

Development of a computer controlled cognitive diagnostics and rehabilitation method for the use on the Internet

J Szabo¹, A Pall¹, C Sik Lányi¹ and I Pataky²

¹University of Veszprém, Department of Image Processing and Neurocomputing
H-8200 Veszprém, Egyetem u. 10., Hungary

²National Centre of Brain Vein Diseases OPNI
H-1021 Budapest, Húvösvölgyi u. 116., Hungary

ABSTRACT

In this paper we introduce a computer controlled method (HELp Neuropsychology = HELEN) which enables - as a difference to methods used internationally - not only the establishment of the diagnosis, but permits measurement of the effectiveness of the therapy. It allows

- To produce a database of the patients that contains not only their personal data but also the results of the tests, their drawings and audio recordings.
- It is an intensive therapeutic test which contains tutorial programs too.

1. INTRODUCTION: COGNITIVE COMPUTER AIDED THERAPY

It is a computer controlled flexible procedure that enables clinical neuropsychological tests and therapeutic systems. The single tasks contain decision-making situations, for these the system provides material of assistance. The methods, how the patient solves the problems shows how he or she thinks about the question, in case of failure the system provides the possibility of a new trial. For these we had to elaborate such interactive procedures, which enable the solution along different concepts. This should not influence the test results, expressed in points, but should influence the way of rehabilitation. By this we enable the patients to control their own manifestations, and the way they deal with the problems. Thus this enables the use of the problem solutions encountered during the diagnostic phase and makes their transfer to the rehabilitation possible; it uses them in selecting the best strategy. The method uses syndrome-analysis, thus it is not only a mere collection of computerised tests, but has been built in such a form that it uses the solutions provided by the patient to choose the next task. At the same time it shows the efficiency numerically. By this it enables to develop diagnostic and therapeutic programs according to the individual needs and at the same time it supplies exact results and comparative data. This means that we investigate the cognitive and behaviour deficits in such a form that we activate the intact functions. The system contains tasks that relate to the perception, memory, attention, writing, reading, counting, etc. By this technique the patient controls the course by its own procedures, he or she is rehabilitated along his or her own activity, i.e. gets involved in the process and thus one can hope that the speed of his rehabilitation will increase. New aspect is that by using modern technical support, within the described system one can change the difficulty of the task by using colouring, changing the local or global intensity, adding noise.

The main menu of the HELEN program is constructed in such a way that the series of the tasks that was given in the beginning of the therapy can be changed any time depending on the patient's performance.

2. THE SPECIFICATION OF THE LOGICAL STRUCTURE OF THE HELEN SOFTWARE

The software consists of three parts:

- A framework that manages the data of the neurophysiologists and the patients, and in which the series of tasks can be created.

Új orvos felvétele

Vezetéknév: Keresztnév:

Orvos azonosító:

Telefon

Vezetékes:

Mobil:

Login név: Jelszó:

Jelszó mégegyszer:

Új beteg felvétele

Vezetéknév: Keresztnév: TAJ szám:

Ir. szám: Város: Utca, házszám:

Állampolgárság

Magyar Külföldi

Szül. dátum: Szül. hely: Anyja neve:

Telefon

Vezetékes:

Mobil:

Neme

Nő Férfi

Kezesség

Jobb Bal

Figure 1. Getting the data of the neuropsychologists and the patients.

