Access to Computer-Assisted Learning Environments for Severely Handicapped Children by Semantic Level Adaptations

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Abstract: Within the project CATI (Computer-Aided Therapeutic Intervention) new potentials and limitations of computer-supported multimedia applications for the therapeutic advancement of severely handicapped children are investigated. In this context, we are conducting a case study involving a 12-year old physically handicapped child with behaviour typical of autism. A memory game featuring various individualised semantic adaptations was developed for the training of metacognitive skills. The design of the training adopts procedures used for cognitive behaviour modification. A significant other defined as a person with high social and rewarding power is used for instructional purposes in the computer-assisted learning environment. It is to investigate how the readiness to attend and the achievement motivation can be enhanced by the implementation of such a person. First results show that the motivation to stay on task is developing and the goal of achieving problem solving techniques appears to be attainable.

The potentials of information technology for the compensation of functional handicaps became already apparent in various research projects (PIEPER et al. 1998, PIEPER et al. 1999). However gaining access to computer-assisted learning environments by adaptations on the semantic level of software systems is still to be investigated for children with special needs so far unable to use this educational tool.

Within the project CATI (Computer-Aided Therapeutic Intervention) a case study is conducted involving a 12-year old severely handicapped child. He is physically impaired and exhibits behaviour as described for autism. So far, he is unable to use computer-assisted training materials due to attention deficits and a lack of problem solving techniques. Therefore, a computer-assisted memory game for the training of metacognitive skills was developed featuring various individualised adaptations on the semantic level of the learning environment.

The adaptations include the implementation of a socially significant other for instructional as well as interventional purposes referring to a person with high social power. Interventional strategies are derived from procedures used for cognitive modelling and are employed according to the results of the constant evaluation of the problem solving behaviour of the child. In order to achieve a better understanding for

the background of the design of the computer-assisted learning environment, the handicap of the child concerned will be described in short.

1. The CATI Case

The child participating in this case study is suffering from cerebral palsy, a motor impairment due to brain damage. In this case, the handicap affects all extremities, so walk, the use of arms, hands and fingers is functionally impaired but possible without prosthetic measures. As a result of brain damage, perceptional deficits occur rather often (BATSHAW et al. 1992) and seem to be present also in this case.

Perceptional deficits influence all information processing procedures from the stimulus input to the integration of the perceived stimuli. Attentional deficits due to inhibited selective processes during the attention focussing phase as well as inappropriate reactions are the consequence. Relevant stimuli are often not detected and deficient variability in the reactive repertoire causes the rigid holding on reactions once learned.

The child concerned in this case study strongly prefers information input by the acoustic channel. He likes to listen to music and also likes to play on a piano. He shows a remarkable skill in memorizing text and melody of songs for a long time as opposed to rather poor memory skills in other academic areas. So far, he is not able to read or write and does not understand numbers. He is attending a public junior high school, which mainstreams special needs children in a model project for the first time.

The primary physical handicap of this child is accompanied by secondary handicaps like behaviour typically described for children suffering from autism. This concerns mainly his language abilities and behavioural disturbances. He repeats seemingly senseless and incoherent words and sentences (immediate echolalia) and asks stereotypically questions may be with the goal of finding back into a conversation.

Beyond disabled speech and language abilities, behaviour disturbances as described for autism occur. Permanent repetition of seemingly meaningless behaviour called perseverating behaviour pattern prevails for instance when using a computer-mouse. He permanently pushes the mousebutton without any goal-orientation.

2. Technological Requirements on the Input Device

Due to the severe impairments of the child as described above, it is impossible for him to use the standard equipment for operating a computer. An alternative input device needed to be searched and tested for. The results showed, that a touchscreen as input device seems to be the most appropriate, since his fine and gross motor control allows for isolating one finger and touching a given area on a computer screen (see figure 1).

Figure 1

During the testing, we payed very much attention to what input could be carried out independently, that means nobody needed to serve as a facilitator for operating the computer. This issue appeared to us very important, because from a motivational point of view independency of performance is crucial for the achievement of self-esteem. The outcome of an action needs to be attributed to one's own abilities in order to trigger off reinforcing effects (HECKHAUSEN 1987). Furthermore, the discussion about authenticity of input facilitated by somebody else could be avoided (CUMMINS et al. 1992).

