Mammographic interpretation training profile in the UK: current difficulties and future outlook

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ABSTRACT

In the UK, most mammographic interpretation training needs to be undertaken where there is a mammo-alternator or other suitable light box; consequently limiting the time and places where training can take place. However, the gradual introduction of digital mammography is opening up new opportunities of providing such training without the restriction of current viewing devices. Whilst high-resolution monitors in appropriate viewing environments are de rigour for actual reporting; advantages of the digital image over film are in the flexibility of training opportunity afforded, e.g. training whenever, wherever suits the individual. A previous study indicated the possible potential for reporting mammographic cases utilising handheld devices with suitable interaction techniques. In a pilot study, a group of mammographers (n=4) were questioned in semi-structured interviews in order to help establish current UK film-readers' training profile. On the basis of the pilot study data, 109 Breast Screening Units (601 film readers) were approached to complete a structured questionnaire in order to establish the potential role of smaller computer devices in mammographic interpretation training (given the use of digital mammography). Subsequently, a study of radiologists' visual search behaviour in digital screening has begun. This has highlighted different image manipulations than found in structured experiments in this area and poses new challenges for visualising the inspection process. Overall the results indicate that using different display sizes for training is possible but is also a challenging task requiring novel interaction approaches.

.**Keywords:** mammogram interpretation, computer display, training, eye movement, visualization

1. INTRODUCTION

Breast cancer is the most common type of cancer amongst women [1]. Since 1988 the UK National Health Service Breast Screening Programme (NHSBSP) has screened all women aged 50-64 for the presence of very early signs of cancer [2]. Such signs are difficult to identify and so there is an ongoing need for mammographic interpretation training. In the UK, screening cases are discussed at weekly multidisciplinary meetings, which therefore serve as a very important training resource, within each screening centre. Also, as part of the quality assurance programme for the NHSBSP, individuals undertake the PERFORMS (PERsonal perFORmance in Mammographic Screening) scheme which is a free and anonymous educational exercise for all screening film readers in the UK. This is undertaken bi-annually and requires film readers to interpret recent difficult, known screening cases. The scheme also serves as a training tool [3]. However, any examination of a number of mammographic films needs to be undertaken on mammographic multi-viewers which, of necessity, are statically sited at breast screening centres. Consequently, this limits the time and places where any detailed training can take place. Current developments are producing a digital version of PERFORMS for nationwide roll out.

The increasing use of digital mammography, and its forthcoming widespread adoption in the UK (Full Field Digital Mammography screening is being rolled out gradually and within the next three years every screening centre will have at least one digital imaging system) is opening up new opportunities to provide a wider range of training without such restrictions [4]. For instance, as well as being able to view digital breast images on high resolution monitors at the Breast Screening Centre, it could be possible also to view training images on a range of computer displays - for instance desktop or laptop PCs or even handheld devices. These could be used to offer mammographic interpretation, anytime, anywhere to fit the individual's needs, provided that it were possible to: maintain the acceptable image quality on the device; devise acceptable interaction methods, as well as performing such viewing in appropriate viewing conditions [5].

Consequently, this would offer the opportunity for extending the PERFORMS self-assessment scheme to provide increased dedicated and individualised training without any restriction to only doing this in a screening centre's reporting

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suite. For instance, as well as being able to undertake the bi-annual self-assessment on mammographic interpretation, it could be possible for film readers to view further training images according to the outcome of the self-assessment on a range of computer displays - for instance desktop PC, laptop or even smaller handheld devices, provided that it were possible to zoom, pan, and otherwise interact with such images appropriately. This raises the possibility of having mammographic interpretation training delivered both whenever, and wherever it suits the individual. Clearly such displays would never be advocated for prime clinical diagnostic purposes but these could be useful for training purposes.

To use a computer display for such a purpose would be very useful but currently it is not known whether such this could be accepted by screeners or even be used effectively for such large and high resolution images. Therefore, further details of current mammographic interpretation training in the UK were first investigated and screening mammographers' views investigated on the potential for using standard computers, laptops, and other devices to display mammograms for interpretation training purposes.

2. USER REQUIREMENTS STUDY

In a pilot study, a group of film readers (n=4) were questioned in semi-structured interviews in order to help establish a general picture of current mammographic interpretation training in the UK along with their perceived training requirement and preferences given the implementation of digital screening. Content analysis revealed several main categories of training preferences including: the requirements of individualized tailored training, the location and timing of training opportunities, and their perspectives on the possible clinical applicability of hand-held devices.

