatively easy to observe in families who focus on promoting relaxed interactions for hours and hours and attending to all the subtle ways the children have of showing their intimacy. In the review of 200 cases, over half the children evidenced a deep rich capacity for intimacy and over 90 % showed a continuing growth in this pattern (Greenspan and Wieder 1998) (Fig. 8.22).

When teaching individuals with autism about emotions, it is important to describe each feeling pictorially, using pictures with clear outlines, and with minimal detail. Relate the emotion to what can be seen, such as facial expression or body language.

Fig. 8.22 Stimulation via novel unfamiliar patterns to enhance tolerance to unexplored feelings

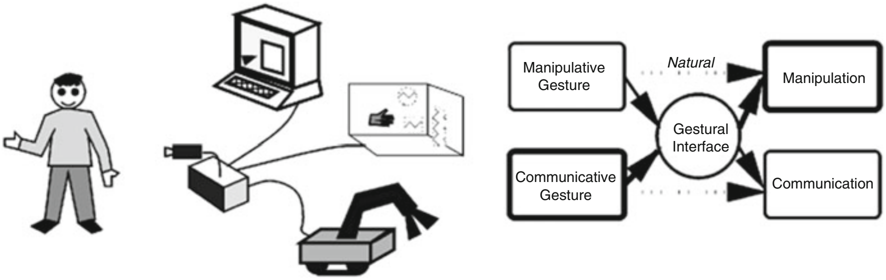

Fig. 8.23 Applications of gestural interface for HCI. Unlike the gestures in a natural environment, both manipulative and communicative gestures in HCI can be employed to direct manipulations of objects or to convey messages

8.6.4 Teaching Gestures

CwA need to be taught gestures as an efficient way of communication.

The taxonomy that seems most appropriate within the context of HCI was recently developed by (Quek 1995). A slightly modified version of the taxonomy is given in Fig. 8.24 and Fig. 8.23. All hand/arm movements are first classified into two major classes: gestures and unintentional movements.

Gestures themselves can have two modalities: communicative and manipulative. Manipulative gestures are the ones used to act on objects in an environment (object movement, rotation, etc.) Communicative gestures, on the other hand, have an inherent communicational purpose. In a natural environment they are usually accompanied by speech. Communicative gestures can be either acts or symbols.

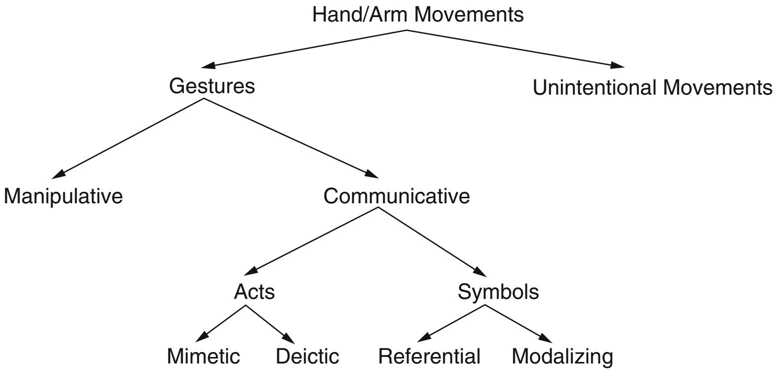

Fig. 8.24 A taxonomy of hand gestures for HCI. Meaningful gestures are differentiated from unintentional movements. Gestures used for manipulation (examination) of objects are separated from the gestures which possess inherent communicational character

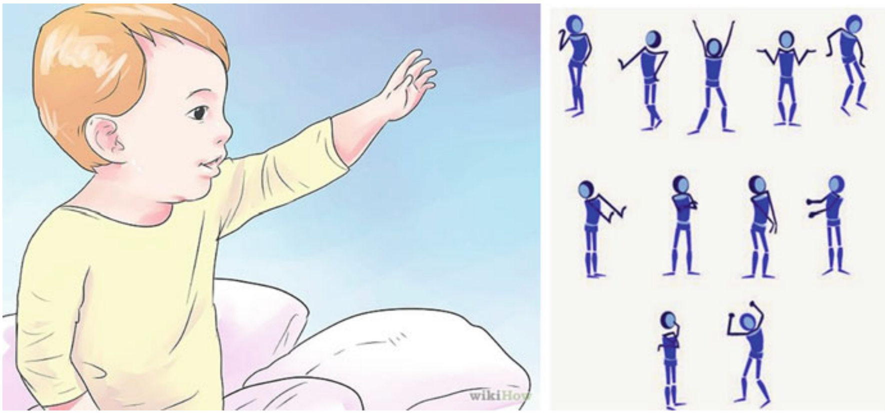

Fig. 8.25 Using gestures for communication

Symbols are those gestures that have a linguistic role. They symbolize some referential action (for instance, circular motion of index finger may be a referent for a wheel) or are used as modalizers, often of speech ("Look at that wing!" and a modalizing gesture specifying that the wing is vibrating, for example). In HCI context these gesture are one of the most commonly used gestures since they can often be represented by different static hand postures (Fig. 8.25).