3. *Met*ho*d*olog*i*c*a*l B*a*s*i*s o*f t*h*e* D*e*v*e*lo*ped* L*earnin*g E*n*v*ir*o*nment*

The shift from understanding learning disability as an information processing problem rather than a structural deficit evoked the development and evaluation of training programs for cognitive behaviour modification (SCRUGGS et al. 1993, LAUTH et al. 1997). The training of metacognitive skills is part of these training programs, since the knowledge about cognitive processes is crucial to the success of the intervention. Metacognitive skills in this sense include the proper comprehension of a given problem, the mental representaion of the problem, the conscious selection of a suitable problem solving strategy and finally the evaluation of the outcome of the problem solving process (DAVIDSON et al. 1994).

The child considered in this case study is most obviously affected by an attention deficit influencing the (meta)cognitve processes as described. He is unable to select relevant stimuli and his problem solving behaviour is guided by an impulsive cognitive style. In addition, he does not evaluate the result of his reaction. Therefore, the development of a computer-assisted training aimed at the advancement of cognitive control in accordance with the cognitive training programs as mentioned above appeared to be most appropriate. In the first step, the selection of relevant stimuli as well as a systematic and reflective strategy for solving a given task were determined as the goal of accomplishment.

The didactic strategy to convey problem solving strategies in the developed computer-assisted learning environment incorporates methods derived from procedures used for scaffolding (TINZMANN et al. 1990). Scaffolding is an instructional technique

whereby the teacher models the desired learning strategy. Cognitive as well as behavioural aspects of the problem solving process are verbalized and demonstrated by this model. Research shows, that this and similar working methods are successful in conveying problem solving behaviour and became established training programs for cognitive behaviour modification in special education (BROWN et al. 1990, HASSELHORN et al. 1990). However, the success of these methods depend on the ability of the observer to imitate somebody. Due to the autistic behaviour pattern of the child concerned in this case study, it was not expected that he would imitate a model. As described in chapter 4, the procedures of the scaffolding strategy, though, were incorporated in the training and formulated as questions or instructions.

Besides considering the didactic strategy to achieve the learning goal, it was very important to ensure that attention as the precondition for learning can be evoked by the computer-assisted learning environment. So far, the child concerned strongly depends on somebody else for attention focussing. He always needs to have somebody at his disposal. Therefore, a very important goal of the computer-asssisted learning environment was to enable him to work independently as much as possible.

In this context, it is important to state, that the goal of the study is by no means to withdraw personal care und support by other people. It is rather aimed at conveying learning competence, so the child involved will be able to work independently as it is required for attending a regular school and working with standard educational software.

“Human support“ was implemented in the learning environment by the employment of a socially significant person mainly for instructional purposes. As it is known from social psychology, ”significant others“ gain social power because their opinion about and reflected to the person concerned, influences his or her self-concept (BACKMANN 1974). Further, the degree of influence a person can exert on somebody else is defined by the attributed degree of social power (BACKMANN 1974). Social power in this sense has many facets. The person can have the power to reward, coerce, provide emotional support and the like. In this case study a significant person with high social power through attribution of sympathy and competence by the child involved was expected to be most successful. A person with these attributions is also expected to have the most efficient rewarding power necessary for reinforcement. The investigation will show, whether an individually significant person can retain social power and gain attention even though he or she is present only virtually.

Due to many failures experienced with learning, this area is associated with ambigous feelings for the child participating in this case study. Therefore, a comic figure was implemented for prompting the correct responses in case the intervention of the significant other person was not sufficient. This way, it could be avoided that the relation between child and the implemented significant other would be burdened with feelings of failure which often leads to withdrawal as the child tends to.

For the presentation of visual information, criteria valid for the instruction of children affected by a so- called attention deficit disorder need to be considered (NADDA 1999). In order to avoid stimulus overflow, colouring, for instance, is used carefully for the facilitation of selective perceptional procedures. The motives of the picture cards of the memory game are chosen according to the personal preferences of the

child concerned in order to employ the motivational aspect of individually meaningful information. Training material like completion of samples and the like as it is used in common computer-assisted attention training programs (see SODIS 1999) would not allow for the consideration of these issues, so the need for designing new picture cards became apparent. Since the child likes animals very much, we designed 27 memory cards with common animals and typical sounds they produce.

Since children affected by attention deficits lose the attentional focus while waiting for response to their actions, they are not able to deal with delayed responses. Thus, it is crucial to the success of the training that the learning environment provides immediate feedback. The possibility of a computer to give always immediate feedback is an already well known strength of computer-assisted learning as opposed to group learning.