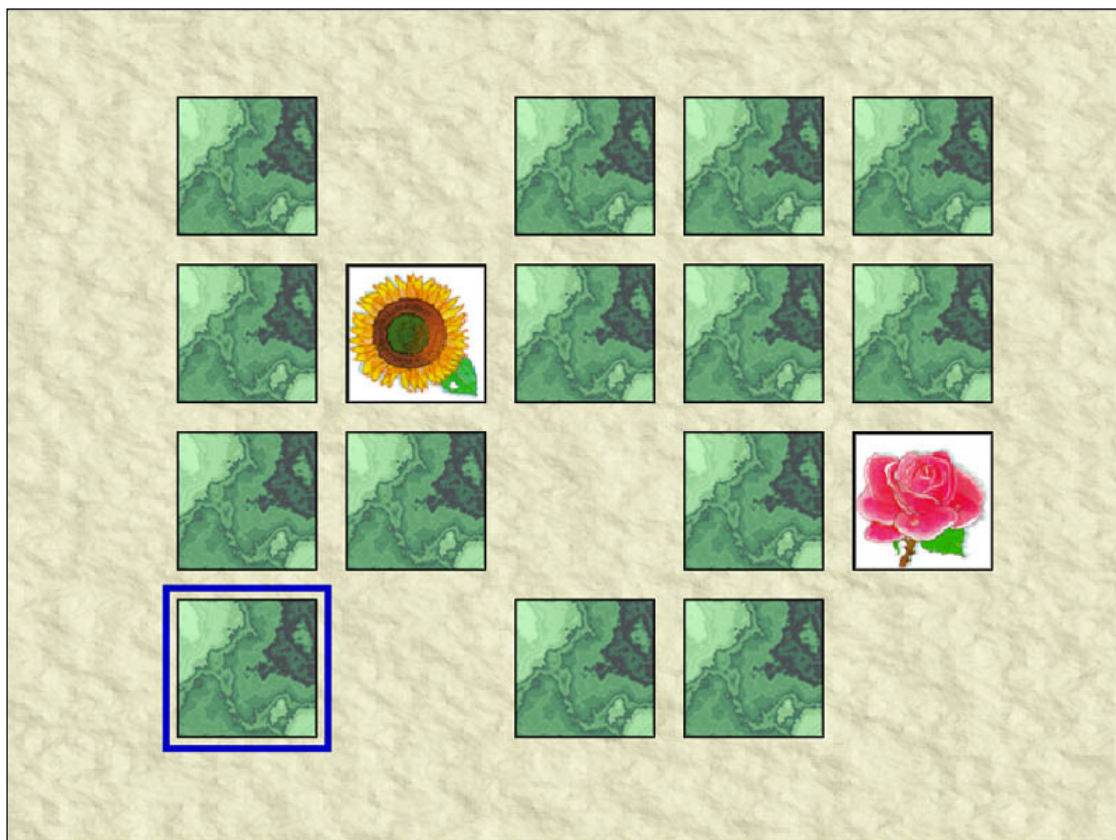


Figure 2. Task Memory.

- The database that stores the data of the neuropsychologists and the patients, and the results of the tasks solved by the patients.
- The tasks

The following data are stored in the database of the software

Personal data:

- Name (maiden name as well)
- Name of mother
- Date of birth
- TAJ number (Hungarian social insurance number)
- Address
- Telephone number
- Name of next of kin
- Accessibility (Tel., e-mail)
- Left or right handed (this has to be known for the best strategy of some tasks)

Data obtained from tests:

- Results of the tests
- Strategy of solution
- Drawings prepared by the patient
- Audio recordings.
- Remarks of the neuropsychologist

The HELEN interactive therapeutic test and teaching software contains the following tasks:

Tasks available on Internet too	For medical examination only	For medical examination only
1. How many pictures do you see?	9. Recognition of faces	17. Story
2. How many black and white checked drawings do you see?	10. Stories similar to the Binet pictures	18. Ordering of sentences
3. How many cubes do you see?	11. Recognition of emotions	19. Clock
4. Where	12. Ordering according to form and colour	20. Situation practice
5. Labyrinth	13. Identify!	21. Blind map
6. Memory	14. Ordering of pictures	
7. Concealed pictures	15. Picture with noisy background	
8. Puzzle	16. Logical cards	

The tasks in the leftmost column can be downloaded from the internet too, so the neuropsychologist can give “homework”, to practice at home.

