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A randomised test of printed educational materials about melanoma detection: Varying skin self-examination technique and visual image dose

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Abstract

Objective: Melanoma incidence and mortality rates continue to rise globally, making it essential for researchers to identify effective approaches to disseminating information to the public that improve key outcomes. This study compared two skin self-examination (SSE) educational strategies: the ABCDE (asymmetry, border irregularity, multiple colours, diameter greater than 6 mm and evolution over time) approach and the ugly duckling sign (UDS).

Design: A randomised experiment testing different presentations of SSE techniques and visual image dose.

Setting: The experiment took place at a shopping centre in the Midwest USA.

Method: Participants (N = 301) participated in the study in which they viewed brochures featuring one of two SSE training methods, ABCDE or UDS, along with a low, moderate or high dosage (frequency) of visual images.

Results: The brochures improved willingness to perform SSE and skin cancer knowledge across all groups, with brochures featuring the UDS increasing willingness to perform SSE as visual image dose increased. Sensitivity and specificity outcomes were similar across all groups, with a slight advantage found for displaying a moderate visual image dose visualising the ABCDE condition (sensitivity = .63, specificity = .79).

Conclusions: Overall, both the ABCDE and UDS approaches demonstrated utility in improving early skin cancer detection and education. A balanced presentation of typical and atypical nevi images seems to be an important consideration when presenting visual and written information about melanoma to laypersons.

Keywords

Cancer of the skin, health communication, melanoma, secondary prevention, visual perception

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Although overall cancer incidence continues to decline in the USA, melanoma incidence and mortality rates continue to increase (Siegel et al., 2014) and projections suggest the trend will continue (Rigel et al., 2010). Early identification of melanoma results in improved prognosis (Kirsner et al., 2005). The potential utility of skin self-examination (SSE) as a prevention tool has been noted (see U.S. Preventive Services Task Force, 2009), but more research is needed to increase the efficacy and adoption of the technique.

SSEs offer individuals the opportunity to identify new moles and lesions on their body, as well as identify moles and lesions that change over time. The likelihood of most lesions and nevi transforming into melanoma is low (Tsao et al., 2003), but there is a greater likelihood that atypical lesions and nevi will develop into melanoma (Tucker, 2009). As such, it is important for research to attempt to identify strategies that could lead to improvements in people's abilities to classify lesions and nevi accurately and, as a result, consult their physician or dermatologist about atypical lesions and nevi.

Some methods of visually identifying suspicious pigmented lesions, such as the ABCDE (asymmetry, border irregularity, multiple colours, diameter greater than 6 mm and evolution over time) approach (Friedman et al., 1985) and the ugly duckling sign (UDS) (Grob and Bonerandi, 1998), have been suggested for use in training individuals to perform SSE. The ABCDE approach trains individuals to observe lesions that exhibit the following attributes: Asymmetry, Border irregularity, multiple Colours, Diameter (greater than 6 mm) and Evolution over time (Abbasi et al., 2004; Friedman et al., 1985). The UDS approach trains individuals to identify lesions that stand out on their body, with the 'ugly duckling' being the one that appears most different from the other lesions (Scope et al., 2008). These training approaches both originated primarily in clinical settings but have also been promoted on web sites and printed materials intended for wider audiences (see, e.g., National Cancer Institute (NCI), 2010; Scope and Marghoob, n.d.). To date, no study has compared the two approaches, ABCDE and UDS, to determine how they influence lay knowledge, SSE intentions and efficiency of early melanoma detection. This study addresses this gap in the literature.

Visual images, skin cancer and identifying atypical nevi

Visual images – referring to photographs and illustrations rather than graphs or charts – are common in materials promoting skin cancer prevention and detection (King, 2014; McWhirter and Hoffman-Goetz, 2013, 2014). Research suggests that images are useful in health education and health communication efforts (Houts et al., 2006) and have high utility for skin cancer specifically (McWhirter and Hoffman-Goetz, 2013). While the utility of visual images has been noted, there is still a dearth of work that considers what structural and content features are more likely to influence educational material evaluation and effectiveness positively.

