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Pathologists dislike sound? Evaluation of a computerised training microscope

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Abstract

***Aim*—To evaluate the use of multimedia enhancements, using a computerised microscope, in the training of microscope skills.**

***Methods*—The HOME microscope provides facilities to highlight features of interest in conjunction with either text display or aural presentation. A pilot study was carried out with 10 individuals, eight of whom were at different stages of pathology training. A tutorial was implemented employing sound or text, and each individual tested each version. Both the subjective impressions of users and objective measurement of their patterns of use were recorded.**

***Results*—Although both versions improved learning, users took longer to work through the aural than the text version; 90% of users preferred the text only version, including all eight individuals involved in pathology training.**

***Conclusions*—Pathologists appear to prefer visual rather than aural input when using teaching systems such as the HOME microscope and sound does not give added value to the training experience.**

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The use of computer aided learning (CAL) in medical education has increased markedly in the last 10 years and is considered to improve the learning process,[1 2] Factors encouraging this include cheaper hardware and software, and improvements in image acquisition, storage, and display. Recent developments in multimedia systems enhance communication by integrating different media in a single user-friendly environment, and are suitable for wide application in medical training, making teaching more exciting for students by demanding interaction, involvement, and attention.[3]

Current applications of computers in teaching may take two forms. In the first, computers are used as teaching aids to augment conventional techniques, with many students working at computer monitors alongside teachers who are available to provide additional information or assistance. In the second the computer is used as an alternative teaching medium without teacher attendance. Tutorials are designed to provide the necessary information and students work through these without assistance.[4] In this paper we have evaluated the use of such computer based systems for teaching in pathology.

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The CAL tutorial system used in this study was designed as an alternative to conventional microscope training methods involving multi-headed microscopes and teacher/student interaction, specifically for training of pathology junior staff. It avoided the problems inherent in CAL programs that rely on purely digitised images by providing the ability to look at the whole slide and to alter the focal plane and the magnification. Employing this system we have compared the presentation of information in conventionally displayed text with that in the spoken format as sound.

Methods

HARDWARE

The training program has been developed for use with the AxioHOME (Zeiss, Oberkochen, Germany) which comprises: an Axioskop microscope with built in 1 inch (2.5 cm) VGA monitor visible through the eyepiece display; an encoded nosepiece; and an encoding stage (fig 1). The whole system is controlled by a personal computer with user interaction via the mouse and, where necessary, the keyboard.[5 6]

The built in miniature monitor superimposes the computer output display upon the real microscope image. This allows annotation of the microscope image with text and graphics, and the construction of a teaching system which indicates features on a microscope slide, informs, and poses questions. The computer mouse can be used for drawing around or pointing to objects in the specimen, or for selecting menu options.

Two versions of the teaching software were constructed. In one all information was presented as text on the VDU display (the text only version), while in the other information

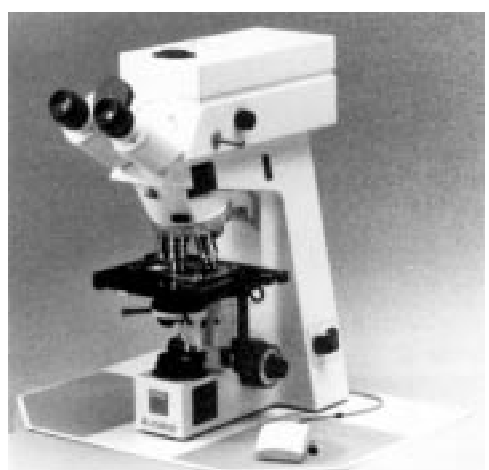

Figure 1 AxioHOME microscope, the student system.

