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Skill Acquisition in Skin Cancer Detection

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Summary. Previous research has shown that the ability to detect potentially dangerous skin lesions is not improved by viewing a pamphlet describing the characteristic features of such lesions. A different approach to improving this skill was investigated in this study. One hundred student recruits were tested to investigate the effect of practice at distinguishing between dangerous and nondangerous skin lesions. Around 30 minutes of such practice, viewing 360 pictures of skin lesions, provided a significant advantage in making decisions about a target set of dangerous and nondangerous lesions, compared to no practice or practice with a filler task. Viewing a skin cancer pamphlet for five minutes at the beginning of the experiment made no difference to the speed or accuracy of decisions regarding the test lesions. The results are interpreted as evidence for a form of implicit learning of a skin cancer detection skill, a finding that is consistent with what is known of the nature of expertise in dermatologists. The results also point to the ineffectiveness of pamphlets to engender such expertise in the general public.

Australia has the highest rate of skin cancer in the world, being around four times that of the USA, Canada and the United Kingdom (Cancer Council Victoria, 2008). In a report produced by the Australian Institute of Health and Welfare, it was estimated that approximately one in two Australians will develop skin cancer at some point in their lives (van der Hoek, 2000). As a result, Australians have been targeted by a number of skin cancer control programs, the most prominent of these being Sunsmart (www.cancer.org.au/cancersmartlifestyle/SunSmart.htm) and Slip! Slop! Slap! (www.cancer.org.au/cancersmartlifestyle/SunSmart/Campaignsandevents/SlipSlopSlap.htm). These health campaigns were aimed at promoting public awareness of the dangers of sun exposure, whilst reducing the incidence of mortality by improving the rate of early detection for cancerous skin lesions. As is the case with most forms of cancer, time is of the essence. The sooner a diagnosis is made and treatment administered, the greater the probability that a complete recovery will be made. Therefore, the emphasis of cancer control programs is on improving the rate of early detection by encouraging members of the public to undertake frequent self examinations and medical checkups.

Some discernible progress has been made in the wake of public education programs and it is now reported that 60% of the Australian public perform frequent self-examinations (Australian Bureau of Statistics, 2000). The downside to this outcome is that the same publications encouraging individuals to perform skin checks, may not actually have any effect upon the individuals' ability to do so. Van der Zwan, Matthews, and Brooks (2001) examined the ability of individuals to identify cancerous skin lesions. They reported that the majority of people tested were unable to make a clear discrimination between what is and what is not a potentially dangerous skin lesion. The participant sample taken was representative of four different groups: members of the general public, trainee nurses, registered nurses and expert dermatologists. The first two groups received a cancer foundation pamphlet to study before commencing training. The third group attended a training program for a week and were given a manual to work through over the period of a year. Dermatologists were not provided with any additional training. As might be expected, the dermatologists performed the task of discriminating between dangerous and nondangerous skin lesions with a high degree of accuracy (90-95%). The other three groups, however, were not nearly as capable and performed this task with a mean accuracy rating of 50%, namely, no greater than chance. Similarly, Mickler, Rodrigue, and Lescano (1999) reported that, in preparing people to visually discriminate cancerous and noncancerous skin lesions, reading pamphlets produced by the Skin Cancer Foundation (USA) provided no significant advantage compared to not reading the pamphlets (i.e, a wait-list control condition). Thus, print resources that describe the common features of skin cancers appear to be inadequate for training people to detect skin cancers.

Since most individuals do not possess the skill required to recognise a potentially harmful skin lesion, there is a danger in developing an over reliance on one's own self diagnosis. This then raises the question of how best to present information regarding skin cancer to the general public so as to provide individuals with the ability to more accurately detect a potentially harmful skin lesion.

In the task of detecting cancerous skin lesions, no single group outperforms dermatologists. Dermatologists have proven with great consistency their overall superior performance compared to not only members of the general public, but also compared to general practitioners (Ramsay & Fox, 1981) and registered nurses (Van der Zwan, *et al*., 2001). It is perhaps obvious that the superior performance of dermatologists is a direct consequence of their specialist role in examining and diagnosing skin disorders. Nonetheless, this statement does not sufficiently explain how their expert skill in detecting skin cancer has been attained. There is a need to identify how the specific processes brought about by training and experience integrate to enable the dermatologist's skilled performance.

One possible strategy for examining the relationship between training and performance is to ask dermatologists to explain the various processes that contribute to their skilled performance. As it happens, many experts are unable to provide an adequate explanation for what it is they do. One by-product of spending many years practicing a task is that it renders inscrutable to both performer and observer the very knowledge that underlies performance (Speelman, 1998). The expert therefore, may only be capable of providing a vague account of how they perform an activity within their skill domain. While this may seem extraordinary to the observer, according to theories of skill acquisition, the development of expertise is simply the product of an inherent cognitive mechanism designed to promote efficient human learning.

Theories of skill acquisition characterize expert performance as the activation of specific responses by particular stimulus conditions (Anderson, 1982, 1993). For instance, chess experts have reported being able to “see” potential moves in specific chess configurations (Charness, 1991). Medical practitioners can make an “on the spot” diagnosis when presented with a patient’s clinical information (Ericsson & Kintsch, 1995) and radiologists can make accurate analyses of disorders by studying x-ray images (Lesgold, Glaser, Rubinson, Klopfer, Feltovich & Wang, 1988). Each of these experts is able to obtain critical information required to form a diagnosis from merely glancing at the presenting stimuli.

Numerous studies conducted on expertise have demonstrated that one of the main distinctions between experts and novices is that experts have the ability to perceive features in presenting stimuli that are not apparent to the novice (Chase & Simon, 1973). Similarly, the aforementioned study by Van der Zwan, *et al*. (2001) regarded the development of expertise in dermatology to derive from an ability to recognize features in cancerous lesions that novices were unable to detect. This was thought to originate from the advanced perceptual abilities of dermatologists. As a result, the researchers were concerned with the particular features of cancerous lesions that might signal the presence of malignancy. In capturing the essence of expertise in dermatology, their ultimate aim was to catalogue these features in a way that might illustrate the process of discriminating between benign and malignant stimuli. However, the relevant literature relating to expertise suggests that this endeavour may be misguided.