A questionnaire was then designed to amass full details nationally of breast screeners' current and future training needs. This included four main categories on the basis of the pilot study:-

- Details of current screening position (e.g. profession; experience of digital mammography);
- Individual's current usage of mammographic interpretation training (e.g. forms of training available; the amount of training opportunities; any difficulties of current training; advantages and disadvantages of current training);
- Future training outlook (e.g. attitude towards 'whenever, wherever' training; views on tailored training that could be based on the individual's PERFORMS report);
- Views towards digital training that could be delivered on different types of computer displays and further suggestions about mammographic interpretation training using digital images.

After piloting of the questionnaire, it was sent out to all 109 breast-screening units. This meant that 601 current screening readers were approached to seek their views on current mammographic interpretation training, and the possibility of delivering mammographic interpretation training opportunities as an additional possible future part of the PERFORMS scheme. The respondents (n =273; a 45% response rate) covered the main professions in breast-screening film reading, e.g. 152 consultant radiologists, 78 advanced practitioners (in the UK these are specially trained technologists), and others (see Figure 1). Data were also collected about the participants' experience of digital mammography as shown in Figure 2.

2.1 Current UK mammographic interpretation training

The questionnaire data were analyzed as a whole first and then analyzed by three different main groups; radiologists, technologists and others. Participants were asked to rate the current amount of mammographic interpretation training available to them. The result showed that 40% of participants believe that the training is 'not enough' or 'could be more' along with 60% of participants considered the training amount was 'adequate', 'more than adequate' or 'highly adequate'. For current formal training opportunities, then multi-disciplinary meetings (MDTs), interval cancer reviews (both held within the screening centres) and the PERFORMS scheme were the three most commonly used training forms. See Figure 3 for more details.

In the UK all interpretation of screening cases used to be performed by consultant radiologists, although in recent years technologists have been specially trained, as advanced practitioners, to also undertake this screening reporting role; additionally developments within radiography have led to the institution of the role of consultant radiographer. A third

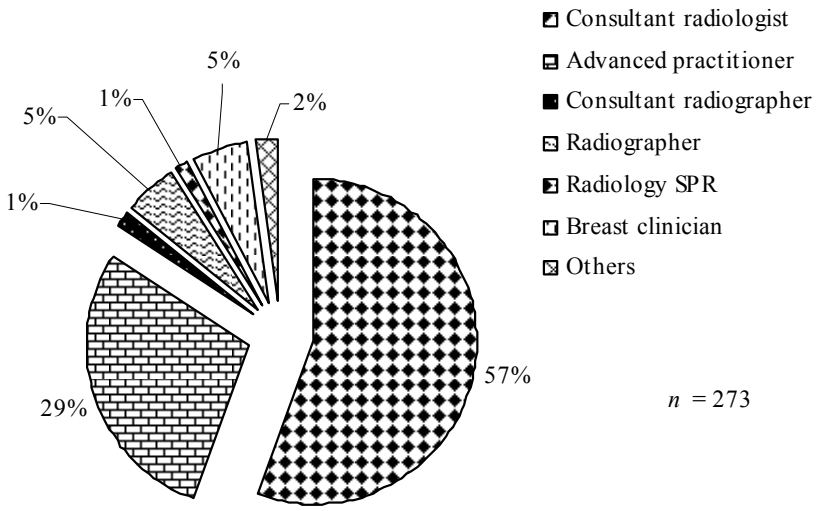

Figure 1: the percentage of participants' professions

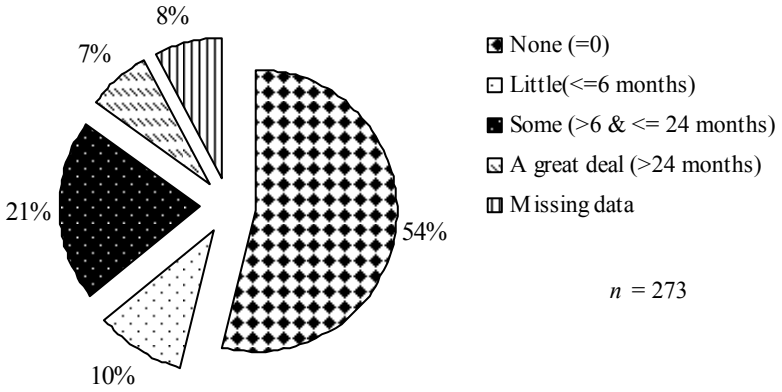

Figure 2: the percentage of participants' digital mammography experience

group also undertake screening reporting and these are mainly physicians who have a special interest in screening and have been trained to read screening cases. The participants were then divided into three main groups for further analysis. This comprised 154 radiologists (consultant radiologists; 56.4%), 98 technologists (advanced practitioners, consultant radiographers, and radiographers; 35.9%), and 21 'others' (this included radiology SPR [specialised radiologist in training], breast clinician, other film readers; 7.7%.) Data collected from these groups were then compared on the different forms of current training , their ratings on the amount of mammographic interpretation training, and any identified difficulties when undertaking training. Current training included Arbitration/consensus, MDT's (multi-disciplinary team meetings), interval cancer review, conferences, review of individual film reading data, PERFORMS

and CPD (Continuing Professional Development) courses, etc. These are shown in figure 3 for each group. There was no significant difference amongst the groups for undertaking different types of mammographic interpretation training.

