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# **Medical students and professional anatomists do not perceive gender bias within imagery featuring anatomy**

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**Running title: Sexism and Anatomical Imagery**

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**Abstract**

Previous studies suggest that, while both medical students and professional anatomists recognise the importance of gender issues and do not wish to associate with sexism, most are unaware of the possible negative aspects of sexism within anatomy (Morgan *et al.*, 2014, 2016). To further investigate these issue, we provided second year medical students at Cardiff University (n=293) and at the University of Paris Descartes, Sorbonne Paris Cité (n= 142) and professional anatomists in Europe (n= 208) with a questionnaire inviting them to address the possibility that gender factors within anatomical imagery (both historical and contemporary) hinder the dispassionate representation of anatomy. Ethical approval for the survey was obtained from the universities at both Cardiff and Paris. In the light of previous findings, the hypothesis tested was that medical students and professional anatomists do not perceive a gender bias when reflected in imagery that is based upon anatomical iconography. Our survey results support this hypothesis and suggest that most students and anatomists are unaware of the possible negative aspects of sexism within the culture of anatomy. We consequently recommend that teachers of anatomy and authors of anatomical textbooks should be aware of the possibility of adverse effects on professional matters relating to equality and diversity issues when using imagery.

**Keywords:** Anatomy, Textbooks, Attitudes, Medical Students, Anatomists, Gender, Sexism, Anatomical images.

## INTRODUCTION

In our previously published studies on gender issues and anatomy (Morgan *et al.*, 2014, 2016), we reported that, contrary to our expectations, both medical students and professional anatomists were not unduly concerned about gender imbalance in anatomical texts. Indeed, we also found that many contemporary textbooks of gross anatomy and surface anatomy lack gender neutrality, both in terms of imagery and text (Morgan *et al.*, 2014) and this is supported by the recent findings of Parker *et al.* (2017). Our surveys (Morgan *et al.*, 2014, 2016) further showed that medical students and anatomists were not generally sympathetic to gender politics, were not particularly in favour of gender matters being incorporated as part of anatomy courses, and were not worried by anatomical phraseology or concepts that had sexist overtones. All these negative aspects relating to gender issues were shown despite the respondents recognising that medicine was still male dominated. In our previous articles, however, we did not report on the reactions of medical students and professional anatomists to images that feature possible gender issues. Here, we report on the reactions of students and anatomists to a variety of anatomical images in terms of possible gender imbalance.

Anatomy as a scientific discipline has placed a high value on images since Vesalius questioned the authority of the textually-based, Galenic, scholarly tradition. His emphasis on the importance of obtaining first-hand, ocular knowledge through dissection and use of 'realist' illustrations to 'capture', and clarify, descriptions resulted in publications that became the standard for judging the pictorial representation of the body (as well as an enduring epistemic approach). Indeed,

confidence in the reliability of diagrams, maps, graphs, scientific drawings and illustrations, photographs, computer visualisations, body scans and 3D models has helped to develop a highly visual culture with respect to scientific knowledge more generally. However, the possibility that images can be used to falsify information, rather than to straightforwardly illustrate accurate factual information, has led to concerns relating to authenticity and veracity. Hopwood (2015), for example, has drawn attention to the way in which embryo illustrations by Haeckel continue to be used as standard images in textbooks, despite the information conveyed being disputed by scientists.

Furthermore, research on scientific representations suggests that, far from being straightforward *descriptive* reflections of Nature, images in science can be understood to be *prescriptive*, as objects of imitation that reveal socio-political values and theories (Daston and Galison, 1992, 2007; Latour, 1986, 1987). Our concern, as with other researchers (Anderson, 1995; Bruce *et al.*, 2015; Lacey, 1999; Lloyd, 2006), is that, if students during their medical education are exposed in an uncritical way to historical and contemporary images that perpetuate sexual stereotypes, there is a danger that this will stand in the way of ensuring that medicine is an equitable and caring profession.

Based upon our previous findings (Morgan *et al.*, 2014, 2016), our hypothesis for this study is that medical students and professional anatomists do **not** perceive a gender bias when reflected in imagery that is based upon anatomical iconography. Our investigation thus continues our study into gender imbalance within anatomy and the

extent to which social and cultural factors might interact with, and impact upon, anatomical and medical education.