Firstly, while it is true that experts and novices do perceive stimuli in different ways, the reason for this may be more general than presumed by Van der Zwan, *et al*. (2001). Theories of skill acquisition portray this ability as the consequence of many years of practice and experience within a single domain (Anderson, 1982). Thus, it is not a superior perceptual ability that underlies the development of expertise in dermatology, but rather the "on the job" experience gained in working within a professional capacity.

Secondly, Van der Zwan, *et al*. (2001) assumed that the diagnostic reasoning of dermatologists was formed through a feature-by-feature analysis of stimuli. This assumption is based on an "independent cues" model of expertise, whereby knowledge of the diagnostic features of cancerous lesions forms the basis of skilled performance in dermatology (Kellogg & Bourne, 1989). Research investigating the development of expertise in dermatology, however, has refuted this model of expertise (Norman, Rosenthal, Brooks, Allen & Muzzin, 1989). Norman, *et al*. found that when a dermatologist inspected a suspicious skin lesion, it was usually judged as a whole without regard to individual features. In particular, it is the visual cue of a skin lesion that leads a dermatologist to make an automatic diagnosis without requiring further processing.

The diagnostic processes utilised by dermatologists tend to defy traditional disciplines of medicine as they rely almost exclusively on visual perception to distinguish between benign and malignant skin lesions. In this respect, expertise in dermatology may be more closely allied with expertise in radiology and histology than with other medical disciplines (Norman, *et al*., 1989). Studies of expertise in radiology have indicated that radiologists process slides automatically and within a single eye-fixation (Kundel & Nodine, 1975; Christensen, Murray, Holland, Reynolds, Landay, & Moore, 1981). Kundel and Nodine (1975) observed that experienced radiologists were able to detect, with 70% accuracy, the major pathological features of an X-ray film within seconds. Dermatologists, too, have been reported to exhibit this type of reflexive reaction in response to presenting stimuli (Norman, *et al*., 1989).

One of the reasons that experts can perform certain tasks so quickly and so simply, is because very little processing is actually involved. As skill develops, task performance grows faster and fewer errors are made in processing (Fitts & Posner, 1967; Anderson, 1982, 1993). It is hypothesized that the developing skill requires progressively fewer cognitive resources, which according to Huey, "frees the mind of attention to details" allowing the speedier processing of stimuli (Huey, 1968, p.104). Indeed, one of the fundamental characteristics of the developing skill is an incremental increase in speed and accuracy. According to Anderson (1982), when a specific task is practiced, a cognitive "inventory" of task-related stimuli and appropriate responses is developed. This inventory facilitates the production of an appropriate response which enables experts to respond quickly and efficiently to stimuli.

Previous research investigating the effect of skin cancer education resources have usually measured the efficacy of differing types of instructions by following up the provision of a training brochure with a discrimination task (Borland, Marks, Gibbs, & Hill, 1995; Miles & Meehan, 1995; Borland, Mee, & Meehan, 1997). Results on these types of tasks have generally indicated that brochures containing a combination of photographic and written information appear to "sensitise" individuals to make more cautious judgments of skin lesions. Although these studies have reported a general increase in the number of cancerous lesions being accurately identified as "problematic", this increase is equalled by the total number of benign lesions also identified as "problematic". Evidently, this type of training is affecting only an individual's awareness of the necessity of early detection, and fails to produce any tangible improvement in their performance. The missing link is, of course, practice.

Indeed, research investigating the effect of skin cancer educative resources has negated the efficacy of providing individuals with information such as the "ABCD of melanoma" (Borland, *et al*., 1995). Although such rudimentary training has been shown to improve the superficial knowledge held by individuals, it fails to have any real effect on the general ability to accurately discriminate between benign and malignant skin lesions.

According to studies of learning in dermatology, medical students learn to diagnose cancerous lesions through a process defined as "rapid pattern recognition" (Burge, 2004). There is a body of evidence to suggest that the type of skill acquisition associated with pattern recognition learning is highly dependent upon prior experience in the form of exposure to multiple exemplars

(Norman, *et al*., 1989). Therefore, the diagnostic reasoning associated with evaluating a skin lesion is based to a degree on resemblance to prior examples. Consequently, the most effective method for training individuals in learning to accurately identify cancerous lesions is through repetition of exemplars such as photographs or clinical slides (Burge, 2004).

Many domains of expertise appear to involve practitioners processing information in an implicit manner. That is, decisions are made without the necessity to invoke conscious mental processing. Indeed, many particularly complex tasks such as those involving pattern recognition, involve aspects that are too complicated to learn via instruction and are therefore learned through processes that are considered largely automatic, such as those associated with implicit learning (Seger, 1994).

Implicit or “tacit” learning is acquired without intention or effort. As such, it is often regarded as a function of observation and discovery, where learning is incidental rather than imposed (Seger, 1994). There is considerable evidence that rapid pattern recognition processes, such as those associated with detecting cancerous skin lesions, can be learned implicitly (Bransford, Franks, Vye, & Sherwood, 1989). This is supported by previous studies conducted on implicit pattern learning. One particular example of pattern learning involves visuospatial concepts, in which constructs have imprecise features and exemplars are formed by distorting prototypes (Seger, 1994). Studies investigating these processes have used stimuli such as dot patterns (Posner & Keele, 1968), or coloured squares within a grid (Fried & Holyoak, 1984). Through implicit learning, individuals have shown the ability to accurately discriminate between differing patterns of stimuli. Moreover, Posner and Keele (1968) found that individuals were often unable to report the rules that were adhered to in forming decisions about stimuli.

When learning is implicit, it is not necessary to provide the learner with directions on how to perform a task. This is because the knowledge required for performance is embedded directly in the learning process, rather than in any instructional guidelines that could be provided at the outset of training. Indeed, the only other factor required in addition to practice is feedback. According to

Trowbridge and Cason (1932), simple repetition of a skill will not automatically lead to improved performance. Feedback is a critical factor of learning, particularly when the proficiency of performance is based on accuracy.

According to Reber (1989), the knowledge base acquired through implicit learning can be utilized implicitly to inform decisions and solve problems about newly encountered stimuli. One critical aspect of implicit learning is that it is exceptionally flexible. This feature is of particular importance in considering the adaptation of previous knowledge to new tasks. Indeed, expertise in dermatology requires a large degree of flexibility since each instance of a presenting lesion is as unique as a human fingerprint. Producing abstractions of stimuli is a critical aspect of this process.