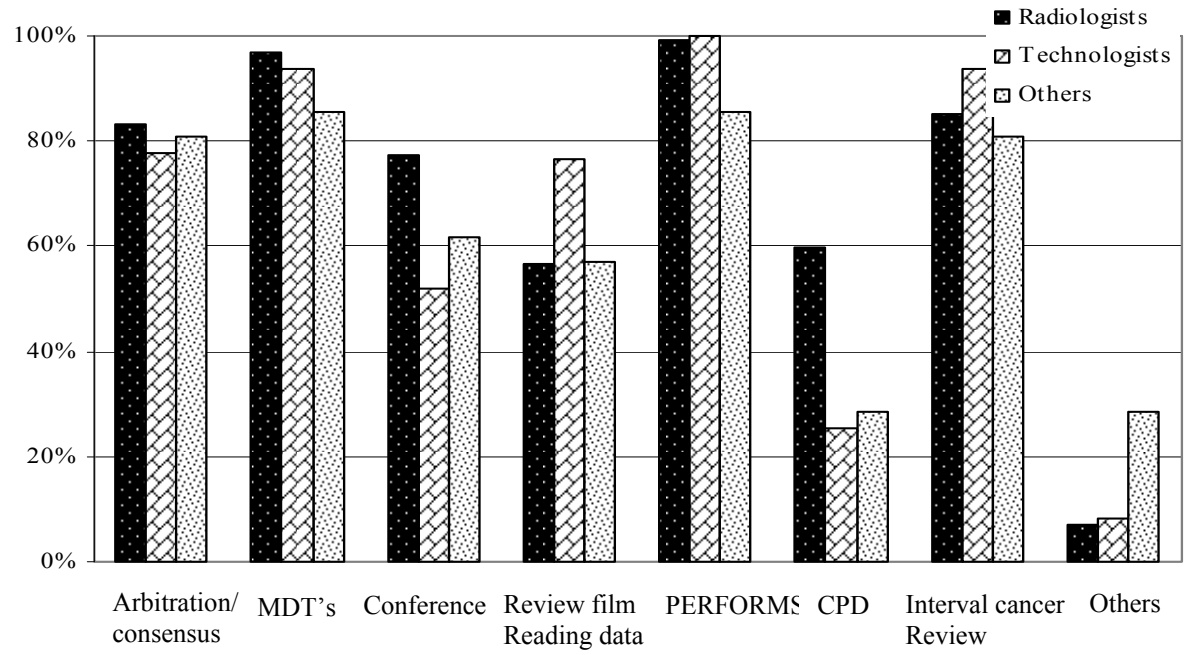

Figure 3: Undertaking different mammographic interpretation training forms profile