CwA have trouble reading body language, which makes it increasing difficult for them to interact with others. The good news is that it is possible to learn how to read body language through practice and role-playing.

Noticing the signals that people send out with their body language is a crucial social skill. A few of CwA can read it naturally, but most of us are notoriously oblivious. Fortunately, with a little extra attentiveness, you can learn to read body language, and with enough practice it can become second nature.

Body language often encompasses (a) how our bodies connect with material things (e.g., pens, cigarettes, spectacles and clothing), (b) how we position our bodies, (c) how we touch ourselves and others, (d) our breathing, (e) our closeness to – and the space between – us and other people and how this changes, (f) our eyes – especially how our eyes move and focus, and (g) our facial expressions. Being able to “read” body language therefore helps us greatly to understand ourselves better, understand better how people might be perceiving our own non-verbal signals, and know how people feel and what they mean.

Here are the tips for reading body language:

1. A clenched fist can indicate anger or solidarity.
2. A thumbs up and thumbs down are often used as gestures of approval and disapproval.
3. Blinking is natural, but you should also pay attention to whether a person is blinking too much or too little. People often blink more rapidly when they are feeling distressed or uncomfortable. Infrequent blinking may indicate that a person is intentionally trying to control his or her eye movements. For example, a card player might blink less frequently, because he is purposely trying to appear unexcited about the hand he was dealt.
4. Clasping the hands behind the back might indicate that a person is feeling bored, anxious, or even angry.
5. Closed posture involves keeping the obscured or hidden often by hunching forward and keeping the arms and legs crossed. This type of posture can be an indicator of hostility, unfriendliness, and anxiety.
6. Crossed arms might indicate that a person is feel defensive, self-protective, or closed-off.
7. Crossed legs can indicate that a person is feeling closed off or in need of privacy.
8. Dilated pupils mean that the person is interested. Keep in mind, however, that many substances cause pupils to dilate, including alcohol. So a CwA should not do a mistake of having a few drinks for attraction.
9. If people purposely touch their feet to yours, they are flirting!
10. If someone mimics your body language, this is a very genuine sign that they are trying to establish a communication channel with you. Try changing your body position here and there. If you find that they change theirs similarly, they are mirroring.

Substantial interest in gestural interface for HCI is stimulated by a vast number of potential applications. Hand gestures in connection with human-computer interface can simply enhance the interaction in “classical” desktop computer applications by replacing the computer mouse or similar hand-held devices. Hand gestures can also replace joysticks and buttons in the control of computerized machinery or be used to help the individuals with special needs and physically impaired to communicate more easily with others. Nevertheless, the major impulse to the development of gestural interfaces has come from the growth of virtual environments (Uras and Verri 1995). Hand gestures in natural environments are used for both manipulative actions and communication. However, the communicative role of gestures is limited, since hand gestures tend to be a supportive element of speech (with the exception of deictic gestures, which play a major role in human communication). Manipulative aspect of gestures is fairly important for HCI. Some applications have emerged recently that take advantage of the communicative role of gestures.

8.6.5 Modifying Emotions in an Image

A set of exercises where CwA is asked to modify a schematic image or a photo to substitute an emotion turned out to be fairly fruitful. Modifying certain areas in an image, CwA learn that emotions are expressed by a number of facial features. This helps them to eventually learn to recognize these facial features and then emotions in the real world.

Using a touch-pad or a mouse for drawing emotion-related features helps to develop a tactile reinforcement with visual perception of emotion. A trainee should select features in an image and modify them to convert a sad face into a happy one and other way around. The eyes and the mouth can be altered, using rotations or mirror mappings, or having their elements re-positioned (Fig. 8.26).

These exercises demonstrate that emotions are instant states, not permanent, and external factors can change them. They also help to understand pre- and post conditions of actions which change emotions, and resultant emotional states.

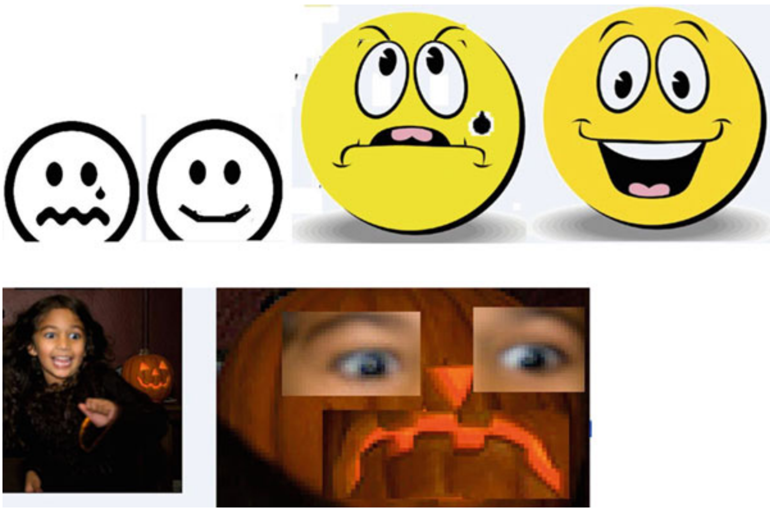

Fig. 8.26 Demonstrating that emotions can change and can be affected from outside