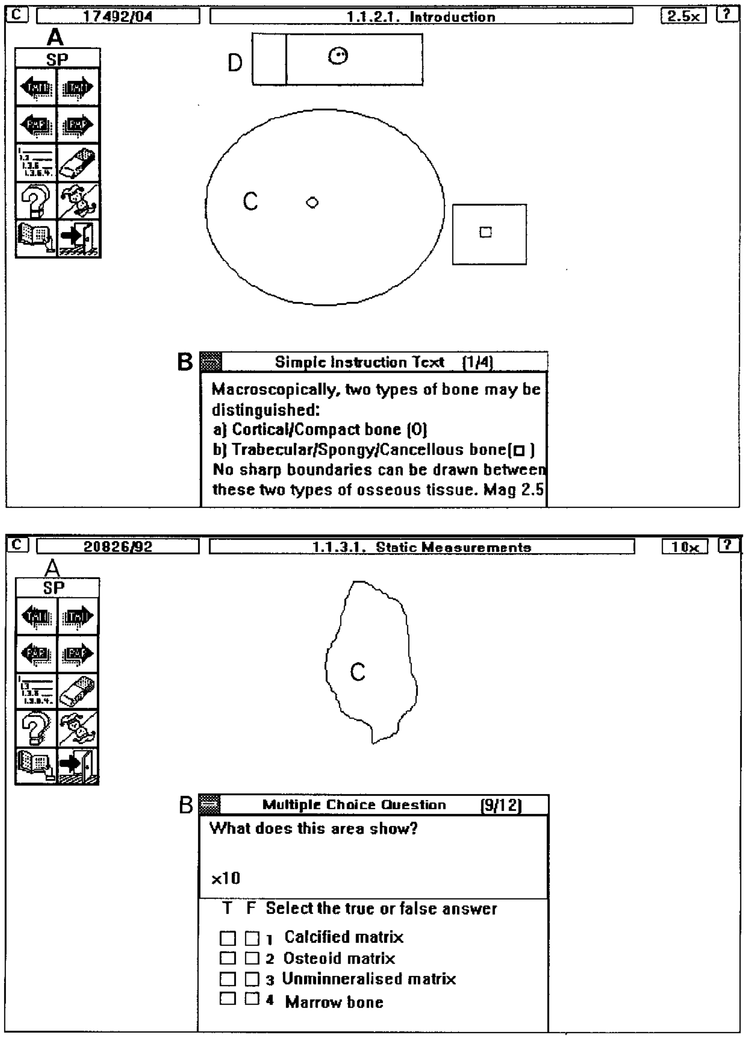

Figure 2 Example of a teaching screen. For reasons of clarity only the overlay is shown; normally a field of view lies behind the screen. Top panel: Instruction TAM: components of the unit are (A) control menu, (B) explanatory text, (C) marked feature of interest, and (D) feature finder. Bottom panel: Question TAM: components of the unit are (A) control menu, (B) multiple choice question, and (C) marked feature of interest.

was presented as prerecorded speech or as displayed text (the aural version).

SOFTWARE

Prototype authoring software was used to create student tutorials where the information was presented either as text or as speech. Only the text version is described in detail and any significant differences between this and the aural version are highlighted.

The text version

The basic element of the teaching unit is the text and its associated marker (TAM) which is displayed over a field, to which the student is directed, on the microscope slide. Once the correct field is in view, markers are displayed overlying the relevant cells and the appropriate text appears. After the observer has digested the information they are directed to the next field. TAMs are linked together to form paragraphs, which are then arranged into chapters, chapters into lessons, and lessons into topics. At each of these top three levels the student is presented with a menu listing the study options.

Each chapter contains a variable number of paragraphs that begin with a short introduction, followed by a series of TAMs. These consist of either instruction TAMs (marked features and associated explanatory text; fig 2, upper panel), or question TAMs (marked feature with associated multiple choice questions; fig 2, lower panel). Paragraphs are sequentially linked, thus allowing the student to step through each, with the option of returning to the previous one or skipping to the next.

Locating marked areas

In order to find each example a "cell finder" has been developed to help the student relocate the marked object. The current field and the position of the field containing the example are displayed on the slide map, as an open circle or filled area (fig 2, upper panel). Manoeuvring the open circle over the filled area, by moving the stage, brings the TAM into view.

The aural version

In order to incorporate the multimedia speech facilities some modifications to the text version were made. The introductory text of paragraphs and explanatory text associated with markers was recorded by the Windows Quick Sound Recorder. The sound is played back through headphones at the start of a paragraph or when a marker appears in the field.