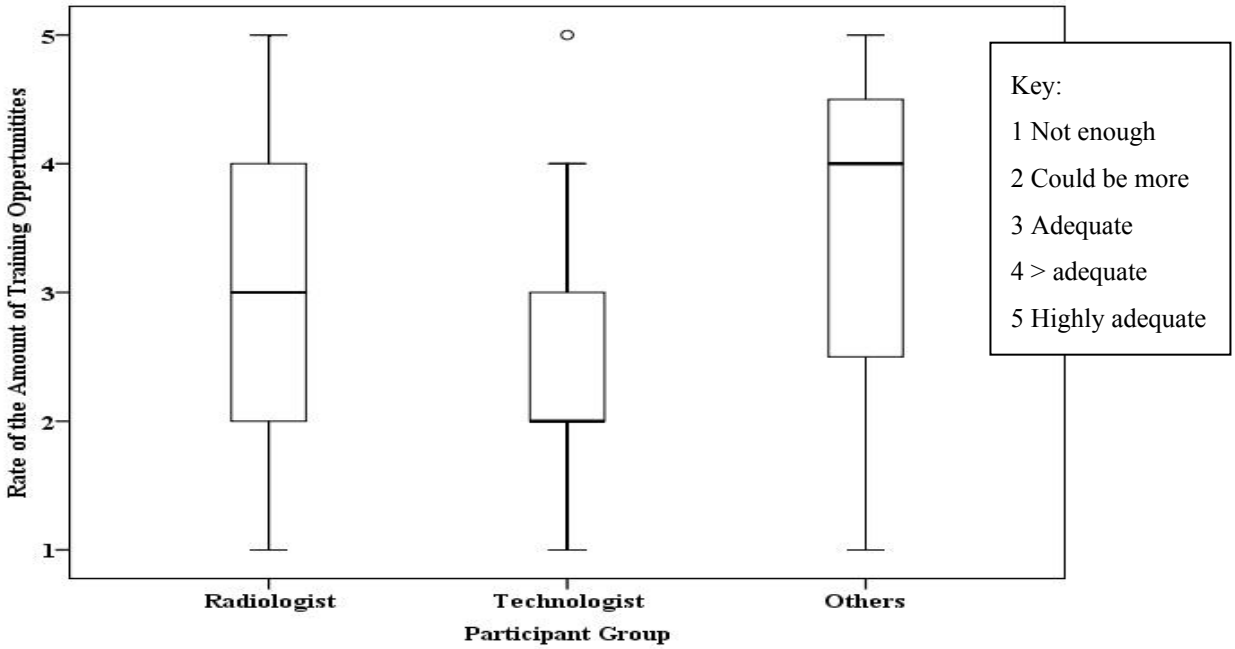

Figure 4: Distribution of mammographic interpretation training opportunity rating

It was shown that in general, 40% participants considered mammographic interpretation training opportunity "could be more" or "not enough". However, there were significant differences ($p<.05$) amongst the three groups for their rating of mammographic interpretation training opportunity. 58.2% of participants from the technologists' group considered the opportunity "could be more" or "not enough". See Figure 4 for the distribution of opportunity rating for each group.

There were 142 participants (52%) reported training-related difficulties (66 radiologist, 67 technologists, 9 others). These difficulties were then grouped into four main sections, namely; limited time, limited access to mammographic roller-viewer, limited access to digital workstation where appropriate, and other difficulties (see Figure 5). Reported other difficulties included financial issues, lack of validated training sets, lack of management support, etc.

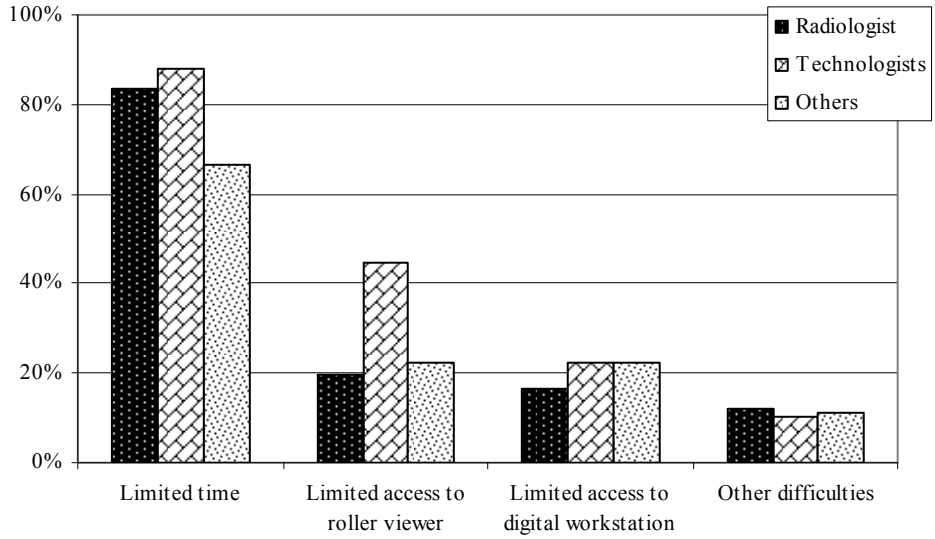

Figure 5: Training difficulty types: the percentage of participants identified training difficulties

2.2 Attitude on possible future digital training

Apart from details concerning current mammographic interpretation training, information was also sought on breast-screening readers' thoughts on possible future digital training, in particular in receiving training whenever, wherever convenient, and whatever suits the individual.

For the possible 'whatever required' training (e.g. tailored training) poll, 222 participants (81.3%) showed their strong interest. For the possible 'whenever, wherever' training poll (see Figure 6), 213 participants (78%) responded positively. Within these participants, 79 of them specified the details of when they would like to undertake such training. This included 'anytime convenient', 'a specifically allocated time', 'during general working time', 'after-work', and 'others'. Of these, 135 participants have given detailed answers on ideal places for their training (one or more answers were given), such as, 'in the breast screening centre'; 'anywhere convenient'; 'using digital workstation', and 'using home PC', etc.