8.7 Teaching Hide-and-Seek Game

One of the important steps in learning the mental world is the hide-and-seek game. This game requires a substantial reasoning about mental states and actions, in both rule-based mental and emotional domain. A child needs to understand the pre- and post-conditions for searching as a desire to identify where the peers are located. A concept of *hiding* needs to be explained as an *opposite* desire of not being found. Children need to be aware that searching may lead to finding, and hiding – to not being found. If one does not search then nobody can be found, and if one does not hide she will be found immediately. It is a game of deception, which requires acknowledgment that other people may have different beliefs. Therefore, many CwA avoid it and/or are not capable of participating in it. Playing hide-and seek requires understanding and handling third-order mental states such as *"I know that he wants me not no know where he is"*.

In the emotional space, a hide-and-seek player is expected to express appropriate emotions when he finds another child, or when he is found by someone else. A rule should be taught that an emotion is appropriate when there was a desire and at the given moment it succeeds. Some emotional expressions are suitable when a child is hiding, he is being looked at but not found.

Another import skill is to conceal yourself in an environment. A child needs to be taught to position himself in the location of a seeker and track his potential gaze to avoid being found. A seeker needs to be able to close his eyes and count to a predetermined number while the other players hide. After reaching the number (such as reaching 10 or 20) the seeker attempts to say, "Ready or not, here I come!" and then to locate all concealed players (Fig. 8.27).

Training starts with identifying hide-and-seek players in an image with schematic depiction of playing characters. CwAs are encouraged to use a touch-pad to track the gaze with their fingers. Children are asked questions about the role of players, who is doing what, who desires what, and who is seeing whom.

After CwA trainers are capable of recognizing players at an image, a trainer can proceed to similar tasks on the photos of children playing hide-and-seek (Fig. 8.28) and ask similar questions:

Once CwA are prepared to play hide and seek, having completed the exercises, a trainer can attempt to involve them in an actual game, first indoor and then outside. To play a role of a seeker or to hide, a CwA needs to be accompanied by a trainer, and a role of an opponent can be performed by a parent, sibling or another trainer. The trainer needs to hide together with CwA and explain her the goal of hiding and the object they are hiding behind.

Fig. 8.27 The hide-and-seek training starts with schematic depiction of a seeker and two concealed players

What game do the children play? Which objects from the environment are used to be hiding behind? Do those who hiding want the seeker to find them? Does the seeker want to find those hiding? Do the hiding children see the seeker? Do they know where he is? Does the seeker see the hiding children? Does he know where they are? Why does the seeker have to close his eyes?

Fig. 8.28 After CwA is confident with schematic depiction of hide-and-seek game, a trainer can proceed to photos. The seekers close their eyes and are counting

Fig. 8.29 An older trainee finding a direction using GPS (on the left). Some young adults become fairly skillful once the introduction to orienteering with GPS is completed (on the right)

8.7.1 Orienteering Exercise

For most children, orienteering is the next logical step after the hide-and-seek game. However, some children are good at orienteering even if their emotional skills for hide-and-seek are rudimentary and they cannot play independently.

The reason orienteering is not too hard for CwA is that no reasoning about other human is required. CwA usually memorizes the commands and navigation of GPS menus in no time. CwA needs to associate what GPS is showing with what is observed in the real world (Fig. 8.29). Doing that, formulating, adjusting and rejecting of hypotheses of such association is required, based on hypotheses management exercise Sect. 7.5.

The main focus of how orienteering activity supports reasoning is hypotheses management. Looking at a GPS, the child obtains the direction to and distance to the goal. Then observing the landscape, the child selects an object such as a tree and forms an estimate for how far it is from this tree to the goal (Fig. 8.30).

Once the tree is reached, CwA observes her position relative to the goal and possibly updates the hypothesis on where she was relative to the goal. CwA now needs to form a new hypothesis on which direction in the landscape to chose and which position relative to the goal to expect, and proceeds towards the goal.

What this exercise teaches is the skill to maintain hypotheses, revise it when appropriate, and expect it to be wrong again and again. This is opposite to a conventional autistic reasoning which sticks to a given hypothesis once it is formed. After that, CwA will be reluctant to revise this hypothesis, and an observation that it does not fit the real world would be very stressful and unproductive: CwA would give up on the exercise.

Fig. 8.30 A trainee is being helped to link the GPS indication with the real world spatial references. An orienteering map (on the right) may assist in this activity

8.8 Language Improvement

For language development, a trainer is recommended to use a language that is insignificantly more complex than the current language of a child. Once a given round of training is completed, the trainer should observe how the child communicates on his own. Once the previous trainer level of language is achieved, it can be taken to the next step.