Sound files were created with the "Quick Recorder" option of the Microsoft Windows sound system. For each file both the sampling and compression rate can be altered, affecting the quality of the sound and the memory space used. Sampling rate is the number of times a second that the Quick Recorder takes a sample of the sound recorded—the higher the rate, the better the quality. The compression rate determines the number of bits available per sound sample—the higher the number of bits, the more digital numbers available to be assigned to represent the sound sample, and the better the quality. Sound files occupy much more memory than text files; for example, a text file containing 20 words uses about 150 bytes of memory, while a sound file of the same text can use 80 kbytes. Thus a compromise had to be made to allow a suitable sound quality to be used while reducing the memory requirements of the program to reasonable levels. After initial trials a sampling frequency of 222 Hz and a compression rate of 4 bits/s was found to provide acceptable sound quality and a suitable file size.

Although the relocation method is the same for the text and sound versions, the method of stepping through examples in a paragraph is slightly different, which required the control menu to be redesigned (fig 3). First, the sound does not play when the marker appears in the field, but only once the marker has been stationary in the centre of the field for five seconds. This gives the user time to focus the image properly before the explanation is given. Second, a repeat option is added to the control

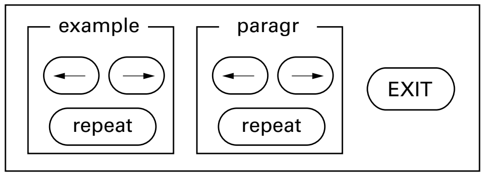

Figure 3 Control menu for sound version, displayed in position (A) of fig 2. Note extra repeat option.

menu in case the observer wants to hear the explanation again. Unlike text, which can be partly reread without further interaction, the speech file has to be replayed in its entirety. Third, when the end of a sound file is reached the system continues automatically, displaying the position of the next TAM on the cell finder. This has the advantage that the user can keep their hands on the stage controls without having to use the mouse to select the "next" option from the menu. Finally, an extra option is supplied to display the *written* text simultaneously as a back up. This can be particularly useful when medical expressions new to the user are employed.

STUDY DESIGN

A tutorial on the methods used in bone histomorphometry was constructed which requires the participants to work through 15 different fields and examples, organised into three paragraphs.

Two versions of the tutorial were prepared: (1) For the text only version, the users were presented with text displayed on the VDU screen. (2) In the aural version, the text was initially presented as speech (which could be replayed) with the additional option of visual presentation if the user desired it.

A group of 10 individuals was tested. These comprised a mixture of medical participants: medical students (2), technical staff (2), and junior pathologists (6), with variable computer experience. Half of the group used the visual text version first followed 24 hours later by the speech version. The other half used the versions in the reverse order.

Results

The data collected from this study were of two types: user opinions obtained from questionnaire replies, and numerical data relating to the time spent on the tutorial. The overall design of the system, the hierarchical structure, the menus, and the overlays were considered clear and user friendly.

USER OPINION

Each participant was asked before beginning which system they thought would be preferred and then asked to complete a questionnaire immediately after finishing each tutorial. Before trying the system all users thought that the speech version would be more "interesting" and expected this to be "better" for training purposes.

Table 1 Questionnaire responses to AxioHOME training program

	Marks/10 (n = 10)	
Question	*Mean (SD)*	*Range*
AxioHOME is an effective training system	7.8 (0.42)	7–8
AxioHOME allows me to work at my own rate	8.3 (1.34)	6–10
AxioHOME makes me less dependent on my instructor	7.4 (0.7)	6–8

Scoring was on a scale of 1 to 10, with 10 representing total agreement with the statement and 1 indicating complete disagreement.

Table 2 Time (seconds) to complete tutorial program

	Run 1: speech version	*Run 2: text version*
Group 1	478	292
	563	454
	293	233
	583	415
	330	263
Mean (SD)	**449 (132)**	**331 (97)**
	Run 1: test version	*Run 2: speech version*
Group 2	314	381
	296	329
	430	1008
	188	385
	337	701
Mean (SD)	**313 (87)**	**560 (290)**

The questionnaire contained questions about user controls, screen layout, and overall perceptions of the system. Scoring was on a 10 point scale, with 10 representing total agreement with the question posed. After using both versions, nine of the 10 users indicated their preference for the visual text system. Only one expressed a preference for the speech version. All users found the visual text easy to read. The major complaint about the sound system was that, although the speech was clear and understandable, it was difficult to assimilate the spoken information while viewing the field of interest, requiring the information to be repeated or the written text accessed. The text matched the spoken format word for word and yet no participant complained about the complexity of this information. In general the training system was well accepted by the users, who saw major advantages of having microscopic features presented in this way (table 1).