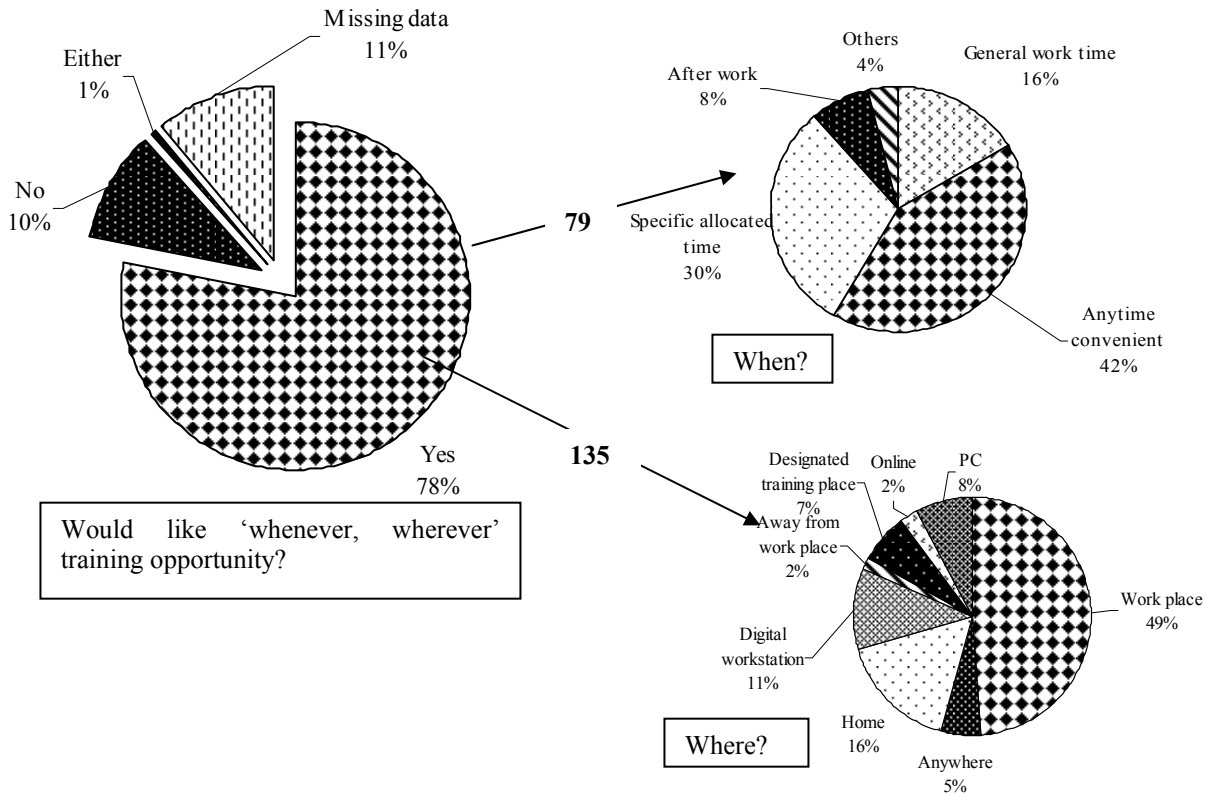

Figure 6: Attitude towards 'whenever, wherever' mammographic interpretation training

Additionally, 222 participants (81.3%) were very interested in undertaking tailored training based specifically upon data from their latest PERFORMS performance evaluation.

Furthermore, the correlation was examined between participants' experience of digital mammography and their attitude to different possible tools that could deliver digital mammographic interpretation training (i.e. digital workstation, desktop PC, laptop PC, and handheld device). Data showed that respondents' attitude plotted against their experience of digital mammography (in months). Overall, not surprisingly, a Spearman's rank correlation test indicated that there was a positive relationship between all three groups' digital mammography experience, and their attitude to using the digital workstation as a tool to deliver mammographic interpretation training ($rho(242)= 0.146$; $p<.05$. $r^2 = 0.02$)).

In terms of using other smaller displays for training purposes the results were more variable. For the technologists a positive attitude to using smaller computer displays as a possible training tool was significantly correlated with their digital mammography experience $rho(67)= 0.252$; $p<.05$. $r^2 = 0.06$ (desktop pc; figure 7a); $rho(78)= 0.327$; $p<.05$. $r^2 = 0.10$ (laptop PC; figure 7b); $rho(54)= 0.278$; $p<.05$. $r^2 = 0.07$ (handheld device; figure 7c). For the radiologists there was no significant correlation between their digital mammographic experience and attitude to using smaller displays for training purposes.