## **METHODS**

We provided second-year medical students at Cardiff University and at the University of Paris Descartes, Sorbonne Paris Cité with a questionnaire inviting them to address the possibility that social/gender factors continue to hinder the dispassionate representation of anatomy. Fully completed responses were obtained from 149 students at Cardiff and 142 students at Paris. The questionnaire included 6 images featuring anatomy taken from various historical periods (Figures 1 to 6). Except for Image 1, all convey anatomical information and were originally produced, not for artistic reasons, but for research and/or didactic purposes. Note that all the images within the questionnaire were reproduced in colour and most were considered by the authors of this article to have elements that could be deemed sexist or which reflected gender bias, anatomical tradition privileging the male body as the active or dominant norm and the female body as a passive illustration of difference (see Discussion). The task required of the students was to evaluate whether or not each image displayed gender bias against the female. This was done using Likert scales from 0 (no concern or bias) to 5 (great concern or bias). The two cohorts of students in Europe were employed in order to compare culturally different groups where, although anatomy teaching involves quite different pedagogic approaches, the students nevertheless demonstrate a high regard for the clinical importance of anatomy (see Moxham and Plaisant, 2007). The questionnaire also included questions to provide personal information (age, sex, etc.), to rate their sympathy with gender politics, and to evaluate issues relating to the perception of male domination

within medicine.

To assess the perceptions of professional anatomists, 208 anatomists from Europe (particularly from the United Kingdom, France, Italy, and Spain) and the USA completed a questionnaire, either electronically (Bristol Online Survey, BOS) or by hardcopy. This questionnaire incorporated the same questions and images as those posed and displayed to the medical students. In addition, given that the anatomists were surveyed after completion of the study for the students, to increase, and refine, the findings a further set of five images were included for this group. Figures 7 to 9 show three of the images that can be published within this article without copyright restrictions. The two images that cannot be exactly reproduced for copyright reasons are both taken from *The Anatomical Basis of Medical Practice* by Becker et al. (1971). This textbook caused controversy because some of the images of females within the book were reminiscent of pinups in adult magazines and calendars. Because this anatomy textbook was considered scandalous, it was withdrawn from public distribution by the publisher. One of the figures we employed in our questionnaire shows a female torso with prominently exposed breasts and an erotic posture and gaze. The other image, on the other hand, was a straightforward view of the male chest without posturing and without display of the remaining regions of his body. Figures 10 and 11 provide outline drawings from the photographs to indicate to the reader the nature of the images.

The questionnaire was approved by the ethical committee at the Cardiff School of Biosciences in accordance with procedures laid down by Cardiff University and by the regulating authorities at the University of Paris Descartes, Sorbonne Paris Cité.

Thus, the survey was conducted anonymously, the data were strictly confidential, no vulnerable groups were included, and participation in the survey was voluntary and required written consent.

The data from the survey were entered in EXCEL spreadsheets. To compare statistically male and female responses, and also to enable comparisons between the data from Cardiff and Paris medical students, Student t-tests were employed. To compare data across the groups of students and professional anatomists with different attitudes to gender issues, ANOVA was used and a least square difference (LSD) method was undertaken to enable post-hoc analysis. For questions where percentages were calculated, chi-squared tests were undertaken.

## **FINDINGS**

Table 1 shows the numbers of respondents within the survey, together with a breakdown of the attitudes towards gender issues.

Figure 12 provides a histogram summarising the attitudes of the total sample of respondents, both professional anatomists and medical students studying in Paris and Cardiff, to the perception of gender bias in images 1 to 6 (Figures 1 to 6). It indicates that, regardless of the image, the main response was to have no concern, there being scores of 0 and 1 on the Likert scale in excess of 48% of the sample for the images. Image 1 elicited the most concern (with approximately 36% and 12% of respondents recording scores of 0 and 1 respectively and with approximately 9% scoring 5). Images 4 and 5 caused the least concern (with



approximately 78% and 69% of respondents respectively recording scores of 0 and approximately 0.9% and 3% respectively scoring 5). Comparing the total scores for the medical students ( $8.11 \pm 7.8$  SD) and for the professional anatomists ( $7.02 \pm 6.46$ ), there is a high statistical significant difference ( $p = 0.000$ ), suggesting that there is slightly less concern from the professional anatomist for the totality of images 1 – 6.

