Whole body scanning as a tool for clothing sizing: Effects on women's body satisfaction

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RUNNING HEAD: WHOLE-BODY SCANNING

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Abstract

Whole-body scanning is increasingly used in the clothing industry, including in large-scale sizing surveys and virtual fitting. However, the impacts of 3D scanning on women's body satisfaction are unclear as no previous studies have investigated impacts in a controlled experiment. This experiment investigated any causal effect of 3D whole-body scanning, as used in clothing applications, on women's body satisfaction. Seventy women aged 18-35 years completed body image measures at baseline, immediately post-test, and two weeks later. At post-test relative to controls and controlling for baseline scores, women randomly allocated to the scanner condition scored significantly *higher* on Body Areas Satisfaction and significantly *lower* on Self-classified Weight, and positive effects persisted two weeks beyond the experimental session. Results suggest that whole-body scanning may improve women's body satisfaction and reduce perceived overweight relative to controls, though further research is necessary to examine the reliability of this effect and underlying mechanisms.

Key words: 3D scanning; body satisfaction; self-classified weight; virtual fitting

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Background

Whole-body scans have been used in the clothing industry since early in the 21th Century by those seeking to optimize garment fit (Istook, 2000), and the use of body scanning in clothing surveys to assess body size and shape in large numbers of volunteers means that tens of thousands of women in the UK have been exposed to 3D body scanning since 2000. 3D scanning has also become more widespread in the wider public domain, and clothing consumers in retailers in the UK have been able to access whole-body scanning when buying clothes since 2014 (McCrum, 2015). Any technology that shows women 3D images of their bodies has the potential to impact body image because scans show women views of their bodies that would not be possible through alternatives such as looking in a mirror (Grogan et al., 2013). However, the potential impacts of whole-body scanning on body satisfaction are unclear, and no studies to date have investigated the impact of whole-body scanning on women's body image in a controlled experiment. This has important implications because of the wide use of this technology in the clothing environment and the increased use of the real body and its realistic visualization in virtual fitting (Gill, 2015; Januszkiewicz, Parker, Hayes & Gill, 2017; Miell, Gill, & Vazquez, 2018). The study reported here investigates impacts of scanning on women's body satisfaction using a well-controlled experimental design where women are exposed to body scanning and impacts on body image are compared against a control group of women not exposed to body scanning.

Whole-body scanning

Whole-body scanning generates an accurate three dimensional (3D) image of the body from which body measurements can be produced (Dannen & Ter Harr, 2013; See Figure 1),

giving people unique views of their bodies in three dimensions and from all possible angles (Loker, Ashdown & Carnrite, 2008).

INSERT FIGURE 1 ABOUT HERE

The process of being whole-body scanned normally involves people undressing to their underwear, so that the scanner can capture the body surface, and being scanned in a small cubicle or curtained area. The person is then able to view a detailed 3D screen image, and may also be shown a 2D printed version of their data including body measurements (Figure 1). Scan images provide a potentially very useful means of showing people how their bodies appear to others, and may enable people to focus on body shape alone rather than other aspects of the body such as skin colour or smoothness as these are not visible on the scan image; although it is possible to view a photorealistic image, most scanners only present surface features such as in the point cloud data shown in Figure 1. These outputs are sufficient to inform product development and also create an intervention, though the impact of this intervention is not fully understood.

Impacts of scanning on body image

Existing non-experimental studies where women have been exposed to 3D scan images of their own bodies have produced mixed results. Interviews with twenty 18-40 year old UK women, Grogan, Gill, Brownbridge, Kilgariff and Whalley (2013) revealed that women found scan images informative in providing a realistic and objective view of their bodies, and were positive about how their bodies appeared on the scans. The authors concluded that the relative objectivity of the scan (as the face and other personally-identifiable features such as skin color/smoothness are not visible) enabled women to identify aspects of their own bodies that they found attractive, as well as those more negative aspects that are more common in women's discourse about their bodies (Rogers, Martz, Webb & Galloway, 2017). However,

in a follow-up study where 91 UK women aged 18-81 years reported their experiences of whole-body scanning retrospectively in response to an online questionnaire (Grogan, Gill, Brownbridge, Warnock & Armitage, 2016), women reported feeling threatened and vulnerable when seeing their bodies on the printed output and reported increased body dissatisfaction as a result of viewing their scans. In a separate study in which 14 women aged 22-45 were interviewed before and after scanning (Grogan et al, 2017), women expressed 'surprise' and 'shock' on seeing the scans, focused on perceived negative aspects of their bodies as revealed in scan images, and had noticed additional body parts to critique having seen their bodies as detailed 3D images. It is thus unclear as to whether whole-body scanning may be beneficial or harmful to women's body satisfaction, and this is clearly important in terms of its increased use and the prevalence of virtual bodies in clothing fit applications.