In a CwA does not use words yet, a caregiver should try to model stand-alone words. If single words are used by a child, then the trainer can use two-word phrases. Once the level of two word phrases is achieved, the trainer can proceed to a simple phrase-based speech, followed with the one with descriptors, and then move towards the speech with complex phrases and compound sentences.

Some CwA can imitate long phrases but do not use them on their own without hearing them first. In this case, the trainer is expected to increment the complexity by one element such as an extra word, new word, actions, descriptions, attributes etc. This should be added to a spontaneous communication of CwA. It is advised to simplify the language grammar ("give candy" instead of "please give this candy to your sister").

Speech rate should be slowed down. Then it is easier for the child to learn the important words. These important words should also be stressed. To increase the teaching efficiency, the trainer should use the same language over and over. Specific important words should be repeated, such as physical and mental actions. Visual cues like gestures support the language learning as well. A caregiver should point to an object, animate or inanimate, introducing its name and referring to it. This is critical for nonverbal CwA. Also, it is worth talking about the objects CwA is paying attention to; this will increase the chance the child would borrow the trainers' language for his experience. It can be achieved by a parallel talk and self-talk. The caregiver should comment on, or describe during the process of CwA is seeing, hearing or doing. The trainer's language should be linked to CwA language to be meaningful. A selective set of actions should be chosen for commenting, since an information overload needs to be avoided. For example, when CwA is feeding a stuffed dog, he should say "dog" pointing towards it, or "dog eat". For self-talk, a trainer should talk about what she is doing while CwA watches; short, repetitive sentences should be used.

A caregiver can expand on child's own language by focusing new words or more appropriate grammar or syntax. By adding new terms, the caregiver revises and completes CwA speech and adds information at the same time. When CwA is saying "toy" the trainer can say "give toy", "push toy", "feed toy".

8.8.1 Reading Comprehension

There is a growing body of literature guiding the teaching of reading comprehension including (McNamara 2009) who describes the intervention methodologies linked to theories of readers' cognitive processes. Given the wide variety of strengths and weaknesses exhibited by children on the spectrum, it seems reasonable that reading comprehension interventions targeted for typically developing children who struggle with the complexities of reading comprehension may also benefit children with ASDs. Poor comprehenders are typically adept at phonological processing and word recognition, but are less skilled at handling semantic representations. CwA may focus on word recognition and neglect semantic processing.

Cartwright (2006) described cognitive flexibility exercises, which classroom teachers, parents, and intervention professionals could use to assist children in developing reading-specific cognitive flexibility. The exercises consist of word sorts, in which readers are asked to sort a set of word cards, first based on phonological rules, such as initial consonant sounds, and then again, based on semantic categories, such as foods and non-foods.

"Meaning-focused" remediation such as collaborative learning activities in which peers quizzed each other on vocabulary and factual recall or played games based on reading materials turned out to be efficient. Instructional approaches that consist of reviews and rote activities focus on *practicing* skills, including anaphoric cuing and reciprocal questioning, rather than *learning* skills to build the framework for the cognitive processes involved in reading for meaning.

Trainees are encouraged to read passages under four conditions: answering pre-reading questions, completing sentences, identifying anaphoric references, and reading only. In the anaphoric cuing procedure, students were given a passage with the anaphora or "shortcuts" underlined and they were asked to choose the correct referent, given three choices listed under the underlined "shortcut." Anaphoric cuing significantly increased students' understanding of the passage.

In the other set of exercises, CwA are taught to generate and respond to questions, using a story map framework. CwA increase the frequency of unprompted question generating and responding from the beginning to the end of the intervention. CwA require substantial prompting when generating and responding to inferential questions in comparison with stating facts from the story. This learning strategy relied on peer-tutoring or cooperative learning, giving CwA children an opportunity to develop their language skills in a social setting.

In teaching the oral language skills CwA should be taught to identify materials out of which common objects were made. Given common objects, such as a shirt, a paper napkin, or a leather shoe, the children need direct instruction that included modeling of correct responses, signals to cue students, choral student responses, and correction procedures for incorrect and non-responses. The caregiver can begin instruction using actual objects, then use representations (pictures), and finally move instruction to the abstract stage using words only. Ganz and Flores (2009) concluded that students increased their expressive language skills, based on an increasing number of correct responses to probes posed throughout instruction. The researchers also reported that some students spontaneously used language skills at home and at school, asking others to identify objects made of different materials. This study is significant in that it demonstrates that CwA can be guided to more abstract uses of language through direct instruction (Randi et al. 2010).

8.9 Evaluation of Training

In this section we describe our assessment of exercises in the short-term and long-term training settings.