In conclusion, it is suggested that the provision of publications containing information on how to identify skin cancer is not an effective strategy for promoting general improvement on this task. In considering the type of training required to improve the ability of individuals in identifying skin cancer, previous studies of implicit learning should inform the development of a program. On the basis of the information presented above, an effective training program for learning to identify cancerous lesions should include the following features: 1. Training should focus on providing individuals with practice in discriminating between benign and malignant lesions (Burge, 2004); 2. Training should be extensive (Anderson, 1982), possibly involving several hundred skin lesion stimuli; 3. Training should be implicit (Reber, 1967), and may not require any instructional material to be provided at the outset; and, 4. Training should include feedback on the accuracy of each decision (Trowbridge & Cason, 1932). The current study was designed to test this proposal by comparing the effects of various experiences on the ability to discriminate dangerous from non-dangerous skin lesions. These experiences included a training program, and reading a pamphlet that outlined the features of dangerous skin lesions. It was expected that viewing the skin cancer pamphlet would have little effect on the ability to discriminate between dangerous and nondangerous skin lesions, whereas this ability would be improved by a training program with features as outlined above, compared to a similar amount of training at discriminating between unrelated stimuli (dot arrays).

Method

Design

To investigate the effects of various types of experience on the ability to make accurate discriminations between dangerous and nondangerous skin lesions, all participants undertook a pretest and a posttest. In both of these tests, participants were presented with pictures of skin lesions, and were required to make a decision as to whether or not each one was dangerous. To examine whether reading a pamphlet on dangerous skin lesions would affect the ability to detect such lesions, three groups in the experiment were asked to study a pamphlet for five minutes prior to being presented with the pretest. To test for the effects of training with skin lesions, two groups were provided with such training (Lesion Task) in between the pretest and posttest. Two other groups were provided with training on an unrelated task (Filler Task), while one other group received no training of any kind (No Task). Task type and Pamphlet/No Pamphlet were crossed in a semi-factorial manner across the groups. Table 1 specifies the treatment of the five groups in the experiment.

<Insert Table 1 here>

Participants

Participants were recruited from Edith Cowan University School of Psychology Volunteer register, comprised entirely of undergraduate psychology students. One hundred and two people volunteered for the experiment. Two participants did not respond correctly in the pretest and posttest (i.e., they pressed the wrong response keys), so their data were omitted from the analysis. Participants were randomly allocated to one of the five groups, with 20 participants per group. For participating in the experiment, each person was given a ticket in a raffle with two $50 cash prizes.

Materials

Pamphlet.

The pamphlet that was used in the Pamphlet condition was downloaded from the website of the Australasian College of Dermatologists (http://www.dermcoll.asn.au/public/a-z_of_skin-types_of_skin_cancers.asp, 2 June 2003, see Appendix). When printed, it consisted of two pages of pictures and descriptions of common forms of skin cancers.

Pretest, Posttest and Lesion Task.

The pretest, posttest and Lesion Task all involved the same task. That is, pictures of individual skin lesions were presented on a computer monitor, one at a time. Participants were required to decide whether or not each lesion was dangerous and warranted further attention. Prior to each trial, participants were presented with the following question: “Does the skin lesion in the following picture require further attention?” They were also instructed to press the key on the computer keyboard labelled “N” for a No response and the key labelled “Y” for a Yes response. To initiate each trial, participants pressed the space bar. Each trial was preceded by the instruction information, which disappeared when the space bar was pressed, and was replaced by an image of a lesion. When a response was made, the screen of instructions appeared again.

Two sets of skin lesion pictures were used in the pretest and posttest. Each set comprised 20 malignant (i.e., requiring attention) lesions (16 melanoma, 3 basel cell carcinoma, 1 squamous cell carcinoma) and 10 benign (i.e., requiring no attention) lesions. The two sets of pictures were counterbalanced across participants, group, and test so that each set was presented as the pretest for half of the participants and as the posttest for the other half of the participants. The order of presentation of lesion pictures within the pretest and posttest was random. No feedback as to the accuracy of decisions was provided to participants during the pretest or the posttest.

The Lesion Task was similar to the tasks in the pretest and posttest, except for two features: 1. 360 lesions [240 malignant (120 melanoma, 80 basal cell carcinoma, 40 squamous cell carcinoma), 120 benign] were presented to participants; and, 2. feedback as to the accuracy of participant’s decisions was provided following each trial. Feedback was of the form “Correct/Incorrect. Press Space Bar for next trial.”

The pictures of skin lesions were downloaded from a number of Cancer Society and Dermatology websites. Lesion images were selected using the following criteria: (1) the website represented a reputable medical organisation; (2) lesions were clearly labelled as malignant/dangerous or benign/nondangerous; (3) the type of malignant lesion (e.g., melanoma) was indicated. The collection of lesions used in the experiment is available upon request.

Filler Task.

The Filler Task was designed to give participants the same amount of experience at interacting with the computer as participants training with the Lesion Task. It was considered important to equate two features of the two tasks. Firstly, participants should respond in a similar manner to both tasks. Secondly, participants should practice both tasks for an equivalent amount of time. To achieve this, a task was developed that required participants to make a decision about visual stimuli that were not skin lesions, but the decision involved determining whether or not each stimulus warranted further attention. The Filler Task then was a dot counting task, with a cover story that if the number of dots on the screen was an odd number, the picture required further attention, and so the participant should respond “yes”. Otherwise, if the number of dots was an even number, no further attention was necessary, and so the correct response would be “no”. Prior to each trial, participants were presented with the following instruction: “Does the dot pattern in the following picture require further attention?” They were also instructed to press the key on the computer keyboard labelled “N” for a No response and the key labelled “Y” for a Yes response. To initiate each trial, participants pressed the space bar.

Three hundred and sixty dot patterns were constructed using a 3x3 square grid as the underlying template. The number of dots ranged from 3 to 8, inclusive. There were 240 stimuli with an odd number of dots, and 120 stimuli with an even number of dots. The order of presentation of the stimuli was random. Feedback as to the accuracy of participants’ decisions was provided following each trial.

All tasks were administered using programs generated with SuperLab Pro v.1.74 software. These programs presented the stimuli, recorded participant responses, and provided feedback. The programs were run on PowerMacintosh G3 computers, each with a 17 inch colour monitor and a standard keyboard. The '/' key on the keyboard was labelled "Y" for a Yes response. The 'z' key was labelled "N" for a No response.