There have been numerous studies looking at visual images in skin cancer prevention contexts (see McWhirter and Hoffman-Goetz, 2013). Some studies found brochures with ABCDE information, with or without pictures of benign skin lesions and melanomas, improve one's ability to detect melanoma (Borland et al., 1995, 1997). Additional studies using written or visual instructions about the ABCDE/SSE method similarly find utility in that content to improve relevant outcomes (Bränström et al., 2002; Hanrahan et al., 1997; Kundu et al., 2010; Robinson et al., 2010; Robinson and Ortiz, 2009; Robinson and Turrisi, 2006). Other studies have found that visual images work to promote visual identification ability, but written instructions alone have little positive effect (Girardi et al., 2006).

Far fewer studies have examined the utility of visually conveying the UDS approach (Grob and Bonerandi, 1998) to identify atypical lesions in health education materials. One of the few studies that has tested individuals' abilities to use UDS in examining pigmented lesions assessed sensitivity differences between general dermatologists, nurses and non-clinicians and found that melanomas were more accurately identified after training (Scope et al., 2008).

Visual identification training approaches are dependent on visual information being conveyed to individuals, which suggests a need to study not only the effectiveness of either ABCDE or UDS approach at improving key outcomes but also on what visual display features might be more efficient in communicating identification information. As noted, numerous studies have looked at the utility of visual images to promote SSE and melanoma identification abilities, but few studies have tested different visual message features to determine what specific image content might be most useful for the design and dissemination of educational materials. Additionally, most studies that examine the visual health communication component of skin cancer prevention educational materials neglect to create and test information based on communication theory (McWhirter and Hoffman-Goetz, 2014).

Reviewing numerous studies examining the role of visual imagery in promoting secondary skin cancer prevention and detection, researchers have identified a variety of theoretical frameworks that could – and should – be used to create and evaluate health education materials (see McWhirter and Hoffman-Goetz, 2014). Attribute activation (see Steed, 2006) is suggested as one visual communication theory, based on cognitive theory, which might be particularly useful for explaining processing of visual images. Attribute activation theory suggests that individuals learn from visual stimuli by creating an internal mental referent, which can – in certain circumstances – provide a clearer illustration of information than if communicated verbally or in written form (textually). Similarly, exemplification theory (Zillmann, 1999, 2006) offers an explanation of how people use singular occurrences and events – exemplars – to extrapolate beyond these to populations of occurrences and events, based on identified attributes of the occurrence or event (e.g. pigmented lesions). If exemplars are representative – meaning they offer observers all mutually exclusive criteria by which to evaluate an event – people are likely to judge a singular event accurately. If exemplars are non-representative – meaning they offer a biased view of dimensions that vary among some phenomenon (e.g. typical nevi) – then people are likely to make inaccurate judgements about a singular event.

This study offers a test of exemplification theory by examining differences in two ways of presenting exemplars about atypical nevi to individuals: the ABCDE and UDS approaches. We believe it is the first study to incorporate images depicting the UDS approach to visually identifying atypical nevi into health education brochures. Outcomes of this study compare nevi identification ability of participants after viewing materials, as well as their perceptions of the quality of visual and textual information presented. The study attempts to answer two research questions:

- How does varying SSE training type and visual image dose influence perceptions of material quality and intentions to perform SSE?
- How does varying SSE training type and visual image dose influence diagnostic accuracy categorisation of nevi?