The Current Study

Previous studies that have investigated impacts of whole-body scanning on women's body satisfaction have been limited in using non-experimental designs where women have been asked to talk about their experiences of scanning in interviews or on questionnaires (Grogan et al., 2013; Grogan et al., 2016; Grogan et al., 2017). The current study is the first to investigate impact on body satisfaction of exposure to whole-body scanning in a controlled experimental study, and also to investigate whether any effects are maintained at short-term (two week) follow up. We restrict the sample to those women without self-reported histories of eating disorders for ethical reasons, and also because whole-body scanning is becoming increasingly accessible (Griffiths, 2014) so it is important to understand impacts in a broad range of women. Also, since young adult women may be under particular social pressure to be slender (Grogan, 2017; Murray, 2016), we restrict the sample age to young adult women aged 18-35 years. Our primary outcome variable is body satisfaction, and we compare body satisfaction (as assessed using the Multidimensional Body-Self Relations-Appearance Scales

(MBSRQ-AS; Cash, 2000) Body Areas Satisfaction sub-scale) between women exposed to body scanning and a control group of participants who are not body scanned. We also test to see whether any effects persist at two weeks beyond the experimental session.

METHOD

Design

In a 2 x 3 (condition x time) design, 70 women were allocated at random to experimental (n = 35) and control (n = 35) conditions. Women completed the MBSRQ-AS body image measure at baseline and then immediately following scanning (experimental group) or memory task (control group), and two weeks later. See Figure 2 for participant flow diagram.

INSERT FIGURE 2 ABOUT HERE

Participants

Seventy women aged 18-35 years were recruited from advertisements sent to staff and students at University of Manchester and Manchester Metropolitan University, UK. Sample size was based on finding a medium to large effect ($\eta^2 = .10$), with a power of .80 and $\alpha = .05$, requiring 35 participants in each condition, following Clark-Carter (2010). To be included in the study, women had to be between 18-35 years, with no self-reported history of eating disorders. There were no other exclusions.

Apparatus and Materials

Scanner. The TC2 KX-16 light scanner (TC2, 2011) uses Kinect IR depth sensors to generate a 3D body model that can be represented as a point cloud from which measurements can be extracted. TC2 scanners have been used extensively in clothing related surveys, such as *Size UK* and *Size USA*.

Control group distractor task. The control group completed a distractor task between completing the pre- and post-test questionnaire. This was a neutral task designed to ensure

that participants had a similar amount of contact with the experimenter in both experimental and control conditions, to make the timings for sessions for the two conditions as similar as possible (see Figure 2). To try to minimize any possible effect of this control condition on body image scores, no appearance-related words were used. Participants were asked to memorize a 20-word list: 'audience', 'basis', 'daily', 'function', 'doctor', 'council', 'record', 'extent', 'image', 'volume', 'letter', 'manner', 'member', 'subject', 'table', 'pattern', and 'private' chosen on the basis that words were not appearance-related, had between 5 and 8 letters, 2 syllables, written frequency in the English language from a minimum of 100 occurrences to a maximum of 200 written occurrences, and a mean emotional valance between 5 and 6 (Warriner et al., 2013). Participants were given five minutes to memorize the list of twenty words, and were asked to write down as many words as possible in five minutes (total time 13 minutes including instructions).