Procedure

Participants were tested individually in sound proof booths. Participants in the Pamphlet condition were instructed to read the pamphlet. A period of five minutes was allowed for this task, prior to the commencement of the pretest. Participants in the No-Pamphlet condition were presented with the pretest immediately.

Participants were provided with instructions for how to perform the pretest. The participants were able to test their understanding of the test on two practice trials. The pretest comprised 30 trials and lasted approximately five minutes. At the end of the pretest, the computer prompted the participant to call the experimenter.

Following the pretest, the participants were required to perform in one of three conditions (Lesion Task, Filler Task, No Task). Participants performing the Lesion Task were informed that the task was similar to the pretest. Participants performing the Filler Task were provided with instructions on how to perform the task. Both the Lesion Task and Filler Task comprised 360 trials and required approximately 30 minutes to complete.

The No Task condition involved a waiting period of approximately 20 minutes between the pretest and the posttest. The pretext for this waiting period was that the next phase of the experiment required another set of pictures to be loaded onto the computer which took some time. Participants were provided with magazines to read during this period.

The procedure followed for the posttest was identical to the pretest except for two features: 1. a different set of pictures was presented; and, 2. no practice trials were provided.

Results

Two sets of analyses were performed on the data collected in this experiment. The first set of analyses examined the results for the Lesion Task and the Filler Task, with a view to determining whether there were practice effects on these tasks, and to what degree the Filler Task was an appropriate control condition. The second set of analyses focussed on the performance in the pretest and posttest as a function of whether participants were exposed to the skin lesion pamphlet and whether they received practice at the Lesion Task or the Filler Task.

All analyses were performed on two dependent variables, Accuracy and Reaction Time (RT). Accuracy was defined as the number of trials on which a correct decision was made. In the pretest and posttest, the accuracy data for each participant was expressed as a percentage of the total number of trials in each test (i.e., 30). In the Lesion Task and the Filler Task, Accuracy was expressed as a percentage of the number of trials within a block, where a block consisted of 10 trials.

RT reflects the time taken to respond on each trial where a correct decision was made. For each participant, a mean RT on the pretest and on the posttest was calculated. If a participant performed the Lesion Task or the Filler Task, a mean RT for each block of 10 trials was also calculated.

Lesion Task and Filler Task Performance

The data for one participant who practiced the Filler Task was lost due to a computer malfunction. This person's data on the pretest and the posttest, however, was retained, and included in subsequent analyses. Mean Accuracy and RT for the remaining participants on the Lesion Task and the Filler Task are presented in Figure 1.

<Insert Figure 1 here>

A mixed design ANOVA was conducted on the Accuracy data, with two between subjects variables (Pamphlet vs. No Pamphlet; Lesion Task vs. Filler Task), and one within subjects variable (practice). A similar analysis was performed on the RT data. In both analyses, Mauchley's test of sphericity was significant ($p < .001$). As a result, all F values involving the practice variable are reported with a Greenhouse-Geisser adjustment to the degrees of freedom.

There was an overall effect on Accuracy of task ($F_{1, 75} = 178.64$, $p < .001$, partial $\eta^2 =.70$, power = 1.00), with the Filler Task ($M = 95.00\%$, $SE = 1.00\%$) being performed more accurately than the lesion task ($M = 76.12\%$, $SE = .99\%$). There was no significant effect of pamphlet ($F_{1,75} = 3.93$, $p = .051$, partial $\eta^2 =.05$, power = .50), nor any interaction between pamphlet and task ($F_{1,75} = 1.40$, $p = .24$, partial $\eta^2 =.02$, power = .22).

As is evident from Figure 1, practice resulted in an overall improvement in the accuracy of performance ($F_{16.212, 1215.924} = 17.95$, $p < .001$, partial $\eta^2 = .19$, power = 1.00). The effects of practice and task interacted ($F_{16.212, 1215.924} = 12.09$, $p < .001$, partial $\eta^2 = .14$, power = 1.00), such that participants practicing the Filler Task ($M_{\text{block1}} = 82.98\%$, $SE_{\text{block1}} = 2.14\%$; $M_{\text{block30}} = 97.22\%$, $SE_{\text{block30}} = 1.58\%$) improved more than participants practicing the Lesion Task ($M_{\text{block1}} = 74.22\%$, $SE_{\text{block1}} = 2.11\%$; $M_{\text{block30}} = 82.00\%$, $SE_{\text{block30}} = 1.56\%$). There was also a significant interaction between practice and pamphlet ($F_{16.212, 1215.924} = 2.00$, $p = .010$, partial $\eta^2 = .03$, power = .97), with those who did not see the pamphlet at the beginning of the experiment ($M_{\text{block1}} = 78.03\%$, $SE_{\text{block1}} = 2.11\%$; $M_{\text{block30}} = 91.00\%$, $SE_{\text{block30}} = 1.56\%$) improving more over the course of practice than those who did see the pamphlet ($M_{\text{block1}} = 79.18\%$, $SE_{\text{block1}} = 2.14\%$; $M_{\text{block30}} = 88.22\%$, $SE_{\text{block30}} = 1.58\%$). The interaction between practice, task and pamphlet was not significant.

RT was not significantly affected by task ($F_{1, 75} = 2.68$, $p = .106$, partial $\eta^2 =.03$, power = .36), pamphlet ($F_{1, 75} = .34$, $p = .565$, partial $\eta^2 =.00$, power = .09) or an interaction between these two variables ($F_{1, 75} = 3.06$, $p = .085$, partial $\eta^2 =.04$, power =.41).

Figure 1 reveals some clear effects of practice on RT. These are supported by the ANOVA results, with practice leading to an overall reduction in RT ($F_{8.507, 637.992} = 46.85$, $p < .001$, partial $\eta^2 = .38$, power = 1.00). The only interaction that was significant was between practice and task ($F_{8.507, 637.992} = 2.32$, $p = .016$, partial $\eta^2 = .03$, power = .90), such that participants who practiced with the filler task ($M_{\text{block1}} = 1920ms$, $SE_{\text{block1}} = 92ms$; $M_{\text{block30}} = 1124ms$, $SE_{\text{block30}} = 47ms$)

experienced an overall greater reduction in RT than those who practiced the Lesion Task (M_{block1} = 1823*ms*, SE_{block1} = 91*ms*; M_{block30} = 1072*ms*, SE_{block30} = 46*ms*).

