Non-directive, self-instructive media in the field of behavioural toxicology and addiction

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SUMMARY

This paper presents the design of the self-instructive multimedia program "Behavioural Toxicological Research". This computer program offers professionals in health care, nutrition, clinical psychology and treatment of drug addicts a basic understanding of neurobehavioural research and addiction research. The program focuses on the cognitive aspects of scientific research, emphasising the strategic decisions, domain-specific choices and discussions on validity that go with the process of designing and interpreting scientific research. Results from both formative and summative evaluations of the program are briefly discussed.

Introduction

In everyday life, the human body is frequently exposed to toxic substances that affect the central and peripheral nervous system and, subsequently, give rise to unwanted changes in behaviour. Professionals in the field, that is policymakers and professional practitioners in health care, nutrition, clinical psychology and drug abuse treatment are continuously faced with new outcomes of scientific research. To enable these professionals to assess and evaluate such research outcomes and to search for, criticise, value and process recent knowledge and opinions, they should have a basic understanding of scientific theories and applied research methodologies. To meet these demands the Open University of the Netherlands developed a 100 hours self-instructive introductory course for non-researchers: "Neurobehavioural toxicology and addiction: food, drugs and environment". The course is designed for under-graduates and graduates in the fields of toxicology, nutrition, psychology, medicine and health sciences. It forms an excellent source of information to anyone professionally concerned with neurobehavioural toxicology, psychology, nutrition or medicine.

A central part of the course is a multimedia program on cd-rom that offers a complex, problem-based learning environment (Westera et al. (1997)). In the sequel of the paper we will focus on the design principles and characteristics of this computer program.

Course objectives and contents

The main goal of the course is to learn how to apply scientific knowledge and methods by analysing, assessing and solving (possible) neurobehavioural problems. The course deals with the entire range of neurobehavioural toxicology in humans and animals, including biological (physiological and biochemical), psychological and social aspects of undesirable behavioural changes caused by toxicants. It also covers neurobehavioural effects of natural food components, food contaminants and food additives, drug abuse and effects of environmental chemicals like metals, pesticides and organic solvents on the nervous system.

The multimedia program

In the multimedia program, students are set the task to approach a general health problem and study it by way of a simulated research process. The computer program focuses on the cognitive aspects of the scientific process only: that is, all components that involve actual experimentations and measuring activities, like handling animals or administering injections, are omitted in the program. It supports the understanding of basic concepts, theories and research methods, and it allows for practising scientific reasoning and interpreting outcomes. The program offers 4 authentic case problems in the field of neurobehavioural toxicology and the field of addiction research:

-'Does exposure to low levels of mercury affect cognitive functions?'
-'Are subtle effects of lead during brain development responsible for behavioural disturbances?'
-'Is Ecstasy an addictive drug?'
-'To what extent is naltrexone, an opiate antagonist, effective as pharmacotreatment for alcohol dependence?'

During the course, students are invited to investigate 2 out of 4 tutored cases at least (some 6 hours of work), but are free to do more. After completion of the cases, the cd-rom program can be linked to the internal network of the Open University of the Netherlands to carry out the examination. For this purpose, a new case is randomly generated from a database of examination cases.

Design principles

The multimedia program allows students to design and evaluate their own research processes. The program design is strongly based on theories of problem-based learning (Barrows et al. (1980)), and theories for constructivist and experiential learning (Brown et al. (1989), Duffy et al. (1992)). That is, students are faced with a rich and complex environment that allows for sensible experiences and supports versatile, explorative and individualised student behaviours. In addition to the domain related skills, the acquisition of higher level academic skills, such as critical thinking, creative thinking, reasoning, dealing with conflicting data, reflection and evaluation is stimulated by such an approach.

Process design

After selection of a case the investigation is divided up into five subsequent stages, each of which focus on a simple question.

Step 1. Problem analysis (*What is already known from the literature?)*
In this stage, students have to familiarise themselves with the subject by browsing relevant literature. Students will have to survey what is known about the subject from previous experiments and what aspects demand further research. To this end, the computer provides a database of some five hundred relevant state-of-the-art literature abstracts on the subject.