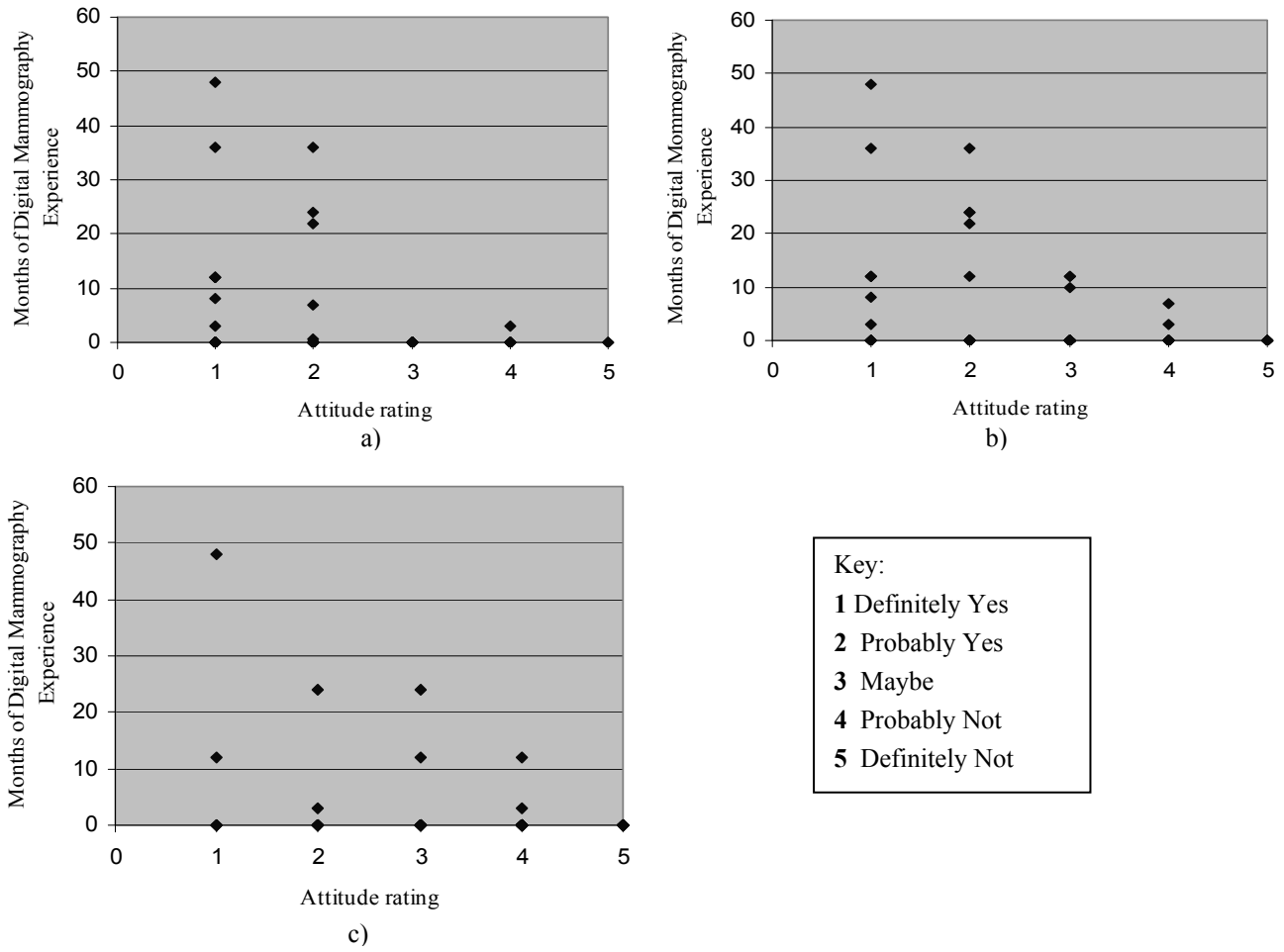

Figure 7: a) Technologists' digital experience and attitude rate on Desktop PC;
b) Technologists' digital experience and attitude rate on laptop;
c) Technologists' digital experience and attitude rate on handheld device.

3. EYE MOVEMENT STUDY

A head mounted eye tracker (ASL 504) was used to monitor the visual search behaviour of experienced radiologists as they examined a series of recent screening digital cases on a GE mammography workstation. This enabled the individuals to perform the task just as they would do in normal everyday screening, rather than performing the task in a prescribed way to suit the experimental situation.