Body image questionnaire. The five sub-scales of the Multidimensional Body-Self Relations-Appearance Scales (MBSRQ-AS; Cash, 2000) were used to assess body image. The Body Areas Satisfaction subscale of the MBSRQ-AS asked participants to indicate on a 5-point Likert scale scored from 1 (very dissatisfied) to 5 (very satisfied) how satisfied they were with face, hair, lower torso, mid torso, upper torso, muscle tone, weight, height, and overall appearance. Appearance Evaluation (seven items, e.g., "I like my looks just the way they are", and "Most people would consider me good looking"), Overweight Preoccupation (four items, e.g., "I constantly worry about being or becoming fat," and "I am conscious of even small changes in my weight"), Appearance Orientation (12 items, e.g. "Before going out in public, I always notice how I look"), were all scored on a five-point Likert scale from 1 (definitely disagree) to 5 (definitely agree). Self-classified Weight was measured using two items; "I think I am" and "From looking at me, most other people would think I am" scored from 1 (very underweight) to 5 (very overweight). The MBSRQ-AS has been shown

to have good internal consistency and reliability in previous research with young women in this age range, with Cronbach's alpha of at least .73 and test-retest reliability of at least .74 on all sub-scales (Cash, 2000).

Procedure

Ethical clearance was obtained through Manchester Metropolitan University Psychology Ethics Committee and all aspects of study design and treatment of participants complied with the requirements of that committee. All participants responded to advertisements for the study posted by the second author to students and staff at University of Manchester and Manchester Metropolitan University, UK asking for volunteers to take part in "a study on body scanning and body image". There was no financial inducement for taking part, and participants received no reward of any kind for their participation. Participants were ensured of anonymity of data and freedom to withdraw with no penalty, and all gave informed consent to participation in the study. Testing took place at the body scanning laboratory at Manchester Metropolitan University. Participants were given a numerical code and the second author, using a random number generator, carried out allocation to groups. All participants were first briefed, completed consent forms, and then completed the MBSRQ-AS on *Qualtrics*.

After completing the MBSRQ-AS, participants in the experimental condition were directed to a private changing cubicle where they removed their clothes down to their underwear and dressed in a robe. They then entered the body scanner where they were scanned, by a female technician, in their underwear. They then put on the robe, returned to the changing cubicle, dressed in their own clothes, and viewed their scan on a computer screen. They were then given a paper copy of the scan and body measurements to take away with them. Following the MBSRQ-AS, participants in the control condition completed a five minute distracter task (memory test) instead of being scanned. After scanning (experimental

condition) or the distracter task (control condition), all participants completed a second MBSRQ-AS. Two weeks later, participants completed the MBSRQ-AS. All participants were debriefed; the study was explained fully, and those in the control condition were given the opportunity to attend for a body scan if they wished to do so at a later date. Participants were given contact details for the second author for any further information, and all participants were given a cut-off date in case they wanted to withdraw their data retrospectively using their numerical code. Participants were also given details of support services should they have experienced any negative impacts of scanning. 100% of participants completed the pre-tests and both post-tests.

Data Analysis

Internal reliability for MBSRQ-AS subscales at pre-test was first calculated using Cronbach's alpha. Means and standard deviations were then calculated for both groups, and MANOVA was used to compare scores on the MBSRQ-AS subscales at pre-test between experimental (scanner) and control (memory test) groups to ensure that groups did not differ significantly at baseline. This was followed by 2 x 2 ANOVAs (condition x time) to compare scores on MBSRQ-AS subscales between the two groups immediately post-scanning and two-weeks post-test; pre-test scores were used as covariates, following suggestions from Van Breukelen (2006) and Senn (2006), to ascertain whether there was a difference in the post-test repeated measures after adjusting for the pretest scores.

RESULTS

Internal Reliability

Cronbach's alpha demonstrated high internal consistency for Appearance Evaluation (.92), Appearance Orientation (.87), Body Areas Satisfaction (.79), Self-classified Weight (.78), and Overweight Preoccupation (.86) subscales.

Comparison of Experimental and Control Groups

There were no missing data and all participants completed all questions at all time points in both experimental (n = 35) and control (n = 35) groups (see Figure 2). After checking for violations of normality and other assumptions, MANOVA, with condition as the independent variable and MBSRQ-AS scores as dependent variables, was used to establish whether women in the experimental condition and control conditions differed significantly on MBSRQ-AS subscales at pre-test (Table 1).