Methods

Procedure

Participants were patrons at a shopping mall in a mid-sized city in the Midwest, USA (see participant details below). In total, 301 people were recruited to participate in the study in May 2011. Large signs were posted in a high traffic area of the shopping mall advertising the study, detailing approximate length of participation (15–30 minutes), incentive ($15 mall gift card) and university/researcher affiliation. We estimate that 1 of every 25 people who walked by the study display stopped to participate. Participants who sought information about the study and agreed to participate were seated and given a paper-and-pencil pre-test. Upon completion of the pre-test, participants were given a brochure created specifically for the study. These brochures varied on two factors: training type/visual identification method (ABCDE or UDS) and visual image dose (low, moderate, or high). Participants were asked to spend 5–10 minutes reading through the pamphlet. After participants indicated they had read the pamphlet, the pamphlet was returned and a post-test administered. After post-test completion, participants were thanked and given their incentive. Procedure and study materials were all reviewed and approved by an institutional review board.

Participants

The average age for participants ($N=301$) was 36 years old ($M=35.99$ years, *median* = 31 years, standard deviation (SD) = 14.05 years). More participants were women ($n=184$, 61.1%) than men ($n=116$, 38.5%) and predominantly White ($n=226$, 75.1%); other individuals identified as Black/African American ($n=36$, 12.0%), Asian/Pacific Islander ($n=20$, 6.6%), Hispanic/Latino ($n=12$, 4.0%) or other ($n=5$, 1.7%). The sample was well educated, with over half of the participants having completed some college, attained a college degree or an advanced degree ($n=171$, 56.8%), with the rest of the sample indicating having not completed high school ($n=21$, 7.0%) or completed high school or equivalency tests ($n=108$, 35.9%). Just over half of the sample ($n=153$, 50.8%) identified as having performed SSE in the past year. The brief skin cancer risk assessment tool (BRAT; Glanz et al., 2003) was used to determine participant skin cancer risk. Overall, BRAT scores indicated low skin cancer risk among participants ($M=24.24$, $SD=12.10$). In total, 163 participants (54.2%) in this study are classified as low risk, 110 (36.5%) as moderate risk and 28 (9.3%) as high risk (Glanz et al., 2003). Condition randomisation occurred prior to data collection in the mall, ensuring that participants were randomly assigned a pamphlet. Analysis of mean comparisons and frequency counts suggested no demographic or risk category was overrepresented in any one experimental condition. No control group was used in this study as the goal was to examine the relative impact of two SSE techniques.

Stimuli

Brochures used were created specifically for this study and are provided in the Supplementary Information. Covers and written information were held constant for all brochures, only the images differed. Written messages addressed steps about performing SSE, general skin cancer statistics and one-paragraph descriptions of both the ABCDE method and UDS method of visually identifying atypical nevi. The text of the brochures was presented at an eighth-grade reading level (Flesch–Kincaid grade = 7.5).

In the ABCDE condition (Supplementary Figure 1), participants were shown one row of moles (five images) in the low-dose condition, with each image illustrating one of the dimensions of the ABCDE visual identification training method. In the moderate-dose condition, participants were shown an additional row of moles (five images), but all were typical-looking nevi to provide a juxtaposition of typical and atypical features. The high visual image dose condition in the ABCDE brochure featured an additional row of five atypical moles exemplifying the ABCDE dimensions. Images for the ABCDE condition were obtained from online sources of skin cancer information, including the National Cancer Institute's Visuals Online database (NCI, 2014).