Whilst this study is ongoing at the time of this report it is important to note how very different the observed behaviour is to that which has often been reported previously in such eye tracking tasks. An example only of one reader examining a single case is shown for illustrative purposes in Figure 8, together with corresponding times, which is taken directly from the initial eye movement record (the large cross hairs indicating the fixation location at that particular point in the recording). This figure clearly demonstrates that the overall examination time was less than 30 seconds. Initially the two medio-lateral views (MLOs) were examined in full (5s), followed by zooming in to examine the corresponding upper MLO quadrants (for 3s) and then the lower MLO quadrants (4s). This was followed by full MLO viewing again (2s) then switching to the cranio-caudal (CC) view for both breasts (6s) followed by upper (2s) and lower CC (2s) quadrants then the full CC view (1s) again. This record of visual search behaviour serves to illustrate how experienced observers readily utilise the different digital controls of the workstation to examine in detail the image areas of interest.

4. GENERAL DISCUSSION

This study was completed by four semi-structured interviews with groups of experienced breast screening film readers, along with a wide ranging questionnaire. The questionnaire had an unusually high response rate (45.5%) and these covered all the different professions in breast cancer screening in the UK. It provided insight into the current and potential future mammographic interpretation training in the UK. The majority of respondents were consultant radiologists (57%) with advanced practitioners making up 29%. Overall, 38% had had some experience of digital mammography: 10% having less than six months experience with the majority (21%) having between 6 and 24 months experience. Some 7% had more than 24 months experience. This broadly reflects the gradual introduction of digital mammography into the UK. Considering the data in terms of the three main groupings of respondents then over 80% took part in arbitration/consensus meetings on specific cases, interval cancer reviews and multi-disciplinary meetings where all professionals involved (including pathologists and surgeons) meet to discuss specific cases on a regular basis. Virtually all screeners took part in the PERFPORMS scheme. Review film reading and conference attendance was seen variably by over 50% to be important. Continuing professional development (CPD) was rated as more important by the radiologists than the other groups. Some 40% of respondents considered the amount of current training be less than ideal, with the main difficulties classified as 'limited time' and 'limited access to image viewing facilities'. The technologists in particular indicated less current opportunities for training than did the other professional groups.