4. Description of the Memory Game

In the following, a short description of the developed memory game is presented in order to illustrate how the methodological considerations as described are realized in the game. So far, there are two modes of the game available. In the first mode up to 8 picture cards are shown on a computer screen presenting only one pair of animals (see figure 2). All the other picture cards show different animals. This is a discrimination task geared at conveying the concept of ”the same“, since this is the underlying concept of a memory game.

Figure 2

The instructions are all given acoustically as the child involved is unable to read so far. He is addressed very often by his name in order to gain attention. Each step of instruction or intervention is formulated in different ways expressing the same aspect, because he easily learns things by heart preventing him from reacting to the verbal input. In case the response was correct, a short sound-track including, for example, how this animal “calls“ for other group members is presented.

During the whole problem solving process, the developed software evaluates all given input and intervenes, based on an accordingly derived user model, by verbalizing the required behavioural and/or cognitive aspect, e.g. requests or questions like: “Take a close look…„ (behavioural aspect), “Compare all animal pictures one by one. Which pictures show the same animal?“ (cognitive strategy), “Look for two picture cards,

that…“ (attention (re)focussing). Due to the reduced attention span, instructions need to be very brief and are rather subdivided into several steps.

If verbal intervention does not lead to a successful response, a comic figure (a magician called “Mirko“) is shown on the computer screen prompting the correct reponse by “sitting next“ to the picture card looked for. It is pointed out to the child, that Mirko will show him the animals, that look the same. In case the child is still not able to find the correct answer, the solution is presented and a new task appears. After a certain amount of correct responses, a reward is implemented by a comic figure looking like a little boy dancing on stage according to the favourite songs of the child.

The second mode of the memory game presents up to 4 pairs of picture cards with animals (see figure 3). At first all animals on the picture cards are shown. After about 5 seconds, all picture cards are covered and the child is asked to remind where he has seen animals that look the same. The intervention and reward strategy was selected according to the first mode of the game.

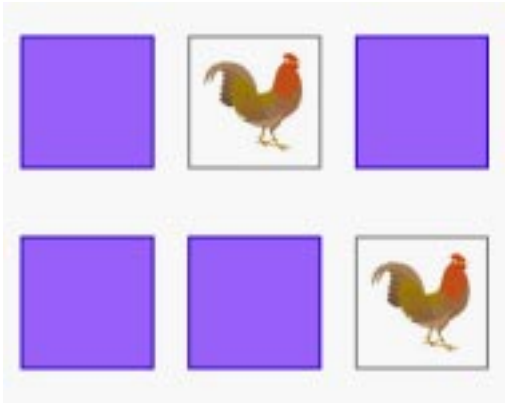

Figure3

5. F*irs*t *re*sul*t*s

The computer-assisted learning environment has recently been implemented. Each session is recorded by means of a short questionnaire rating achievement motivation, degree of independency while working and the like. Furthermore, a log file recording all clicks on the touchscreen in accordance with the instructional/interventional step was installed. First evaluations of the questionnaire showed, that the child shows good achievement motivation and pays attention to the instructions presented by the socially significant person. He shows very much interest in working with this person via the computer, stays on task and reacts to initiated interventions. Furthermore, he enjoys listening to the animal sounds and watching the comic figure while his favourite songs are played. The touchscreen as input device has proven to be appropriate. After some training sessions, the child concerned was able to operate the computer independently.

Thus, the first step is taken as the child concerned has gained access to a computer-assisted learning environment which appeared to be impossible so far. This is already

a success. However, all the observed effects might be due to novelty. In order to evaluate thoroughly the methodological concepts leading to the individualised adaptations on the semantic level of the developed system as described, a working period of at least three months is regarded as necessary. After that period of time, data will also be available allowing for an evaluation of the learning process while working with the learning environment.

Since the presented investigation is conducted as a case study, results are not to generalize. However, the investigation will give evidence about an innovative approach of designing learning software for children with special needs unable to benefit from standard educational software. The approach uses new multimedia technology for implementing a socially significant person facilitating the learning process. Since this person will be individually changing, all comments spoken by this person can easily be exchanged by another speaker. The approach of initiating metacogntive processes necessary for solving the given tasks can therefore easily be implemented in different settings.

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