Pretest and Posttest Performance

A mixed design ANOVA was conducted on the Accuracy data, with two between subjects variables (Pamphlet vs. No Pamphlet; Lesion Task vs. Filler Task), and one within subjects variable (practice). A similar analysis was performed on the RT data.

There were no significant effects on Accuracy of the factors of task ($F_{2, 95}$ = 2.30, p = .106, partial η^2 =.05, power = .46), pamphlet ($F_{1, 95}$ = 1.11, p = .295, partial η^2 =.01, power = .18), or an interaction between these two variables ($F_{1, 95}$ = 1.86, p = .176, partial η^2 =.02, power = .27).

<Insert Figure 2 here>

The mean Accuracy results for the pretest and posttest are presented in Figure 2. As is evident from this figure, there were clear differences in the accuracy of performance on the pretest and posttest for the various conditions. There was an overall increase in Accuracy from the pretest ($M_{\text{pre-test}}$ = 70.77%, $SE_{\text{pre-test}}$ = 1.24%) to the posttest ($M_{\text{post-test}}$ = 77.35%, $SE_{\text{post-test}}$ = .96%; $F_{1, 95}$ = 14.24, p < .001, partial η^2 =.13, power = .96). The pattern of the increase in Accuracy was dependent on the viewing of the pamphlet ($F_{1, 95}$ = 5.36, p = .023, partial η^2 =.05, power = .63), with those who were exposed to the pamphlet ($M_{\text{pre-test}}$ = 69.09%, $SE_{\text{pre-test}}$ = 1.60%; $M_{\text{post-test}}$ = 77.68%, $SE_{\text{post-test}}$ = 1.24%) improving the accuracy of their performance by a greater amount than those who did not see the pamphlet ($M_{\text{pre-test}}$ = 73.30%, $SE_{\text{pre-test}}$ = 1.96%; $M_{\text{post-test}}$ = 76.84%, $SE_{\text{post-test}}$ = 1.52%). Improvement from pretest to posttest was also a function of what happened in between these tests ($F_{2, 95}$ = 8.02, p = .001, partial η^2 =.14, power = .95), with those who practiced the Lesion Task ($M_{\text{pre-test}}$ = 69.49%, $SE_{\text{pre-test}}$ = 1.96%; $M_{\text{post-test}}$ = 82.63%, $SE_{\text{post-test}}$ = 1.52%) improving more than those who practiced the Filler Task ($M_{\text{pre-test}}$ = 71.36%, $SE_{\text{pre-test}}$ = 1.96%; $M_{\text{post-test}}$ = 72.91%, $SE_{\text{post-test}}$ = 1.52%) and those who did not receive any practice ($M_{\text{pre-test}}$ = 72.18%, $SE_{\text{pre-test}}$ = 2.77%; $M_{\text{post-test}}$ = 75.67%, $SE_{\text{post-test}}$ = 2.15%).

A series of post hoc comparisons were performed using a Bonferroni adjustment to alpha, to compare the accuracy of performance in the posttest as a function of the task practiced and whether the pamphlet was viewed. The only comparisons that were statistically significant indicated that participants who practiced the Lesion Task after viewing the pamphlet (M = 84.07%, SE = 2.15%) were more accurate than those who practiced the Filler Task after viewing the pamphlet (M = 73.32%, SE = 2.15%) and those who practiced the Filler Task without first viewing the pamphlet (M = 72.50%, SE = 2.15%).

The only factor that had an overall effect on RT was that of task ($F_{2, 95} = 4.94$, $p = .009$, partial $\eta^2 = .09$, power = .80), with those who practiced the Filler Task (M = 1960ms, SE = 64ms) performing slower overall than those in the other two conditions (Lesion Task: M = 1680ms, SE = 64ms; No Task: M = 1683ms, SE = 90ms).

<Insert Figure 3 here>

The mean RT for the pretest and posttest are presented in Figure 3. Posttest performance (M = 2093ms, SE = 53ms) was generally faster than pretest performance (M = 1492ms, SE = 41ms) ($F_{1, 95} = 132.18$, $p < .001$, partial $\eta^2 = .58$, power = 1.00). This reduction in RT, however, was dependent on the task that was practiced in between the two tests ($F_{2, 95} = 31.42$, $p < .001$, partial $\eta^2 = .40$, power = 1.00), with practice on the Lesion Task ($M_{\text{pre-test}}$ = 2226ms, $SE_{\text{pre-test}}$ = 83ms; $M_{\text{post-test}}$ = 1134ms, $SE_{\text{post-test}}$ = 65ms) resulting in greater improvement than practice on the Filler Task ($M_{\text{pre-test}}$ = 2105ms, $SE_{\text{pre-test}}$ = 83ms; $M_{\text{post-test}}$ = 1814ms, $SE_{\text{post-test}}$ = 65ms) or no practice ($M_{\text{pre-test}}$ = 1804ms, $SE_{\text{pre-test}}$ = 118ms; $M_{\text{post-test}}$ = 1562ms, $SE_{\text{post-test}}$ = 92ms). No other interactions were significant.

Discussion

The Filler Task used in this experiment was designed as a control condition that would provide participants with a task experience that was in all respects similar to the Lesion Task, except for the stimuli to be evaluated. In this way, any performance changes between the pretest and posttest that were associated with the type of task practiced between these tests could be attributed to the stimuli evaluated only, rather than some general skill associated with additional computer experience. The analyses that involved comparisons of performance on the Lesion Task and the Filler Task indicate the extent to which the tasks provided a similar experience to participants. There was no overall difference in the average time it took participants to perform each task. There was, however, a difference in the mean accuracy to perform the tasks, with the Filler Task being performed more accurately. This reflects the fact that determining whether there is an odd or an even number of dots on the screen has an objectively correct answer that was within the capabilities of the participants to generate. Determining whether a skin lesion is dangerous or not was clearly a skill that participants practicing the lesion task were still acquiring. Practice led to an overall improvement in performance on both tasks, with decisions being made more accurately and more quickly with practice. This improvement, however, was greatest for the Filler Task. It seems safe to conclude then that, in many respects, the two tasks provided a similar experience to participants, particularly with respect to the time it took participants to respond on each trial, and also the fact that practice led to performance improvements on both tasks. Differences in performance between the two tasks can arguably be attributed to differences in the stimuli evaluated in each task.