Step 2. Problem definition (*What should be investigated?)*
Next, students should try to translate the case-problem into a sensible and testable research hypothesis. An essential feature of this stage is that students specify their hypotheses in their own words as free text input. An intelligent text-analysing routine instantly checks and comments on the student's texts. This feature allows the students to gradually improve their hypotheses.

Step 3. Experimental set-up (*How should this be measured?)*
Students are asked to model the experiment they want to carry out. For this purpose, the program offers a broad set of research facilities including various modalities of experimental human and experimental animal research, clinical research and epidemiological research. After completion, an intelligent routine checks whether a satisfactory match of the proposed design can be made to a number of built-in research protocols.

Step 4. Experiment (*What can be learned from the experimental data?)*
The actual experimentations and measuring activities are skipped. Instead, they are represented by existing authentic, experimental data in the form of tables, figures, texts, etceteras.

Step 5. Discussion (*What is the conclusion for the case assignment?)*
The experimental data should be interpreted from the perspective of the specified hypothesis. Using scientific evidence the students should finally discuss the concerned case assignment. At this stage students receive feedback on their conclusions and on the way they dealt with the investigation.

Technical implementation

The interaction design is largely based on the standardised interface objects and style of the Open University of the Netherlands. We will briefly review some of the program objects.

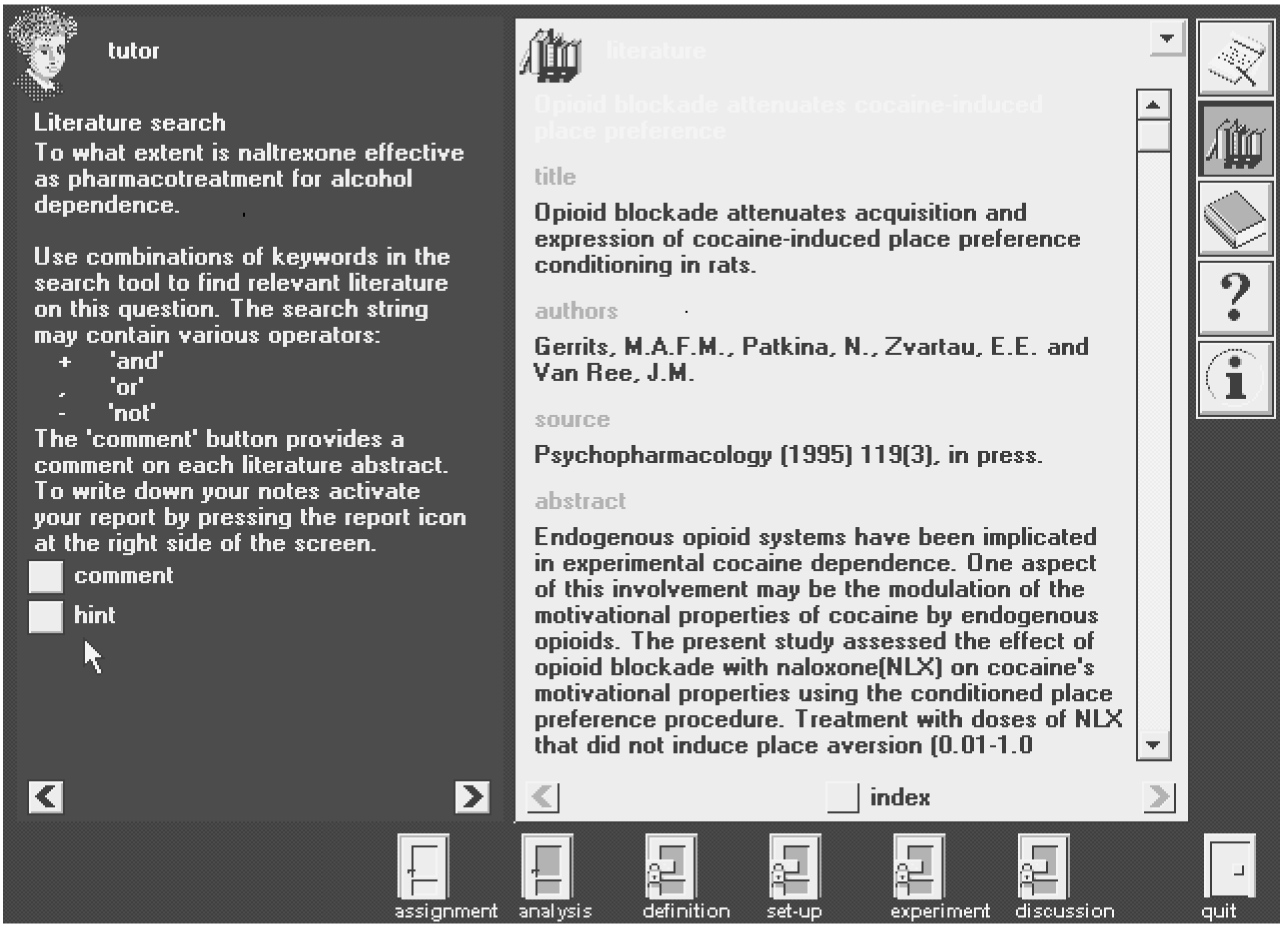

Figure 1 The interface showing the tutor and a literature abstract.

- The electronic coach (tutor)
The *electronic tutor* provides various kinds of non-directive support like assignments, instructions, hints and feedback. Great effort has been put in the quality and level of detail of the feedback. On several occasions, the coach utilises an intelligent routine to analyse the inputs of the students and hence provides tailor-made comments.

- Research tools
Students are frequently asked to write down their findings in the built-in *electronic report*. It is the contents of this report-tool that is used as an input for the feedback routines. In addition, students specify their desired experiment with the help of forms in a *protocol-design tool*. On completion of these forms the protocol tool calculates the best match of the student's protocol against the available built-in protocols. Special mention deserve the animated *audio-visual sequences* that are available for each built-in protocol (fig. 2).