8.9.1 Short-Term Evaluation

We present the results of the *short-term* evaluation in Table 8.3. The training exercises are categorized by the complexity of mental formulas for the entity to be taught. For each category, the reasoning skills were assessed before and after training (Fig. 8.31), with NL_MAMS assistance for one group (12 children) and without such assistance for the control group (10 children). Other than NL_MAMS-specific, the same set of exercises was offered to both groups. All children from both groups were registered with the same rehabilitation center.

Four task categories are shown: from first to fourth order (in accordance to how the complexity/intentionality of mental formulas has been specified,

Table 8.3 Evaluation of the short-term theory of mind training with and without NL_MAMS

Task category					
Mental entity for the task	Autistic one-to-one training with NL_MAMS, 12 children, %		Autistic one-to-one training without NL_MAMS, eight children, %		Impact of NL_MAMS, % of improvement
	Before	After	Before	After	
First-order	22	69	21	62	6.2
Knowing an object and its attributes	*25*	*67*	*25*	*75*	
Not see – > not know	*17*	*58*	*25*	*50*	
Intention of others	*25*	*83*	*13*	*62*	
Second order	14	61	17	54	37.2
Informing	*17*	*58*	*25*	*62*	
False belief	*8*	*58*	*13*	*50*	
Questioning	*17*	*67*	*13*	*50*	
Third-order	8	33	7	22	31.2
Pretending	*8*	*17*	*13*	*17*	
Deceiving	*0*	*17*	*0*	*17*	
Offending	*8*	*33*	*0*	*17*	
Forgiving	*8*	*50*	*13*	*33*	
Reconciling	*17*	*33*	*13*	*17*	
Explaining	*8*	*50*	*0*	*33*	
Fourth-order	13	33	13	25	32
Resolving a conflict	*8*	*33*	*17*	*17*	
Negotiating	*17*	*33*	*8*	*33*	
Overall improvement of theory of mind skills due to using NL_MAMS, %					27.5

Fig. 8.31 Computers help to maintain trainee attention while doing reasoning skills assessment

Sects. 4.2 and 5.6). For each test exercise, a trainee is either assigned a pass or not, and the percentages of passed trainees are specified (shown in italic). Averaged percentages for groups are shown in normal font. The last (sixth) column indicates how the relative percentage of successful exercises is higher for the NL_MAMS-assisted training than for an unassisted training. It is calculated as

$$\frac{\%\ \textit{exper after}}{\%\ \textit{exper before}} : \frac{\%\ \textit{control after}}{\%\ \textit{control before}}$$

We select the experimental and control groups such that there is an insignificant deviation in initial ToM reasoning capabilities of the children from both groups (<4 % in spite of the different sizes of each group). We naturally observe that children's performances both before and after training are lower for the higher order of involved mental formulas (and respective task complexities) for both experimental and control groups. Unsurprisingly, theory of mind training is more fruitful for second-order than for the first order. However, the efficiency of training then drops for third and fourth orders. One can see that using NL_MAMS for first-order tasks is not as important as for higher-order tasks that require memorizing and operating with a larger amount of data. Overall, NL_MAMS improves the results of training by about a third in a short-term setting.

8.9.2 Long-Term Evaluation

The results of the *long-term* evaluation are shown in Table 8.4. The same evaluation exercises and result computation schema are used as in the short-term cases. We managed to conduct the long-term evaluation study with nine out of twelve children who were the subject of the short-term training (Fig. 8.32). The control group included ten children from another rehabilitation center.

We observe a similar natural phenomenon that handling of more complex mental expressions is harder. However, unlike the short-term evaluation where NL_MAMS has contributed almost equally to second-, third- and fourth-order mental formulas, in the long-term case one observes the following. Theory of mind training has improved the second-order performance by more than twice, and then the third- and fourth-order performance by more than eight times, compared with control group.

Overall performance in the long-term setting is improved by almost 40 % due to theory of mind training and by 280 % due to other forms of training and other reasons (judging on the control group, observed in the age range of 6–9, 7–10, ..., 10–13). 40 % may seem not as significant in respect to 280 % as a quantity, but it has a tremendous value as a portion of world knowledge, in terms of behavioral and emotional development of a child with autism. Moreover, we see that high-order mental formulas that are important for handling mental world indeed require NL_MAMS to be properly trained, as both long-term and short-term studies suggest.