The most interesting result in this experiment concern changes in performance from the pretest to the posttest that were associated with the various conditions. In general, performance was faster and more accurate in the posttest than in the pretest. These performance improvements, however, interacted with condition. Firstly, viewing the pamphlet resulted in a greater increase in accuracy than not seeing the pamphlet. It could be argued, however, that this merely reflects the fact that those who viewed the pamphlet were less accurate in the pretest than those who did not view the pamphlet, and so had greater room to improve. Secondly, participants who practiced the Lesion Task between the two tests improved their performance by a greater amount than those participants who practiced the Filler Task, and those participants who received no practice. Finally, the posttest performance of those participants who practiced the Lesion Task was clearly superior to the performance of participants in all other conditions, regardless of whether or not they viewed the pamphlet at the beginning of the experiment.

In summary, there were three important results in this experiment: 1. there was no clear effect of viewing the pamphlet at the beginning of the experiment on the ability to detect dangerous skin lesions; 2. practice on the Lesion Task and the Filler Task resulted in performance improvements on both of these tasks, but only practice with the Lesion Task transferred to performance on the posttest; and 3. practice with the Lesion Task resulted in a superior ability to discriminate between dangerous and nondangerous skin lesions.

Conclusions

Previous research investigating the effect of skin cancer educative resources, has cast doubt on the effectiveness of pamphlets designed to improve the ability of individuals to identify potentially dangerous skin lesions (Borland, *et al*., 1995; Miles & Meehan, 1995; Borland, *et al*., 1997). While these resources appear to promote an improvement in the general knowledge demonstrated by individuals, they fail to affect the ability of individuals to accurately identify harmful skin lesions. The strategy employed by these publications usually involves a description of the features associated with malignant lesions, such as the “ABCD of melanoma”. Since these programs have been implemented, there has been a general increase in the rate of early detection. However, the increasing number of false diagnoses also being presented would suggest that these publications are increasing only the awareness of individuals, rather than their ability.

As demonstrated by research and outlined by several theories of skill acquisition, the development of skill occurs only through extensive practice (Fitts & Posner, 1967; Anderson, 1982). Therefore, rather than attempting to teach individuals how to make an accurate diagnosis of a skin lesion, cancer control programs need to focus on developing training programs to provide individuals with practice in performing this task.

Previous studies of skill acquisition (Reber, 1967) have shown that skill in identifying specific stimulus types can be improved by providing individuals with vast amounts of relevant stimuli, and asking individuals to make a discriminative judgment on the basis of each individual stimulus. Furthermore, it is usually not necessary to provide individuals with instruction as to the method of distinguishing between stimuli. This would suggest that information such as the "ABCD of melanoma" is dispensable.

The current experiment found that thirty minutes of training with several hundred pictures of skin lesions can improve the ability to discriminate between dangerous and non-dangerous skin lesions by 12-15%. Obviously the long-term effects of such a training program were not tested in this experiment, but the results are certainly encouraging. Although this type of program is unlikely to produce budding dermatologists, any improvement in skin cancer detection would be valuable. The next step is to test the effectiveness of such a training program on members of the general public. A possible option for presenting this type of training to the public is to develop a CD-ROM program designed to present skin lesion stimuli and feedback, whilst recording measures of accuracy and response time. Such a program could provide the general public with more effective resources for improving the ability to detect skin cancers. Such a program could also improve the quality of service provided by health care workers such as nurses by improving their ability to recognise deadly skin cancers. It is important to emphasise, though, that the type of training program advocated here should be used to increase the ability to detect a potentially dangerous lesion and not necessarily the ability to detect a nondangerous lesion. Hence the aim would be to increase the likelihood that a suspect lesion is inspected by an expert, and so increase the hit rate in terms of early detection of skin cancer, rather than reduce the false alarm rate by relying on self-identification of nondangerous lesions.

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Table 1: Experiment design

Group	Pamphlet Condition	Training Condition
1	Pamphlet	Lesion Task
2	Pamphlet	Filler Task
3	Pamphlet	No Task
4	No Pamphlet	Lesion Task
5	No Pamphlet	Filler Task

Figure Captions

Figure 1: Accuracy (% correct) and Reaction Time (ms) on the Lesion Task and the Filler Task as a function of Pamphlet condition.

Figure 2: Accuracy (% correct) on the pretest and posttest (error bars represent ±1 standard error).

Figure 3: Reaction Time (ms) on the pretest and posttest (error bars represent ±1 standard error).