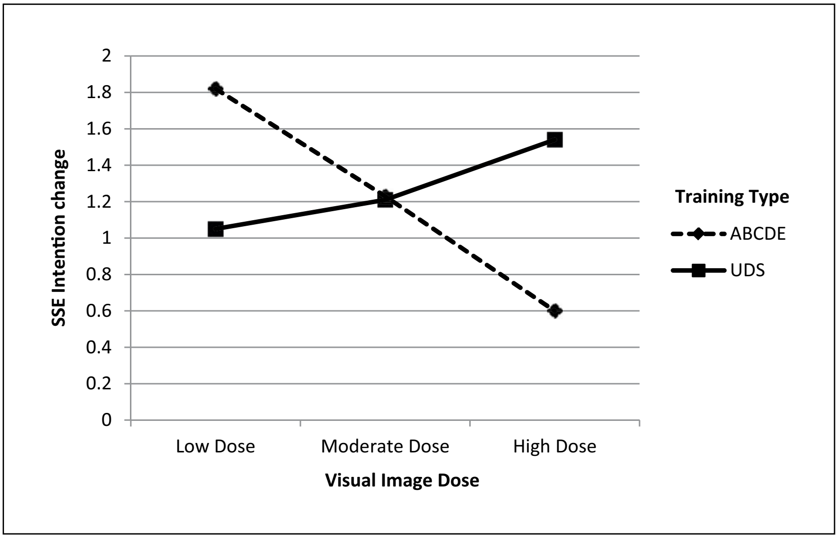

Figure 1. The interaction of training type and visual image dose in predicting SSE intention change.
SSE: skin self-examination.

Brochures in the UDS condition (Supplementary Figure 2) offered participants a series of five mole images that were taken from a patient's back, provided by the company MoleMaps (New Zealand). One of the five nevi was later determined to be melanoma. The melanoma image was highlighted for participants and participants were directed to consider the differences between that image and the other images in the row. For the moderate and high visual image dose conditions, second and third rows of five images were added, respectively.

Measures

To assess perceptions of information and brochure quality, three variables were measured: perceived informativeness (see Cho and Boster, 2008), perceived visual informativeness (King et al., 2014) and perceived attractiveness of the brochure (see Bull et al., 2001). Perceived informativeness (two items, 5-point scale, Cronbach's $\alpha=.71$) and perceived visual informativeness (seven items, 7-point scale, Cronbach's $\alpha=.93$) were found to have acceptable internal reliability. Perceived attractiveness was measured with a single item (0–5 scale). All perceptions were assessed in the post-test only.

Intentions to perform SSE were measured with two items adapted from a study on breast self-examination (Norman and Hoyle, 2004) during the pre-test and post-test. Measured on a 7-point scale with assigned values between −3 and 3, the items showed acceptable internal reliability in the pre-test, Cronbach's $\alpha=.90$, as well as the post-test, Cronbach's $\alpha=.96$. Knowledge items related to skin cancer prevention and melanoma detection were multiple-choice questions created specifically for this project. There were 16 multiple-choice questions asked during the pre-test and post-test.

The final task participants completed during the post-test was a mole identification task. In all, 40 images of moles were presented to participants, 9 of which were images of moles diagnosed as melanoma and 31 that were not images of melanoma cases. Participants were asked to circle the moles they believed to be atypical. Responses were classified appropriately as true positives, true negatives, false positives and false negatives to allow for the calculation of sensitivity and specificity. Sensitivity is the proportion of true positives identified divided by the total number of true positives and false negatives. Specificity is the proportion of true negatives identified divided by the sum of true negatives plus false positives. The mole identification task represents a measure of participant ability to identify nevi later diagnosed as melanoma. For this study, then, atypical nevi refer to moles that were clinically diagnosed as melanoma. This task produces a conservative estimate of people's sensitivity and specificity.

Listwise deletion was used when missing data were present in a given analysis, accounting for shifts in degrees of freedom in some analyses. Only 1% of the data for dependent variables were missing for all outcomes, save sensitivity and specificity. For those two variables, approximately 4% of data were missing. For perceptions of information/brochure quality, sensitivity and specificity, multivariate analysis of variance (MANOVA) procedures were used to test how experimental factors (UDS/ABCDE and mole dosage) influenced perceptions of information. Repeated-measures analyses of variance (ANOVAs) were used to test changes in SSE intentions and knowledge from the pre-test to post-test.