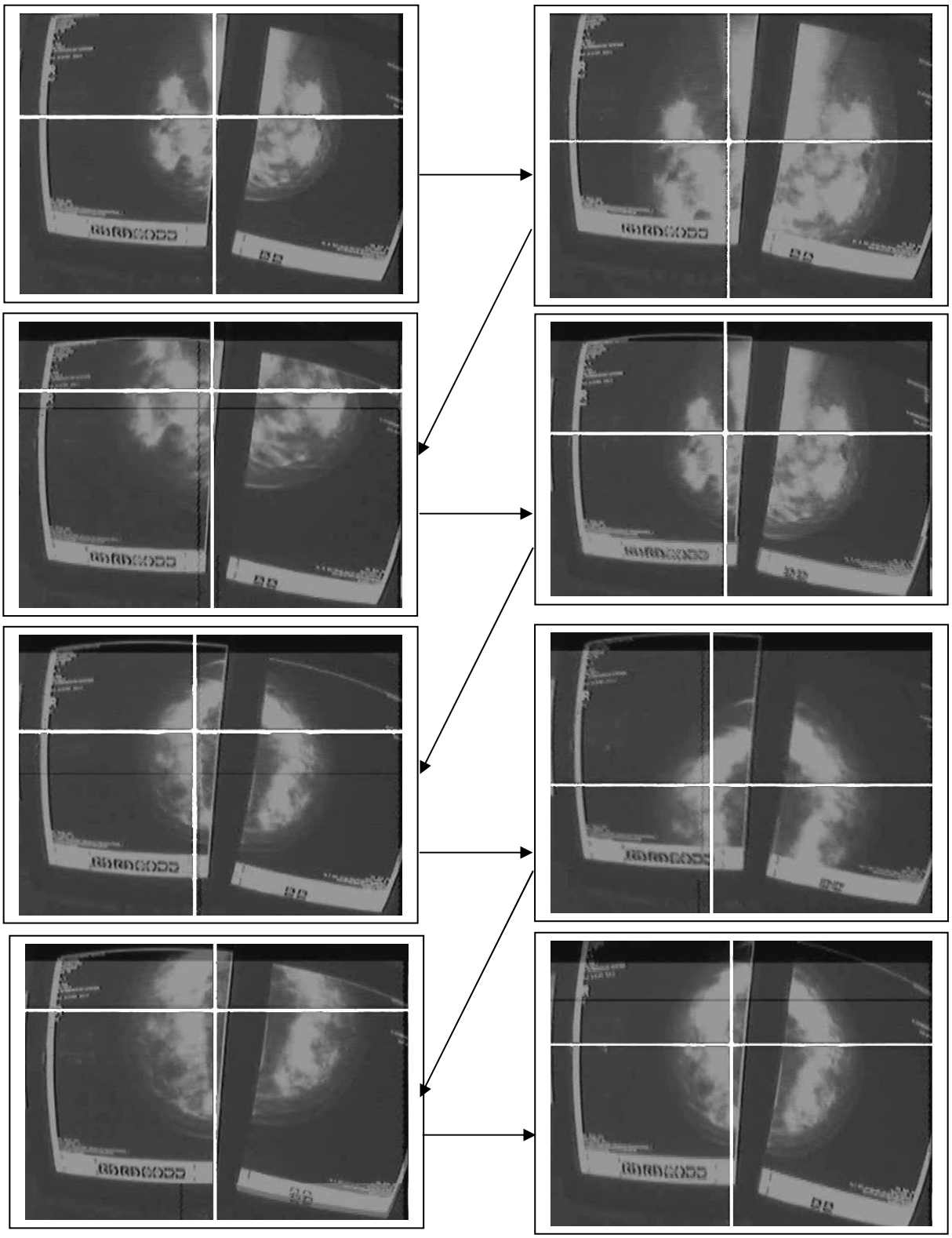

Figure 8: Example of a radiologist examining one case showing the image manipulation sequence together with his eye movement fixations

With regard to future digital training, some 81.3% of participants showed their strong interest in receiving tailored training on the basis of their individual recent PERFORMS scheme outcome and additionally 78% of participants responded positively towards having training whenever and wherever convenient. The questionnaire results show a positive attitude to the use of small computer devices for further training. There may be relatively low confidence on training delivered on small PDA. For the technologists the data showed that a positive attitude to the use of smaller computer displays as a possible training tool was significantly correlated with their digital mammography experience, which suggested that such difficulties may be overcome with increasing digital mammography experience.

Data from the visual search study have begun to illustrate that in real life trying to model visually the rapid manipulation processes of experienced radiologists when examining large digital mammograms is challenging. This has commonalities to the representation of the inspection and manipulation of other digital images [6] and differs to carefully controlled experimental studies of examining digital mammography images [7].

5. CONCLUSION

The gradual introduction of digital mammography opens up the new opportunity of delivering mammographic interpretation training. An initial research investigation into the current situation of mammographic interpretation training in the UK identified the difficulties of training availability, which could be due to the high UK screening workload. A positive attitude to use some potential digital displays as a technology for delivering 3W ('whatever required, whenever, wherever') mammographic interpretation training was found. It also showed that technologists were very supportive of the potential of using different types of computer displays (e.g. PC, laptop, handheld devices) for delivering future mammographic interpretation training; however, radiologists were more reserved. The possible reason could be they did not divorce training from actual making screening identification decisions. On purpose of supporting design such training, a study of radiologists' visual search behaviour in digital screening was carried out. Recording eye movement is an important way to understand how these observers interact with images on digital workstations and other devices. Doing this in a real life situation indicates the sheer complexity of image manipulation that radiologists rapidly and readily use which raises issues of how to represent and visualise such image inspection.

6. ACKNOWLEDGEMENTS

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REFERENCES

[1] World Health Organization, "Cancer", Fact sheet 297, (2006). [Accessed: 12th Jan, 2009].
[2] Patnick, J., editor. "One vision. NHS Breast Screening Programme Annual Review 2005", NHS Cancer Screening Programmes, (2005).
[3] NHSBSP, "Quality Assurance Guidelines for Breast Cancer Screening Radiology", NHSBSP Pub. No. 59, (2005).
[4] "The Cancer Reform Strategy", Department of Health, (2007). [Accessed: 8th Jan, 2009].
[5] Chen, Y., Gale, A.G., Scott, H., "Mammographic interpretation training: how useful is handheld technology?", Proc. SPIE Vol. 6917, 691712 (2008).
[6] Phillips, P.W., Manning, D.J., Donovan, T., Crawford, T. and Higham, S. "A Software Framework for Diagnostic Medical Image Perception with Feedback, and a Novel Perception Visualisation Technique," Proc. SPIE Vol. 5749, 572-580 (2005).
[7] Nodine, C.F., Mello-Thoms, C., Weinstein, S.P., *et al*. "Blinded Review of Retrospectively Visible Unreported Breast Cancers: An Eye-Position Analysis", Radiology, 221,122-129 (2001).