Analysis showed no significant difference across variables, F (5,64) = .574, p = .719, η^2_p = .043, at pre-test. Univariate ANOVAs showed no significant differences at pre-test between groups on any of the dependent variables (Body Areas Satisfaction, F (1,68) = 0.523, p = .472, η^2_p = .008; Appearance Evaluation, F (1,68) = 1.84, p = .18, η^2_p = .026; Appearance Orientation, F (1,68) = 0.66, p = .417, η^2_p = .010; Self-classified Weight, F (1,68) = 1.17, p = .284, η^2_p = .017; or Overweight Preoccupation, F (1,68) = .652, p = .422, η^2_p = .010) showing that the two groups did not differ significantly at pre-test and thereby suggesting randomisation was successful.

INSERT TABLE 1 ABOUT HERE

Effects of the Intervention

Dependent variables included scores on the five subscales of the MBSRQ-AS (Body Areas Satisfaction, Appearance Evaluation, Appearance Orientation, and Self-Classified Weight). Two factor mixed (condition x time) ANCOVAs were used to compare conditions on the MBSRQ-AS subscales immediately post-scanning and two-weeks post-test, using pre-test scores as covariates. These showed no significant main effects or interactions on Appearance Evaluation, F_{time} (1, 67) = .003, p = .959, η^2_p = .000; $F_{\text{condition}}$ (1, 67) = .019, p = .891, η^2_p = 000; $F_{time\ x\ condition}$ (1, 67) = .302, p = 585, η^2_p = .004 ; Appearance Orientation, F_{time} (1, 67) = .1.64, p = 205; η^2_p = .024; $F_{condition}$ (1, 67) = .661, p = .419; η^2_p = .010; $F_{time\ x\ condition}$ (1, 67) = .041, p = 841, η^2_p = .001; or Overweight Preoccupation, F_{time} (1, 67) = .370, p = .545, η^2_p =

.005; $F_{condition}$ (1, 67) = 1.75, p = .191, η^2_p = .025; $F_{time\ x\ condition}$ (1, 67) = .205, p = .652, η^2_p = .003.

However, there was a significant main effect of condition on Body Areas Satisfaction, $F_{condition}$ (1, 67) = 6.06, p = .016, η^2_p = .083, with no significant main effect of time, F_{time} (1, 67) = .031, p = .861, η^2_p = .000, and no significant time x condition interaction, $F_{time\ x\ condition}$ (1, 67) = .198, p = .658; η^2_p = .003, meaning that satisfaction was higher in the experimental group than in the control group and that the effect persisted for two weeks post-scanning. A similar pattern of findings emerged when Self-classified Weight was the dependent variable: F_{time} (1, 67) = 3.97, p = .051, η^2_p = .056, and condition $F_{condition}$ (1, 67) = 8.04, p = .006; η^2_p = .107, with no significant time x condition interaction, $F_{time\ x\ condition}$ (1, 67) = .341, p = .561; η^2_p = .005. The effect sizes associated with the main effects for condition on Body Areas Satisfaction and Self-classified Weight were "medium" with respect to Cohen's (1988) criteria.

DISCUSSION

This study compared body satisfaction in young women exposed to their own whole-body scan images with that of controls exposed to a neutral memory task. The principal finding was that women who had been whole-body scanned scored significantly higher overall on body satisfaction as assessed through the MBSRQ-AS (Cash, 2000) Body Areas Satisfaction sub-scale following body scanning relative to controls. In the experimental group, participants reported significantly greater satisfaction with their bodies post-intervention relative to controls; they also rated their bodies as significantly more slender than controls following whole body scanning. This impact was specific to satisfaction with specific body areas and perceived weight, and did not extend to Appearance Evaluation (more general positive evaluation of appearance; e.g. "I like my looks just the way they are"; "Most people would consider me good looking"), a measure that relates to evaluation of physical

appearance in general rather than just satisfaction with the body, where there was no significant change in scores.

We also explored the possibility that the effects might change over time once women had had a chance to go away and consider the scan images. The non-significant time x condition interactions for Body Areas Satisfaction or Self-classified Weight suggest that effects persisted up to two weeks following scanning.