Results

Perceptions of information/brochure quality

Three measures of information/brochure quality were examined: perceived informativeness, perceived visual informativeness and perceived attractiveness. A two-way MANOVA, with visual identification training type (ABCDE or UDS) and visual image dose (low, moderate or high) as fixed factors, indicated main effects for training type, Pillais' Trace = .07, $F(3, 287) = 2.26$, $p = .04$, and visual image dose, Pillais' Trace = .05, $F(6, 576) = 6.94$, $p < .001$. Multivariate results suggest that both training type and visual image dose influenced one or more of the dependent variables.

The ABCDE training type was significantly related to perceived visual informativeness (see Table 1), while visual image dose was related to perceived attractiveness (see Table 2). Bonferroni post hoc tests revealed that participants in the high visual image dose condition perceived brochures as being more attractive than those in the moderate visual image dose condition. There were no statistically significant interactions between conditions.

Changes in SSE intentions and knowledge

Repeated-measures ANOVA found an increase in SSE intention across conditions after exposure to study stimuli, $F(1, 291) = 133.97$, $p < .001$. This change, however, is conditional on an interaction of visual image dose and training type, $F(2, 291) = 5.22$, $p = .006$. To examine the interaction, change scores were calculated and compared for the experimental factors. Change scores were highest for the ABCDE condition for the low visual image dose ($M_{\text{low dose}} = 1.82$, $SD_{\text{low dose}} = 2.00$), decreasing for the moderate image dose ($M_{\text{moderate dose}} = 1.23$, $SD_{\text{moderate dose}} = 1.98$) and high image dose ($M_{\text{high dose}} = 0.60$, $SD_{\text{high dose}} = 1.63$). The inverse occurred for the UDS brochures. Change scores were highest for the UDS condition for the high visual image dose ($M_{\text{high dose}} = 1.54$, $SD_{\text{high dose}} = 2.06$), decreasing for the moderate image dose ($M_{\text{moderate dose}} = 1.21$, $SD_{\text{moderate dose}} = 2.56$) and low image dose ($M_{\text{low dose}} = 1.05$, $SD_{\text{low dose}} = 1.80$). See Figure 1.

Knowledge also increased across conditions after exposure to study stimuli, $F(1, 291) = 360.91$, $p < .001$. During the pre-test, participants correctly answered between 10 and 11 questions correctly ($M = 10.69$, $SD = 2.80$) of 16 total questions. During the post-test, participants increased their

Table 1. One-way ANOVAs with perceived informativeness, perceived visual informativeness and perceived attractiveness as dependent variables and SSE training type as the independent variable.

	Levene's	ANOVA	ABCDEs	UDS
	F	*F*	*M* (*SD*)	*M* (*SD*)
Perceived informativeness	4.99*	0.85	4.38 (0.58)	4.31 (0.85)
Perceived visual informativeness	6.33*	17.72***	4.31 (0.60)	3.95 (0.86)
Perceived attractiveness	0.07	0.31	3.41 (1.34)	3.32 (1.34)

ANOVA: analysis of variance; ABCDE: asymmetry, border irregularity, multiple colours, diameter greater than 6 mm, and evolution over time; UDS: ugly duckling sign; *SD*: standard deviation.
$N = 301$.
*$p < .05$; ***$p < .001$.

Table 2. One-way ANOVAs with perceived informativeness, perceived visual informativeness and perceived attractiveness as dependent variables and visual image dose as the independent variable.

	Levene's	ANOVA	Low image dose	Moderate image dose	High image dose
	F	*F*	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Perceived informativeness	1.43	0.73	4.28 (0.84)[a]	4.41 (0.61)[a]	4.35 (0.71)[a]
Perceived visual informativeness	1.83	1.23	4.03 (0.90)[a]	4.19 (0.69)[a]	4.16 (0.67)[a]
Perceived attractiveness	2.16	3.82*	3.30 (1.49)[ab]	3.14 (1.42)[a]	3.66 (1.15)[b]

ANOVA: analysis of variance; *SD*: standard deviation.
$N = 301$.
Means that do not share superscripts are significantly different, $p < .05$. Superscripts should be read horizontally, not vertically. The only significant difference present on the chart is between the high image dose and the moderate image dose on the perceived attractiveness outcome.
*$p < .05$.

correct answers to just over 13 ($M = 13.28$, $SD = 2.91$). There were no main effects or interactions for either between-subject experimental factors, suggesting no change in knowledge specific to any condition.