3. EXAMPLE TASKS IN DETAIL

3.1 Memory

This game is similar to the traditional memory game, but the pictures are chosen thematically. Pictures from different topics are included in each game: fruits, plants, vehicles, clothes, etc. Maximum 4*5 sized memory game can be played. The patient can get verbal help after time limit or after several unsuccessful attempts. The program saves the steps of the solution.

3.2 Puzzle

At the beginning we can see the pieces of a picture dispersed and rotated at the border of the screen. On the border of the picture to be assembled we can see the outlines of the piece to be inserted. The picture is fit into a frame. The program saves:

- The order of the chosen pieces (It's important to know whether the patient is left or right handed, because he or she starts elsewhere)
- If the patient tries to put a piece to a wrong place
- If he or she gives up inserting the chosen piece and chooses a new one
- the given helps

3.3 *Where*

The patient sees 4-5 3D objects and 4-5 horizontal plans. The task is to put the objects to the right plans. The program gives help only after several unsuccessful attempts, maybe it rotates the object, the patient can take a look at the bottom of the object, so he can compare it with the horizontal plans. The program saves the attempts and the given helps.

3.4 *How many cubes do you see?*

On the screen a 3D object can be seen, which is built of congruent cubes. The task is to tell the number of the cubes. If the patient doesn't know the answer, we can give a base plan where the patient can write in the number of the cubes in a given place. If he still doesn't know he can rotate the object. The program saves the attempts and the given helps.

3.5 *How many pictures do you see?*

On the screen 2D figures can be seen drawn onto each other. The task is to tell the number of the figures. The program can help with coloring the figures, or it chooses one and shades it. The program saves the attempts and the given helps.

3.6 *Identify*

Only one half of a number of 2D images of everyday objects can be seen, the task is to recognize the objects. The program can help with showing a similar object rotated. If the patient still doesn't know the answer, the program shows the original object rotated and in a different size. We save the number of the recognized objects. It's important to let the patient control which help he uses.

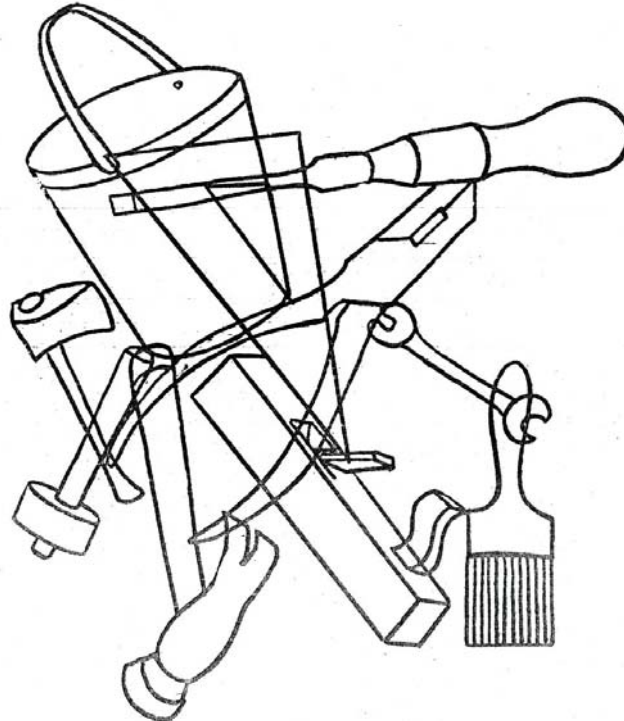


Figure 3. *How many pictures do you see?*

3.7 *Ordering of pictures*

We can see stories in 4, 6 or 8 pictures according to the difficulty level. The task is to put the pictures in an order. If the patient is ready with the ordering, he or she tells the story. If during the story telling the patient

recognizes that the order is wrong, he can put the pictures in another order. If he can't do it, the program gives sentences to the pictures. The program saves the attempts and the story telling.

3.8 Clock

The program tells the patient to draw on a circle the time he heard. The program can help with drawing the main lines of the watch. The program saves the attempts.