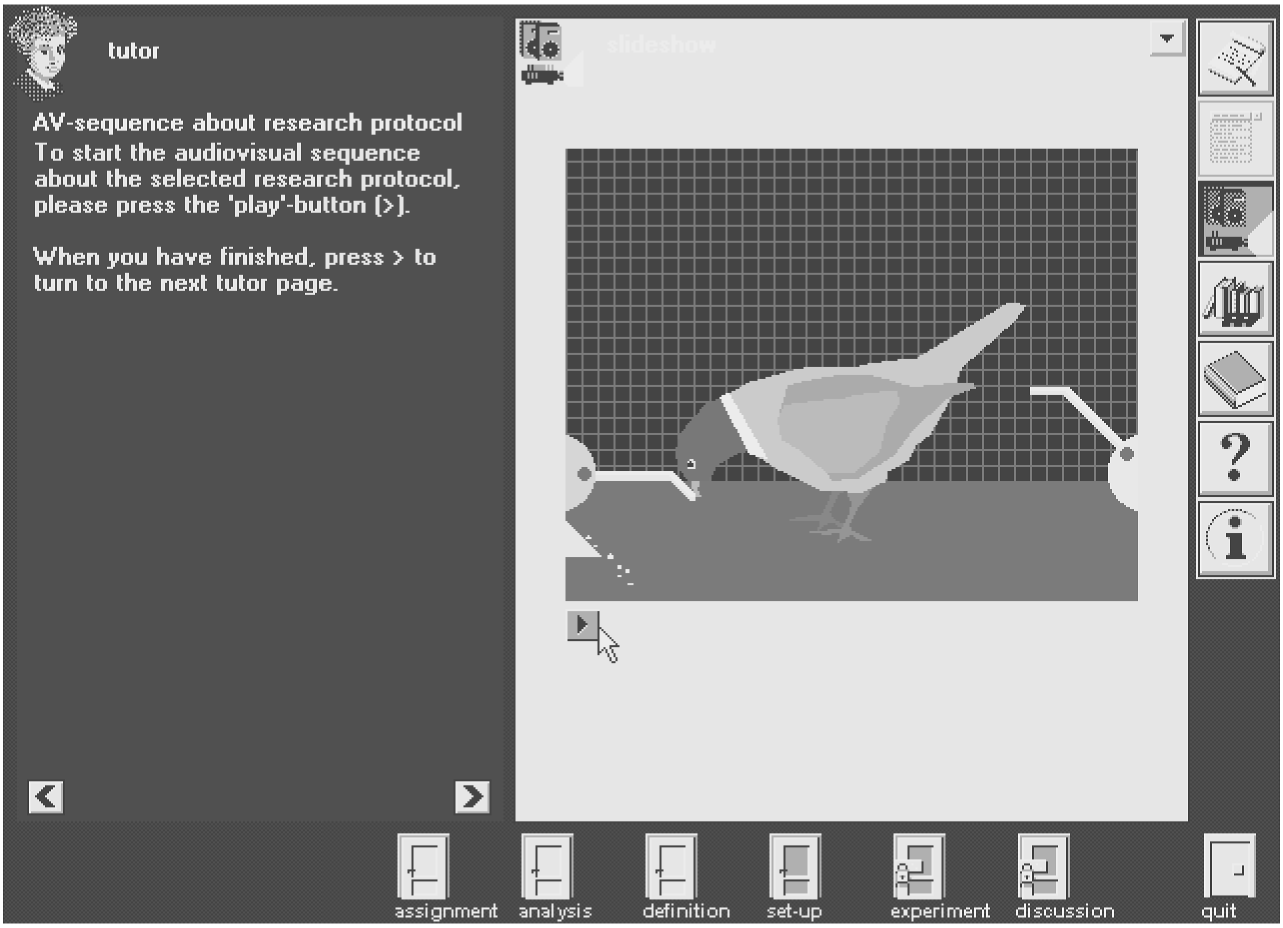

Figure 2 The interface showing an audio-visual sequence of a research procedure.

Once an experiment has been decided on, the outcomes of this experiment become accessible in the *display-tool*. These experimental results may include graphs, tables or even recorded interviews (see fig. 3).