Table 8.4 Evaluation of the long-term theory of mind training for the experimental and control groups

Task category					
Mental entity for the task	Autistic one-to-one training with NL_MAMS, nine children, %		No theory of mind training, ten children		Impact of NL_MAMS-assisted theory of mind training, % of improvement
	Before	After 3 years	Before	After 3 years	
First-order	29	89	26	74	7.8
Knowing an object and its attributes	33	78	22	67	
Not see → not know	22	100	22	67	
Intention of others	33	89	33	89	
Second order	18	74	18	63	17.5
Informing	22	*67*	*11*	*67*	
False belief	11	*78*	*22*	*56*	
Questioning	22	*78*	*22*	*67*	
Third-order	11	48	13	35	62.0
Pretending	11	*44*	*11*	*33*	
Deceiving	0	*33*	*11*	*22*	
Offending	11	*44*	*11*	*56*	
Forgiving	11	*67*	*22*	*33*	
Reconciling	12	*33*	*11*	*22*	
Explaining	11	*67*	*11*	*44*	
Fourth-order	17	62	17	38	63.2
Resolving a conflict	11	56	22	33	
Negotiating	22	67	11	44	
Overall improvement of theory of mind skills due to using NL_MAMS-assisted and other forms of rehabilitation of mental reasoning, %					37.5

8.9.3 Evaluation of Intervention of Adjustment of Actions

To evaluate our methodology presented in this book, we observe the results of training triangulation structures of adjustment of actions (Sect. 6.4) to CwA. Triangulation structures are used to approach a proper application of default rules to handle properly the situations when it is important to adopt an action to an environment.

In the Table 8.4 we compare the trainees' performance completing the tasks they have been trained with, as well as new tasks of a similar complexity. Moreover,

Fig. 8.32 Two trainers are interacting with a boy from different sides

we evaluate how the trainees perform applying learned reasoning patterns to real-world situations. The real time performance is evaluated before the training for each category of learners occurs.

This exercise does not validate whether the learners *understood* the decision making properly because it is expected to be easy just to memorize how to complete them.

1. *Performance completing the exercises which have been introduced earlier* verifies how learners can *reproduce* the decisions which have been shown to them earlier.
2. *Performance completing the exercises with similar rules in a new domain* demonstrates how learners are able to either *memorize* the patterns (rather than details of the offered contexts) of adapting an action to context or to apply them independently, having understood these patterns.
3. *Performance completing the exercises with new rules in a new domain* assesses learners' ability to form (invent) new rules on how to adopt an action to an environment.
4. Observing *correctness of decision-making in similar real-world situations* we can judge on how the learners can apply the skills developed in computer-assisted exercises on default reasoning to the real world environment. This step requires the learners to be capable of *transferring* acquired reasoning patterns from simulation to real world environment and their *application* to real-life objects. In this study we do not evaluate how the learners form new rules in the real world environment as this task is proved to be too hard for the audience of trainees.
5. As a baseline for our experiments, we assess the *Correctness of decision-making in a similar real-world situations without training.*

Our testing environment includes 20 exercises used for both training and evaluation (second column), 20 exercises using the same logic and structure in a distinct domain, 20 exercises for different domains and 20 imitations (or reproductions) of real world environments. A drop-down box-based exercise is considered as completed correctly if more than 80 % of choices are correct, when the exercise is run multiple times with different (randomly generated) initial conditions.

Naturally, each evaluation step is more complex than a previous one to complete: we observe the monotonic decrease of the rate of completion for all three categories of learners. For learners from both autistic and other mental disorder groups the performance is declining faster that that of controls.

For the autistic group of learners *similar rules in a new domain* is the hardest step, and for the group of other mental disorders *decision-making in similar real-world situations* is the hardest step; however it may not characterize these groups with respect to their overall skills of the real world abstraction.

On average autistic individuals perform about 5 % below individuals with other mental disorders for the first task, 2 % for the second task, 9 % for the third and fourth tasks but outperform the children with other mental disorders who did not do any training. This suggests that the case of autism indeed requires harder learning efforts.

The chart for the overall exercise completion is shown in Fig. 8.33. Four data points correspond to the columns 2,3,4 and 5 in Table 8.5. One can see that CwA and other mental diseases with comparable mental age complete exercise similarly compared to CC.

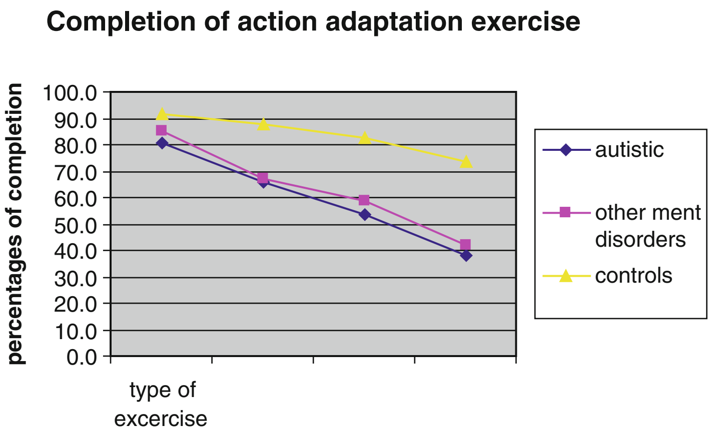

Fig. 8.33 The chart for exercise performance for the tasks (2)–(3)