TIME SPENT ON A TUTORIAL

The system was designed in such a way that the time spent by users over each component of the tutorial could be measured—that is, the time spent on each chapter, paragraph, and TAM, and for relocating the images and for reading/listening to the text. In all cases the speech version took considerably longer to work through than the visual text version (table 2), and using Kendall's rank correlation coefficient a positive correlation was shown ($\tau = 0.6$). This correlation was statistically significant; the number of standard deviations for τ was 2.4 ($0.05 > p > 0.01$).

Discussion

Although CALs are being used increasingly as an education medium in a wide variety of settings, few studies address the effectiveness of the different methods employed for imparting information through this medium. New technologies now make it possible to incorporate media such as sound and video images into CAL programs. There is a presumption, largely based on subjective impressions rather than numerical data, that the use of such media in a program enhances its educational value and thus the learning process. The effectiveness of such innovations, however, is often not investigated.

In this study we assessed the advantages of adding a sound component to the traditional text format. The introduction of sound was considered potentially advantageous for four reasons. First, it is simpler and less time consuming for most teachers to annotate an image and to enter the associated text information by recording rather than by typing it in.[7] Second, there is a fundamental belief that the spoken instruction can significantly enhance the quality of the training. Third, aural presentation of information allowed the system to be more ergonomically efficient, reducing the need to use a mouse to scroll through text blocks and to move through the program. Finally, it was thought that presenting text in an audible form might reduce the chances of developing eyestrain, which is considered to be associated with prolonged reading from a VDU.[8]

The speech system was expected to be better and to make the learning process more interesting. In reality most participants in this study found that, in comparison with the text version, speech made learning more difficult. Most of the users found that speech had to be replayed at least once to allow them to interpret the visual information displayed on the microscopic slide. Often the users felt that when only a small but vital portion of the aural information had to be repeated, it was easier to access the text format as the relevant section could be read many times while ignoring the other information. Selective replay of the aural version was not possible. All users accepted that the spoken text was clear, so the compression rate selected was suitable. However, there was wide variation of opinion on the acceptable speed of the speech. This was dependent on the users and their background in the subject, users unfamiliar with the terminology preferring slower speech. In the text version, all users felt that the text display was clear and easy to read, and an effective means of communicating information.

As most users preferred to access the text format rather than replay speech, the menu design, presentation, and display of textual information are of relevance to both CAL programs.[9–11] Factors affecting “readability” of the screen, for example, display colour and text type, are also relevant.[12] Here the general screen design and use of icons proved popular, the visual symbolism communicating effectively with each user. The text colour (green) stood out from the underlying microscope image, and the use of capitalised text for emphasis allowed quick identification of relevant terms. One of the main criticisms of the aural format was the difficulty in recognising which specific areas and terms were of greatest importance.

Ergonomic design was also considered during this study. The addition of speech allowed the introduction of automated progression of the program without hand movements. Although ergonomically this is “good design,” users actually prefer having more control, even if this means additional hand movements, and automated presentation of TAM position was not widely approved. Since trainee pathologists do not spend long periods using CALs, user control in selecting a course of action rather than ergonomic design appears to be of a higher priority. Such limited use also means problems of eyestrain through excessive VDU use are minimised and not relevant when proposing the introduction of an aural format for this type of training.

CONCLUSION

In this study the inclusion of spoken text in CAL programs did not confer any significant advantage and users indicated a clear preference for a visual system, with nine of 10 participants opting for the text alone version. This conclusion is not intuitive and we suggest that despite the initial attraction of adding another mode of communication to CAL programs, the general acceptance and educational value of such new modes have yet to be established.

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