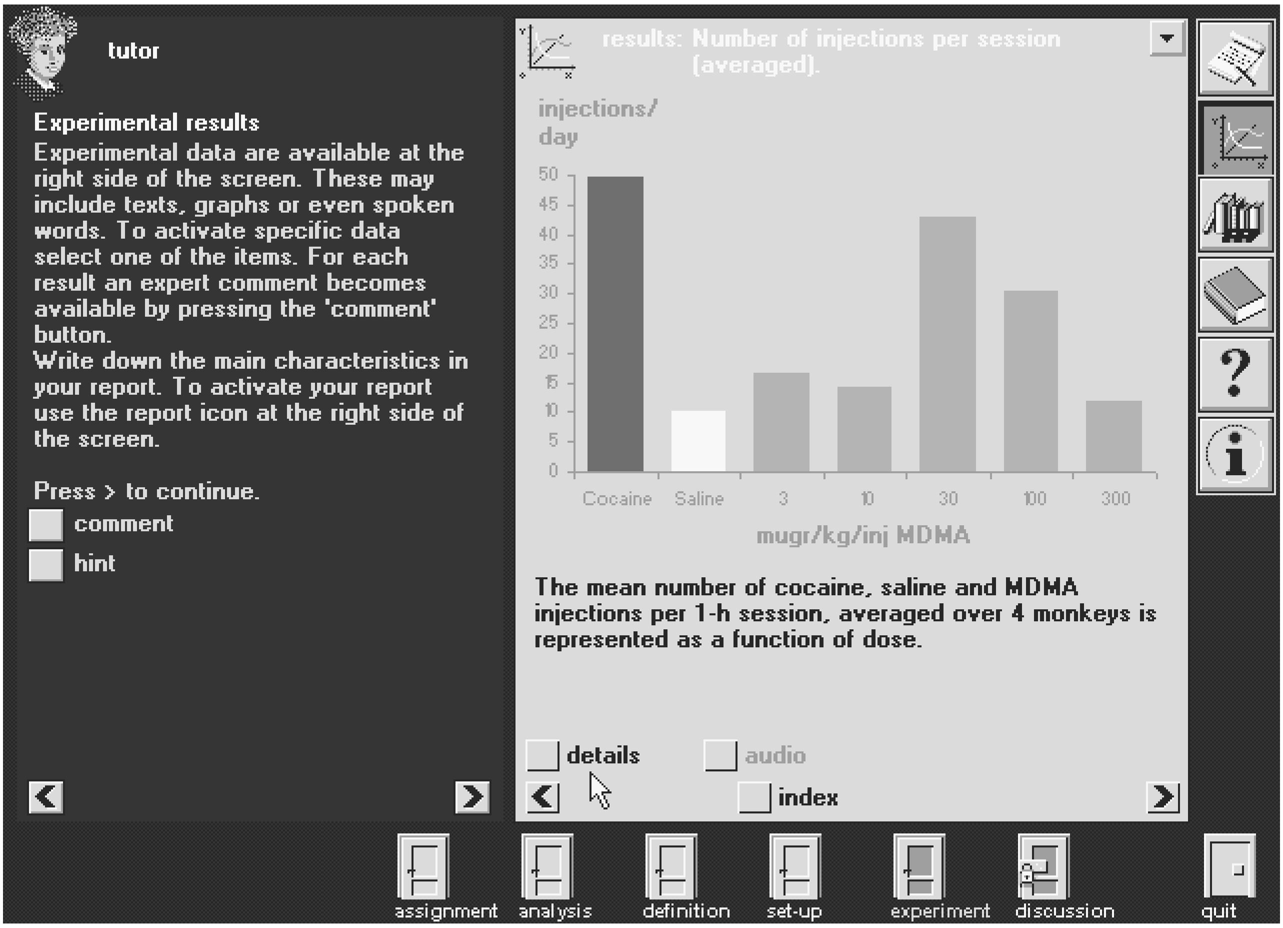

Figure 3 The interface during the experiment stage.

- Additional supportive tools

To enhance the self-instructive nature of the materials the program contains three hypertext systems. First, there is an extended *help facility* for supporting the operation of the program. It comprises explanatory texts as well as animated, audio-visual instructions. The second hypertext system concerns a *glossary*, comprising over a thousand specialist terms in the field of (neuro)behavioural toxicology and pharmacology. The third system concerns a *database of literature abstracts*. In various texts in the program, students are referred to relevant literature via hotwords. These three hypertext systems, that are partly linked to each other, constitute a powerful tool to provide just-in-time information.

Evaluation and prospects

During the development, formative evaluation has been used to adapt and improve the program. By now the 1.0 release has been utilised by some fifty students as part of the academic degree program ‘Food, nutrition and toxicology’. The majority of the students appreciate the clear and simple way of operation, the built-in didactic support and the quality and depth of the contents. They judge the program to be highly efficient and quite appropriate as a self-instructive educational means and indicate that it

enhanced their understanding of the domain. Indeed, most students manage to produce high-quality and substantiated solutions to the case problems in only a few hours.
The program has been designed case-independent; that is, code and data are strictly separated. This allows extension with other cases or even extension to other disciplines, provided that the research from these disciplines can be fit into five basic steps and provided that sufficient authentic data are available. In the near future, we will develop some new examination cases; this allows us to make some of the existing examination cases accessible for training purposes.

References

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Duffy, T.M. & Jonassen, D.H. (1992) *Constructivism and the technology of instruction: A conversation* (Hillsdale, NJ, Lawrence Erlbaum).

Westera, W., Niesink, R.J.M., Vos, M.M.H.L.S. & Berkhout, J. (1997) *Behavioural Toxicological Research*, Multimedia program, Open University of the Netherlands. Minimum requirements: 386-processor, MS-Windows 3.1, 4 Mb RAM, CD-ROM player, audio, 6 Mb of free disk space, VGA-compatible. Literature abstracts by courtesy of the National Library of Medicin, Silverplatter and the American Psychological Association. (More information at http://www.ouh.nl/info-alg-coo-catalogus/681dr.asp).

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