Table 8.5 The dynamics of trainee's development

		(1) Performance completing the exercises which have been introduced earlier	(2) Performance completing the exercises with similar rules in a new domain	(3) Performance completing the exercises with new rules in a new domain	(4) Correctness of decision-making in a similar real-world situations	*Correctness of decision-making in a similar real-world situations without training*
Autistic	A_Subject1	80	75	60	35	*5*
	A_Subject2	85	60	55	45	*15*
	A_Subject3	75	60	45	30	*25*
	A_Subject4	80	65	55	40	*10*
	A_Subject5	85	70	50	35	*5*
	A_Subject6	80	65	55	45	*15*
avg		80.8	65.8	53.3	38.3	*12.5*
Other mental problems (matched for	M_Subject1	95	60	55	45	*15*
	M_Subject2	85	55	55	55	*20*
	M_Subject3	80	65	60	35	*5*
	M_Subject4	80	70	55	40	*15*
	M_Subject5	85	75	65	35	*10*
	M_Subject6	85	70	60	45	*5*
	M_Subject7	85	75	60	40	*10*
avg		85.0	67.1	58.6	42.1	*11.4*
Controls	C_Subject1	90	85	75	75	*60*
	C_Subject2	95	90	80	70	*65*
	C_Subject3	95	85	85	65	*65*
	C_Subject4	90	85	90	80	*70*
	C_Subject5	85	90	85	75	*70*
	C_Subject6	95	90	80	75	*65*
avg		91.7	87.5	82.5	73.3	*65.8*

8.10 Discussion and Conclusions

There is no well-accepted medical treatment for autism, but it has become increasingly clear that early behavioral intervention is highly beneficial for autistic children (Green 1996; Jensen and Sinclair 2002; Galitsky 2005). Indeed, some experts argue that intensive behavioral intervention can even lead to normal behavior of autistic trainees (McEachin et al. 1993). So far, attempts to explain how a behavioral treatment can possibly eliminate autistic deficiencies were not very successful. It is still unclear why these treatments are successful in some cases but not in others (Lovaas 1987). Since a majority of experts consider behavioral intervention as the only approach to compensatory learning (see, e.g., Frith 2001; Howlin 1998), the claims of possible cures remain controversial.

We analyzed the results of assistance to individuals with autism in reasoning about mental world and other domains. This assistance is provided by a natural language multiagent simulator of mental states (NL_MAMS), introduced in Chap. 5. It assists in the tasks that are the hardest for autistic reasoning: operating with mental states and actions. Autistic patients are trained to perform a number of reasoning exercises.

We performed the simulator-assisted training and its evaluation at two levels: short-term and long-term. The short-term approach includes the theory of mind training with and without the simulator for two groups of autistic children of similar mental age and IQ. The evaluation is based on passing the set of tests including the seeing-leads-to-knowing (first-order) and Sally-Anne false belief (second-order) ones so that a uniform coverage of mental states and actions (up to the order three) is evaluated. In the short-term approach we perform a limited evaluation of the skills transfer from artificial situations to real life ones, but do not analyze how the training affects the socials skills of trainees. The short-term approach is utilized for the purpose of evaluation of theory of mind teaching efficiency, and the control group is subject to the simulator-assisted intervention after the evaluation.

The long-term approach has been applied for over a decade, where manual and simulator-assisted teaching of the ToM is combined with intervention strategies of various natures. The goal of our long-term approach is to teach theory of mind reasoning not just for the reasoning skills per se, but also for improvement of social behavior. Therefore, the evaluation criteria are based on tests of decision-making in the real world as well as tests of reasoning and choosing actions in artificial situations.

Educational approach we have developed here may sound too theoretical when compared with other approaches to learning (see e.g. Fry et al. 1999). Instead of teaching by explaining, showing examples, imitating or suggesting a hands-on experience, autistic trainees are taught formal entities, and automated reasoning software is used as a means to introduce these entities. As only the definitions of mental attitudes and links between them acquired by an autistic trainee, the further steps of applying the axioms to real-world situations are conducted in a conventional manner.

An educational strategy with a clear focus on mental states may seem as an exaggeration when it is applied to conventional students. However, there is a strong deviation in how people are capable of performing this task. Certain professions, including business and legal specialties, are quite demanding in this respect. Although average students do not require an intensive reasoning therapy concerning mental states as autistic trainees do, they may need some improvement. Building the educational strategy for autistic children where mental attitudes are crucial, the current study sheds a light on how this strategy may be applied to improvement of decision-making and negotiation skills in general higher education.

We have discovered that various kinds of emotions are built up at different speeds for the same trainees. As we learned from our intervention practice, training of each kind of emotion and mental reasoning should be conducted starting from the earlier ages, because for each mental task there is an age when this task becomes adequate to the current trainee's understanding of the mental world. Therefore, the training NL_MAMS-based toolkit is assumed to be suggested starting from the age when a trainee is able to read, till the full (possible) mental recovery in terms of interaction with other people.