3.9 Story

We adapt known tales (only in foreign languages). On the screen we can turn over the pages just like in a book. The patient has to look at the tale, and has to tell the time he needs to tell the story. The program saves his story telling.

3.10 Labyrinth

The labyrinth program can be played with words or with numbers. This is asked at the beginning and then the size is asked (min 5*5, max 20*20). After that the labyrinth is drawn. The letters of a word or of a number from a mathematical expression are hidden as treasures. These treasures have to be brought out of the labyrinth in the shortest time. If all are brought out the program tells the time elapsed. Then we have to complete the word or the mathematical expression. The program saves the time needed to solve the program.

4. STEPS OF THE SOLUTIONS OF THE APPLIED RESEARCH

The group of interactive computer controlled rehabilitation programs makes it possible that we reveal the individual changes of the mental capacity of the patient, and by doing this get new information on the cognitive functioning of the patient or group of patients.

The information in the database reveals further data on the individual path followed by the patient, thus can provide information on the typical behaviour, how he or she recognises something, and gives us further insight in the sequencing of perceptions.

4.1 Expected results and further plans

We develop the HELEN software together with the organisation OPNI. After finishing the final version (expected for June 2004) it will be available for other institutions of Hungary as well. During the last two quarters of the project work we will already collect the results of the investigations. This will enable the testing of the progress of the rehabilitation of the patients. It is expected that these tests will provide us with data that can help to improve the method, and can cast light upon the possibilities when, under what circumstances and with whom the method can be used with the promise of success. Thus it might show also if there are personalities, persons, or groups of patients, or circumstances when the technique has no advantage or is even disadvantageous, e.g. in case of susceptibility to subordination. These observations and results of investigations will be useful also in other clinical departments.

5. SUMMARY

We have designed such an interactive multimedia test and tutorial software that helps the investigation and rehabilitation of stroke patients. The HELEN software enables the investigation of the cognitive deficits of stroke patients and their treatment in such a form that the patient becomes motivated to find his or her way of rehabilitation, to look for an out way in case of situations that threaten with failures, that he or she should choose an option from a number of possible solutions, and most important that he or she should direct the whole process. At the same time by using a computer it is important that the treatment of the problem should not get mechanic. We played attention to the fact that the patient should not get computer dependent, but the scale of the strategies how to solve a problem should become more diverse. Due to this fact the patients can go their own way naturally with the guidance of the neuropsychologue in their cognitive rehabilitation. This can improve their concern in their rehabilitation increasing their activity. On the other hand the method enables us to get an answer on the question what the most important criteria of the prospect of the cognitive rehabilitation are.

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6. REFERENCES

- C. Sik-Lányi, Development of computer teaching programs for special treatment of backward children in Hungary, *Knowledge Transfer-'96 International Conference*, London July 22-26, 1996 pp. 183-189.
- C. Sik-Lányi, Á. Molnár-Lányi, Psychological and pedagogic testing of handicapped children with locomotion disorder using multimedia programs, *The 3rd International Conference on Disability, Virtual Reality and Associated Technologies ICDVRAT 2000*, Sardinia, 23-25 September 2000., pp. 99-106.
- Pataky I., Nagy Z., Stroke betegek kognitív rehabilitációja. In.: *Stroke kézikönyv*. Szer.: Nagy Z. Springer, 297-302. o.
- Pataky I., Kiss K., A kognitív rehabilitáció alapjai. *Háziorvos Továbbképző Szemle* IV.2 Promenade, 100-103. o.
- Pataky I., Kognitív rehabilitáció post-stroke állapotokban. *Hyppocr.* I/3 164-167.
- Pataky I., Mesefeldolgozás – neuropszichológiai intervenciók lehetőségei *Magyar Pszichológiai Szemle*, XL.4. 559-566.
- Pataky I., Neuropszichológiai rehabilitáció a pszichiátriában – kognitív rehabilitáció. In.: *A pszichiátria magyar kézikönyve*. Szerk: Füredi J. Medicina, 649-654. o.