Sensitivity and specificity

Using ANOVA procedures with visual type and visual image dosage as fixed factors, no main or interaction effects were found. Planned comparisons between dosage conditions revealed significant differences between training type in sensitivity at the moderate visual image dosage level, with those in the ABCDE condition having a higher sensitivity ($M = 0.63$) compared to the moderate dosage of the UDS condition ($M = 0.54$), $F(1, 283) = 4.93$, $p = .03$ (see Table 3).

The same analyses were run with specificity as the outcome. The results suggested no main or interaction effects for training type and visual image dosage level. Planned comparisons between conditions similarly found no differences (see Table 3). Across all participants, both sensitivity ($M = 0.58$, $SD = 0.18$) and specificity ($M = 0.81$, $SD = 0.12$) were similar to ranges found in other studies (see, for example, Muhn et al., 2000).

Table 3. Sensitivity and specificity means across all experimental conditions.

Training type	Visual image dose	Sensitivity	Specificity
		Mean (*SD*)	Mean (*SD*)
ABCDE	Low	0.57 (0.16)[ab]	0.80 (0.10)[a]
	Moderate	0.63 (0.16)[a]	0.79 (0.14)[a]
	High	0.59 (0.18)[ab]	0.80 (0.15)[a]
UDS	Low	0.58 (0.17)[ab]	0.79 (0.11)[a]
	Moderate	0.54 (0.20)[b]	0.82 (0.09)[a]
	High	0.57 (0.20)[ab]	0.83 (0.11)[a]

SD: standard deviation; ABCDE: asymmetry, border irregularity, multiple colours, diameter greater than 6 mm, and evolution over time; UDS: ugly duckling sign.
Means that do not share superscripts are statistically significantly different ($p < .05$). Means and superscripts should be compared vertically in this table. The only statistically significant difference present is in comparing the moderate image dose conditions in the ABCDE and UDS training conditions.

Discussion

The brochures used in this study appeared to be well received by participants and influenced change in two key outcomes: SSE intentions and knowledge. There were, however, few differences among participants based on the experimental factors (training type and visual image dose). For health education researchers and practitioners, the general findings are encouraging. SSE brochures increased knowledge and performance intention, and appear to be an efficient component of a larger education or communication intervention or campaign.

Participants scored the ABCDE brochures highest in perceived visual informativeness, which suggests enhanced perceptions of visual information quality and image-text consistency in that condition. Perceptions of brochure attractiveness were influenced by visual image dose, but inconsistently. Attractiveness, while useful in assessing health education materials (Bull et al., 2001), may be a difficult construct to incorporate into studies of skin cancer given potential perceptions of people having a negative response to the aesthetics of nevi images.

Intentions to perform SSE increased among all participants. While intentions to perform SSE increased regardless of condition, the visual image dosage factor found greater increases in intentions at each level for the UDS pamphlets, while the trend was reversed for the ABCDE brochures. Exemplification theory offers an explanation. In the ABCDE condition, participants in the low-dose condition saw one of the following: only atypical nevi, both atypical and typical nevi in the moderate condition, and an imbalance of atypical nevi in the high dosage condition. The biasing nature of the additional atypical moles may have shifted their judgement about their need to perform SSE. For example, seeing more atypical nevi may have bolstered confidence that it would be unlikely for such nevi to escape their observation in their day-to-day lives. Increased mole dosage in the UDS condition, conversely, may have made participants believe it was important to conduct SSE, as the visual identification approach promotes more nuanced judgements, as well as cognitive and affective responses, about nevi typicality.