In this chapter we evaluated how the learners transfer acquired default rules from artificial to real world situations, which is more feasible task for the target category of children with autism than forming new rules to match the real world environment. Therefore, having an artificial environments teaching children with autism and other mental illnesses how to adopt their actions in specific domains is beneficial. An alternative to this of postponing such training to the mental age when learners can be expected to form new rules in the real world would delay the overall development of learners and therefore seems unacceptable.

Using the literature domain for training to reason about the mental world takes advantages of the variety of plots, appealing and entertaining environment and rather complex mental states of literature characters. We believe such kind of training is essential for business, military, legal, psychological and other professional fields, which require rapid orientation and reaction in emergent situations with inconsistent goals and beliefs of opponents and customers. The system encourages the users (players, students) to demonstrate their knowledge of classical literature, from medieval to modern, asking questions about the mental states of the characters and compare the system results with your own imagination. The system stimulates the trainees to extract the mental entities, which can be formalized, from the totality of features of literature characters. After an answer is obtained, it takes some efforts to verify its relevancy to the question. It takes a little variation in the mental expression to switch from one work of literature to another.

We proceed to the comparison of other computer-assisted intervention technologies with the one based on default reasoning. Multiple technologies have been suggested for mental intervention, including a variety of virtual environments (Sik-Lnyi and Tilinger 2004), and the interactive tool for browsing and recognizing emotional expressions. These computer-based tools assist the development of a wide spectrum of behavioral and cognitive skills. However, this chapter is teaching default reasoning while choosing an action. The goal of this study is to build an intelligent reasoning-based intervention system that is at least capable of reasoning on its own, in contrast to the approaches mentioned above which are the infrastructures for providing access to various media. Dautenhahn and Werry (2004) discuss the potential of using interactive environments with a special focus on autonomous, mobile robots in autism therapy. Being a promising intervention strategy, it might be too expensive to help the majority of families with autistic children even in the Western Europe, US and Japan.

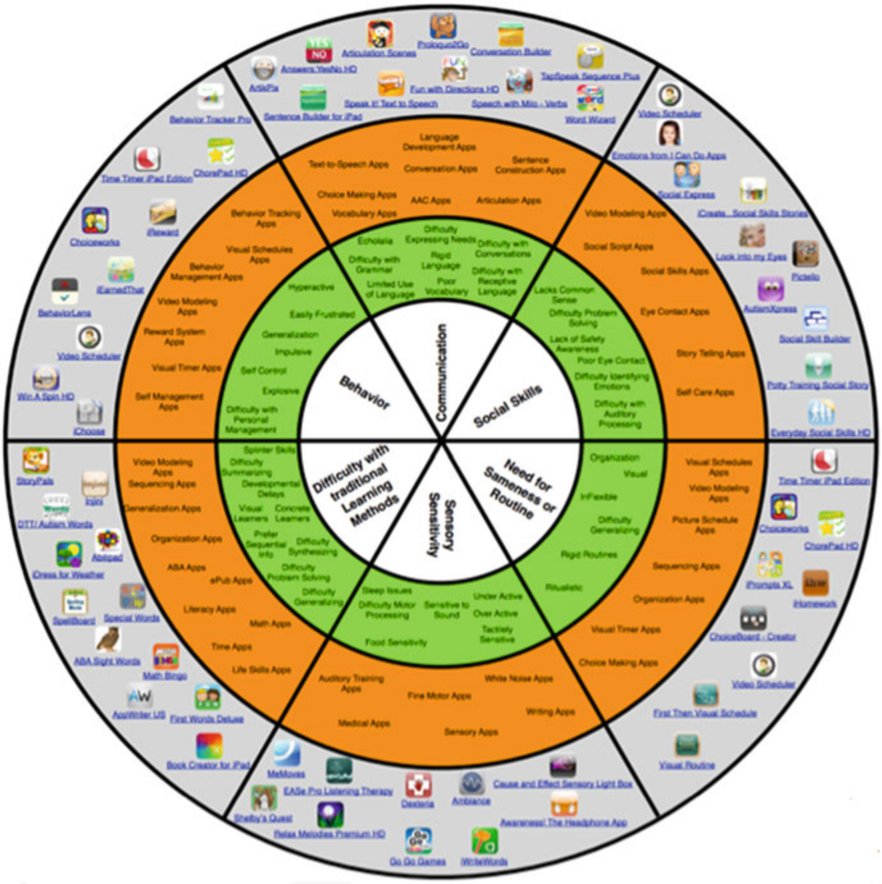

Fig. 8.34 A high-level chart depicting the classes of autistic difficulties, their instances and available training apps

There is a huge number of applications available to assist in autistic development, but none of them targets reasoning directly (Coppin 2012, Fig. 8.34).

The objective of CwA intervention is to make them adaptable. A trainer must accept CwA whoever he is, understand what are the weaknesses and what are the strengths. The trainer should then ground rehabilitation on the features of strength. Improving adaptation mechanisms, a member of intervention personnel should not fight with self-stimulation. Instead, the trainer should attempt to form activity and interaction mechanism with the external world more universal and stronger.

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