Figure 1

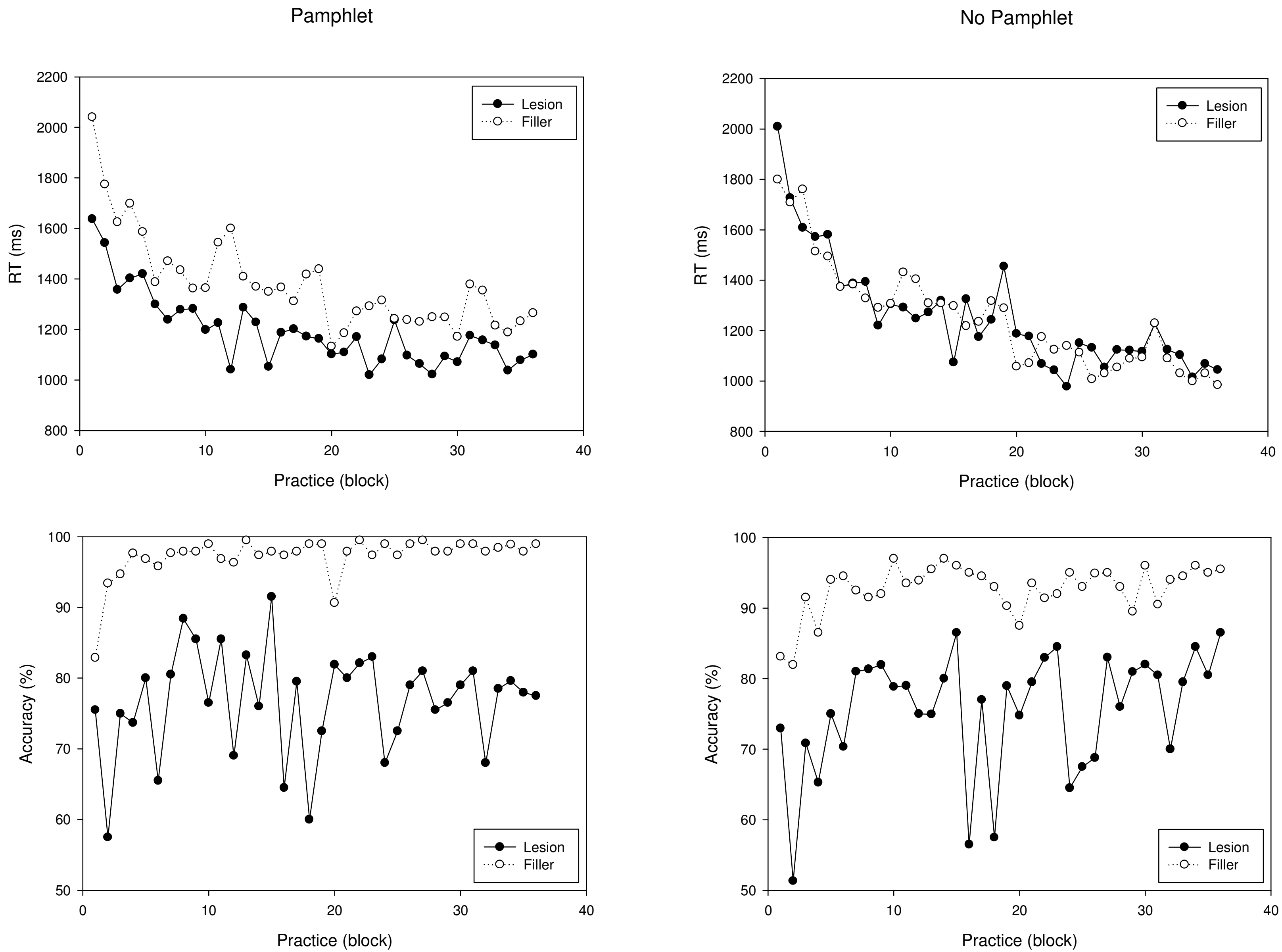

Pamphlet
No Pamphlet
RT (ms)
Accuracy (%)
Practice (block)
Lesion
Filler
2200
2000
1800
1600
1400
1200
1000
800
100
90
80
70
60
50
0
10
20
30
40

Figure 2

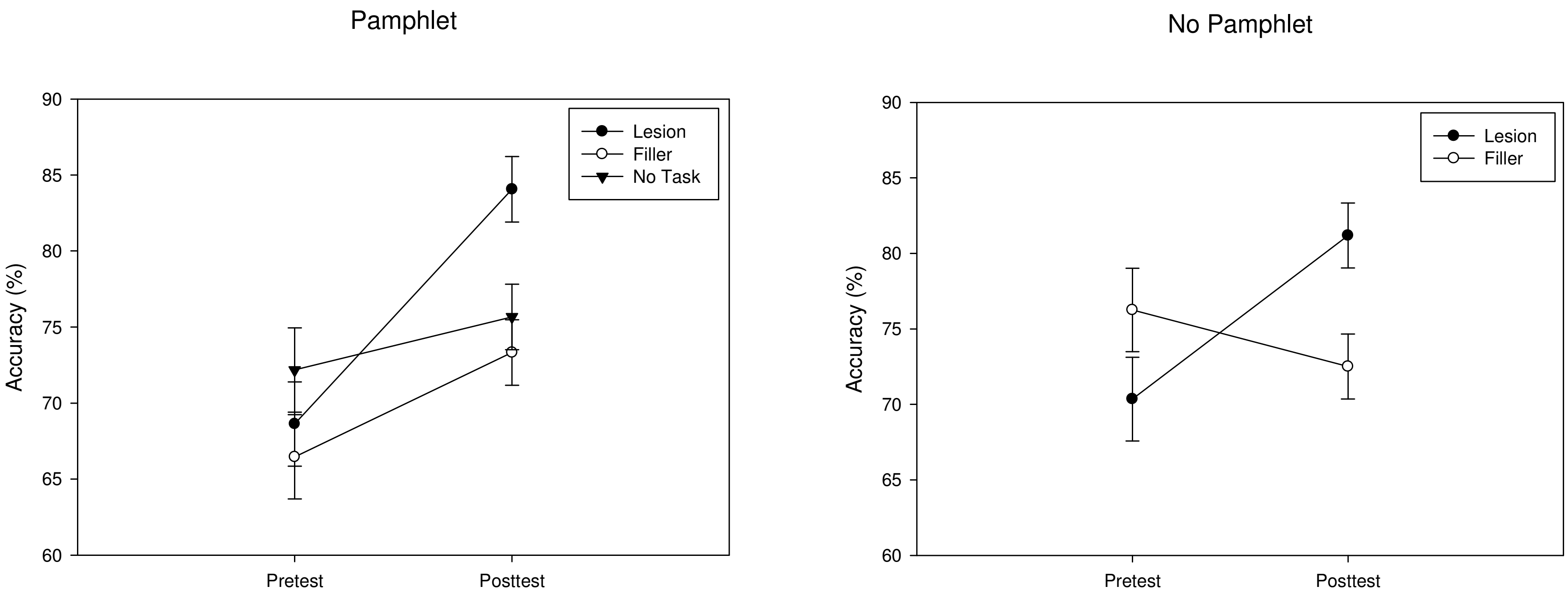
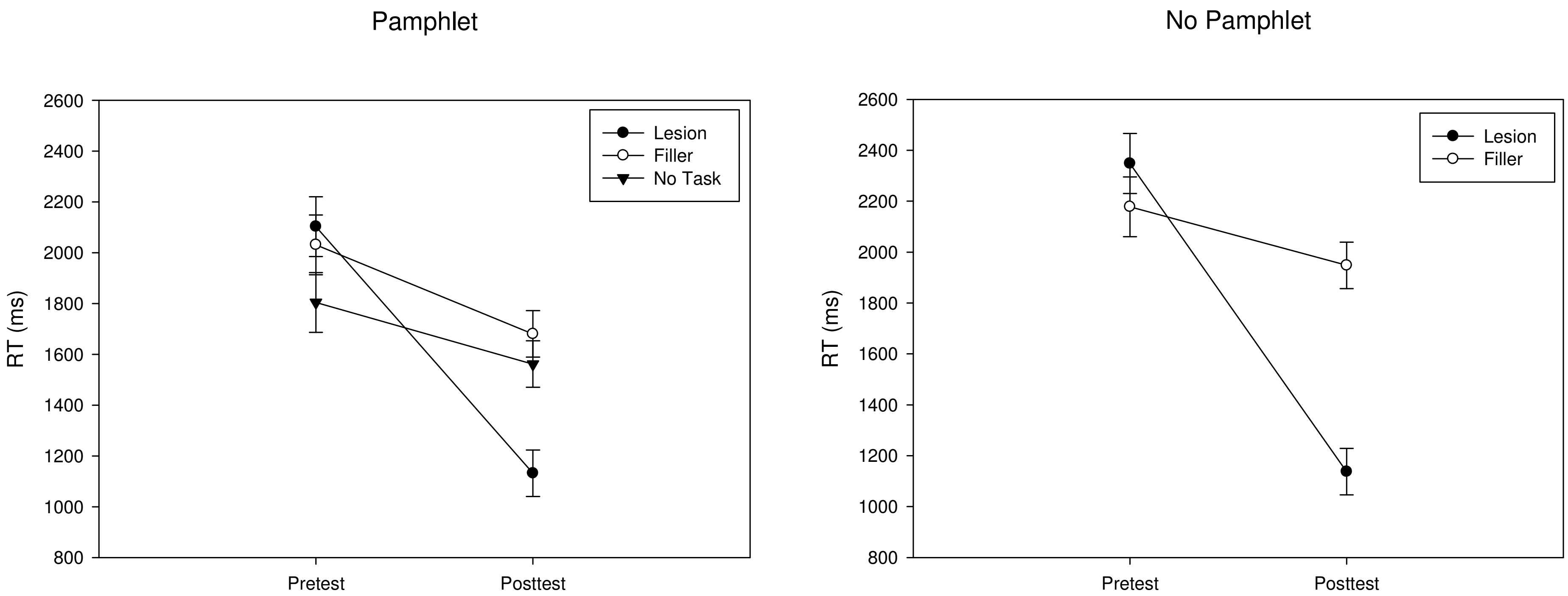