Findings show that body scanning may improve body satisfaction relative to controls who are not body scanned. Further work is needed to evaluate whether this finding is replicable, though findings support data from interviews with 18-40 year old UK women (Grogan et al., 2013) where women reported feeling more body-positive after the scan. Results conflict with suggestions from other UK work (Grogan et al., 2016; 2017) suggesting that scanning may be linked with reduced body satisfaction. The Grogan et al. (2016) study asked women to report retrospectively on remembered change in body satisfaction rather than using the controlled experimental design reported here, and also used a single-item body satisfaction measure as the outcome variable, so may have produced less reliable and valid data than the current study. Reasons for apparent conflict with the qualitative study reported by Grogan et al. (2017) are unclear, and it may be that women felt freer to report positive changes on body image within the anonymous context of questionnaire responses than they did when engaged in face-to-face interviews with another young woman as in the Grogan et al. (2017) study. Further work is now needed to examine whether this is a reliable finding, and will enable a better understanding of the reasons for these differences.

Although the present study provides evidence that whole-body scanning may improve body satisfaction relative to controls, and that positive effects may persist beyond the initial scanner session, it is important to highlight some potential limitations. First, we recruited women through two Universities in the UK, and only accessed women aged 18-35 years,

meaning that caution should be adopted before generalizing the findings beyond this relatively narrow sample. A second limitation concerns the longevity of the observed effects; it is unclear how long these effects might be sustained beyond two weeks. Demand characteristics may also have impacted on women's responses post-scanning; assuming they remembered how they scored pre-scan, it is possible that they may have been motivated to show us that they felt more body-positive after scanning and adjusted their responses in that direction. Another issue is that although random allocation of participants to the two groups should have ensured equity on key variables, we did not record height and weight of participants, so were unable to compare body mass index (BMI) between the two groups; it is therefore feasible that the two groups varied on BMI, which may have affected responses on outcome measures over time. Although we consider it extremely unlikely that differences in BMI between the groups would lead to the specific patterns of responses found here, it would be valuable to examine this issue in future research.

Notwithstanding the limitations highlighted above, findings are encouraging. Positive impacts from body scanning could enhance the case for its use in the clothing industry to help select garments, inform the industry, and benefit consumers, and the finding that viewing a more objective 3D image of their own body can potentially increase women's body satisfaction could be used to persuade fashion marketers to use more realistic and representative 3D bodies for marketing purposes rather than unrealistic idealised bodies.

At the very least, further work is needed to understand women's responses to body scanning. If more evidence is produced showing relatively positive impacts on body image, body scanning could be used as a potential means of improving body satisfaction. Further work is needed to replicate these findings in other samples of women, including older women, to determine the extent to which these potentially positive impacts may be generalised beyond the young women tested here. It would also be informative to investigate

whether women tend to look at the printed versions of the scan images when they take them away, and whether women use the measurement data from their scans to help them find better fitting clothing.

Given the increased availability of scanners in clothing shops and other retailers (Griffiths, 2014; McCrum, 2015), it would be interesting to run field studies to determine whether the impact of scanning observed in this study extends outside the relatively protected University laboratory environment. Also, there are currently no studies comparing impact on body satisfaction of looking in full-length mirrors with impact of scanning, and it would be useful to investigate any value added by scanning; clearly scans offer significantly more detailed information about the body, and qualitative studies suggest that women feel that scanning gives them fuller and more detailed views of their bodies than had been possible through other means such as looking in mirrors (e.g. Grogan et al., 2013; Grogan et al., 2016), but no studies have yet quantified any difference between the two methods. Finally, the precise mechanism of effect of scanning on body satisfaction and self-classified weight is unclear, and needs to be investigated directly; quantification of perceived size of particular parts of the body before and after viewing scans would be informative, eye movement studies could investigate where women look when viewing scan images, and qualitative interviews during and after scanning would assist in understanding any social comparison processes that might take place when women view scan images. This has important implications for the collection of body scan data for clothing purposes, as well as how the body is then presented within virtual fit and sales interfaces.

CONCLUSIONS

This study is the first to investigate experimentally the impact on women's body satisfaction of exposure to whole-body scanning. Clearly, more research is needed to understand more fully the mechanisms underlying changes in satisfaction and longevity of effects. However,

this small-scale experimental study suggests that exposure to this technology may impact positively on women's body image. This has important considerations as the technology for visualisation of the actual body is expanded through clothing development to the use of more realistic bodies on sales platforms.