The materials increased knowledge about SSE, skin cancer and mole identification. The experimental manipulations were largely irrelevant for enhancing knowledge measured in written form. This may have been the issue, however, as measures of written knowledge may have only been capturing knowledge gain from the texts as opposed to the texts and images. Recent work in other areas of scholarship (see Prior, 2014) has measured visual knowledge. Attempting to engage in visual knowledge measurement might be more efficient in the context of skin cancer prevention, given the visually dominant nature of training patients to perform SSE and identify atypical nevi. However, in the context of mole identification, the visual identification task completed by participants seems likely to serve as a measure of visual knowledge.

Sensitivity and specificity scores were mostly similar across conditions. The only notable difference was in the moderate visual image dose condition, with the highest sensitivity rate being located within the moderate-dose ABCDE brochure, which differed significantly from the moderate dose of the UDS brochure. The results of this study suggest, potentially, that static images may be limited in their ability to affect visual identification ability. While sensitivity and specificity scores were similar to other studies (see, for example, Muhn et al., 2000), it was surprising that the different presentations did not shift abilities. One explanation, which would be consistent with exemplification theory (see Zillmann, 2006), is that people need more time for the information presented in the pamphlets to integrate with their experience and existing knowledge. Perhaps results shift or present more marked differences with a longitudinal study design. Future research should consider that the effects of the pamphlets could be immediate only or only manifest with additional time and experience. The use of static images through dynamic delivery options, such as a mobile app that allows for corrected learning of correct/incorrect visual identification of moles, might be one way to address shortcomings of this study.

In addition to the cross-sectional nature of the study, some other limitations warrant discussion. Overall, the sample was well educated and at a moderate risk for skin cancer. The results may be different for the messaging approaches within a high-risk population. Additionally, the sample was one of convenience, so results should be replicated with a more representative and geographically diverse population. Furthermore, while all participants saw the brochures and were asked to spend 5–10 minutes reading the pamphlet, time itself is simply a proxy for attention. Actual attention may have varied considerably, potentially influencing results. Future research should track participant visual attention to determine which elements and how much gaze time, for example, influence sensitivity and specificity scores. Research moving forward this line of work should also consider differences between identification of melanomas versus non-melanomas compared to, for example, dermatologist-identified atypical moles.

Behavioural intentions and the mole identification tasks are only proxies for actual participant behaviour and skills, respectively. Future studies should attempt to link the approach and findings discussed in this article to a clinical sample of high-risk individuals. Visual image dose should be conceptually clarified in future studies. This study treated visual image dose as the total number of images shown to participants. More nuanced visual image dose manifestations should be pursued in the future to determine what dose or ratio of atypical/typical moles should be presented to participants to maximise the visual identification outcomes of interest. Finally, all the comparisons between conditions could be argued to function as active controls within this study. The goal was to make comparisons between messages that contained images, as opposed to messages that did not contain images and because of that very specific image focus a conscious decision was made not to include a text-only control group. However, having a control group added for additional comparisons would have been useful.

Conclusion

To our knowledge, this study is the first using the UDS approach to identifying atypical nevi in educational brochures. It also represents the first comparison of the relative efficacy of ABCDE and UDS. Findings were mixed, but did demonstrate a clear benefit to providing textual and visual information to the public about skin cancer. Further research is needed to determine the best visual and written strategies to present this information in brochure form, online or through interactive interfaces available on mobile devices. Specific recommendations about the number of images and preferred training type to present to audiences cannot be made based on the current results, but in concert with previous reviews considering images in health education materials (e.g. Houts et al., 2006; McWhirter and Hoffman-Goetz, 2013) health educators are encouraged to include images of atypical and typical moles when disseminating melanoma detection information to their audiences. Given the projections of melanoma rates continuing to rise for years to come, continued research is needed to attempt to curb and prevent this deadly type of skin cancer.

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