Pamphlet
No Pamphlet
Lesion
Filler
No Task
Lesion
Filler
Accuracy (%)
Accuracy (%)
90
85
80
75
70
65
60
Pretest
Posttest
Pretest
Posttest

Figure 3


Pamphlet
No Pamphlet
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
RT (ms)
Pretest
Posttest
Lesion
Filler
No Task

Appendix

AUSTRALASIAN COLLEGE OF DERMATOLOGISTS

A-Z OF SKIN: TYPES OF SKIN CANCERS

- Basal Cell Carcinoma (Bcc)
- Why You Need To Treat Bcc's
- Squamous Cell Carcinoma
- Malignant Melanoma
- Other Types Of Skin Cancers

Basal Cell Carcinoma (BCC)

BCC is the most common type of skin cancer. It grows from cells in the lower part of the upper layer of the skin. The growth tends to be quite slow, taking a period of months to years, and only rarely do these cancers spread throughout the body.

BCCs most commonly appear on the face, head, neck and trunk regions and can occur in difficult to treat areas such as near the eye and the lower legs. In short, BCCs can occur on any area of the body. In most cases they are curable and one can achieve excellent cosmetic results.

Types of BCCs

NODULAR AND NODULAR-ULCERATIVE BCCs
These are most common. They start as round, hard, red or red-grey pearly bumps, which might continue to extend and ulcerate if left untreated.

PIGMENTED BCC
This is similar to the nodular BCC but it has areas of pigmentation (darker areas). and could be confused with melanoma, a more serious cancer.

SUPERFICIAL BCC
The superficial BCC occurs mainly on the trunk as a red patch, usually up to 3cm in diameter. The edge of these tumours can be difficult to distinguish.

MORPHOEIC BCC
This looks like a firm yellow-white scar-like area and is often mistaken for one. These BCCs are often bigger than they first appear to the naked eye and may require special treatment techniques (see Mohs' Surgery).

Why You Need to Treat BCC's

Basal cell carcinoma is by far the most common form of skin cancer. Although they are rarely a threat to life, if left untreated they can grow, erode and destroy adjoining structures. Loss of whole organs, such as the nose, ear and eye, can occasionally occur. BCC's are more easily and successfully treated in their early stages. The larger a tumour the more extensive the treatment required.

SQUAMOUS CELL CARCINOMA In Situ (Bowen's Disease)

Squamous Cell Carcinoma In Situ
Bowen's Disease is a squamous cell carcinoma (SCC) which has not spread beyond the epidermis (first layer of skin). They type of skin cancer has no risk of spreading to other sites but can develop into an SCC if left untreated. They are usually red, scaly plaques and are quite common on lower legs and feet.

Squamous Cell Carcinoma

Squamous Cell Carcinoma (SCC)
The second most common form of skin cancer is the SCC. It may grow much faster than a BCC. SCC's may occasionally spread throughout the body (metastasize). SCCs usually form a scaly, quickly growing pink lump or wart-like growth, which may also break down, crust, bleed and ulcerate. They do not usually cause pain but may be tender, or cause a burning or stinging sensation. They most commonly occur on areas exposed to a lot of sunlight such as the face, ears, (bald) scalp, lips and backs of the hands.

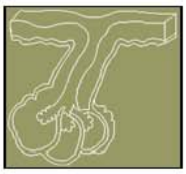
People who have had organ transplants, or medications to suppress their immune system for other reasons, are at higher risk of developing SCCs. In transplant patients SCCs are also more likely to grow quickly and spread throughout the body. This makes regular skin checks and early treatment of skin cancers extremely important for people who have had transplants or have suppressed immune systems for other reasons.

MALIGNANT MELANOMA

Malignant Melanoma
Malignant melanomas are less common than BCCs and SCCs, but a much more dangerous skin cancer. Like SCCs and BCCs, melanomas can occur on exposed skin, but they also occur on skin that is generally covered, but which has been sunburnt in the past. Malignant melanomas may spread throughout the body and cause death. Melanomas either develop from an existing mole or appear as a new brown, red or black spot which changes and grows in size.

Visit our Moles and Melanoma page to learn more.

OTHER TYPES OF SKIN CANCERS



There are some other rare forms of skin cancer. Some skin cancers originate from the skins sweat or oil glands, the nerves and other components of the skin. Cancers starting in other parts of the body such as the breast, or lung can also spread to involve the skin causing lumps, bumps or sores.

NEXT: The treatment of Skin Cancers