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Table 1:

MBSRQ-AS scores for women in experimental and control groups, before and after study manipulation

		Control (N = 35)		Experimental (N = 35)	
		M	*SD*	*M*	*SD*
Appearance Evaluation	Pre-test	2.72	.644	2.92	.590
	Post-test 1	3.03	.471	2.99	.384
	Post-test 2	3.01	.590	3.04	.377
Body Areas Satisfaction	Pre-test	2.95	.620	3.05	.628
	Post-test 1	2.80	.609	3.08	.566
	Post-test 2	2.81	.586	3.15	.602
Appearance Orientation	Pre-test	3.27	.246	3.32	.217
	Post-test 1	3.47	.403	3.52	.363
	Post-test 2	3.29	.373	3.37	.325
Over-weight Preoccupation	Pre-test	3.19	.898	2.99	1.09
	Post-test 1	3.13	.821	3.19	.976
	Post-test 2	3.24	.812	3.41	1.00
Self-classified Weight	Pre-test	3.27	.573	3.11	.642
	Post-test 1	3.33	.528	3.06	.539
	Post-test 2	3.30	.597	2.90	.684

Figure 1:

Example of whole-body scan

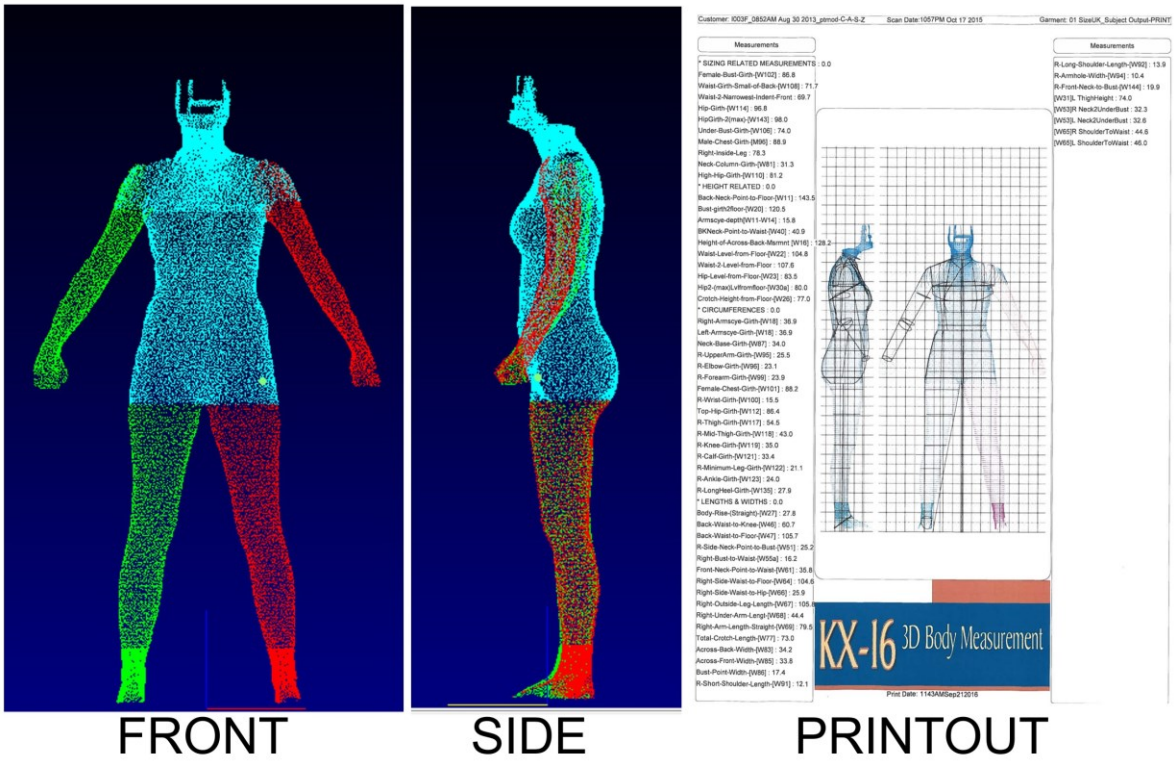

Figure 2:

Participant flow diagram