Image 1 (*Der Arzt -The Doctor-* by Ivo Saliger) was deemed to be of some concern for both Cardiff and Paris student groups (Figure 13A). Within the Cardiff student cohort, while no differences statistically were found across male and female students collectively, those students most concerned were those with positive gender attitudes ( $p = 0.00$  across female groups;  $p = 0.03$  comparing males with positive attitudes with those with neutral attitudes and  $p = 0.00$  for the remainder). Indeed, combining males and females, students with positive gender attitudes were more concerned than students expressing neutrality ( $p = 0.00$ ) who were more concerned than those with negative attitudes ( $p = 0.02$ ). Within the Paris student group, females were more concerned than males ( $p = 0.02$ ) with the male and female students with negative attitudes having least concern ( $p = 0.03$ ). For the professional anatomists (Figure 13B), no significant differences were discerned overall between female and male anatomists for Image 1. Differences were also not found for either females or males with respect to different attitudes toward gender issues. The mean score for this image across the students was  $1.97 \pm 1.73$  (SD) and for the professional anatomists  $1.69 \pm 1.78$  (SD) and these were not statistically significantly different.

Regarding Image 2 (*A Pregnant Woman, Dissected, Lateral View, with Arms Upraised, Accompanied by Separate Sections of the Body and A Seated Woman, Dissected, Holding a Dissected Baby, Accompanied by Separate Sections of the Body*, by Jacques-Fabien Gautier D'Agoty), Figure 14A shows the findings relating to the medical students. Although not as concerning as Image 1, overall the Paris students showed greater concern ( $p = 0.02$ ). No significant differences were found between males and females. Within both the Cardiff and Paris cohorts, the students with positive gender attitudes were more concerned than those with neutrality ( $p = 0.00$ ). Furthermore, in the Cardiff cohort, the students with neutral views were statistically more worried than the students with negative attitudes ( $p = 0.00$ ) but the Paris students with neutral and negative attitudes did not statistically differ. For the groups in Paris with negative attitudes, the findings suggest that they are more concerned than the groups of students with neutrality. Figure 14B displays the findings for professional anatomists with respect to Image 2. Statistically, male anatomists were more concerned than female anatomists ( $p = 0.05$ ). Furthermore, while the attitudes of female anatomists did not differ according to their views on gender issues, male anatomists with negative attitudes towards gender issues were statistically less concerned with Image 2 than were male anatomists with neutral or positive views ( $p = 0.01$ ) respectively. Statistical differences ( $p = 0.000$ ) were also found when the medical students were compared with the anatomists (mean scores  $1.17 \pm 1.46$  SD and  $0.77 \pm 1.21$  SD respectively).

For Image 3 (*Anatomical Venus*: wax model of a reclining female figure, Clemente Susini), overall no differences were found between Cardiff and Paris cohorts of students (Figure 15A). However, females in both groups were more concerned

(Paris  $p < 0.01$ , Cardiff  $p < 0.03$ ). For the students at Paris, no statistical differences were discerned across the spectrum of opinion regarding gender politics when data for males and females are combined. Statistically, females with positive and neutral attitudes were more concerned than males with neutral or negative attitudes ( $p < 0.03$ ). For the Cardiff students, those with positive attitudes likewise were more concerned students with neutral or negative views ( $p = 0.00$ ). For the professional anatomists (Figure 15B), no differences statistically were found between females and males and the female anatomists had similar views concerning Image 3 regardless of attitudes to gender issues. However, for male anatomists, while overall they did not differ from female anatomists, within the group those with positive attitudes differed significantly from those with negative attitudes, as did those with neutral views compared with negative attitudes ( $p = 0.007$ ). Furthermore, overall for Image 3, the mean score for the medical students ( $1.29 \pm 1.61$ SD) was statistically different ( $p = 0.000$ ) from the mean score for the professional anatomists ( $0.97 \pm 1.45$ SD).

Concerning Image 4 (Hunter drawings of the human gravid uterus) (Figures 16A and 16B), no statistical difference was found between Cardiff and Paris medical students overall. Furthermore, within the Cardiff and Paris cohorts, there were no statistical differences between males and females nor, in the case of the Paris cohort, generally for groups with different levels of sympathy with gender issues. However, males with positive attitudes differed significantly from males with neutrality ( $p = 0.01$ ). For the Cardiff group, students with positive attitudes (males and females together) were more concerned than students with neutral attitudes ( $p = 0.00$ ) who, in turn, were more concerned than those with negative attitudes ( $p = 0.00$ ). Within

the female sample at Cardiff, the females with positive attitudes were most concerned ( $p = 0.00$ ) (and more concerned than their Paris female counterparts). As for images 1 and 3 already reported, no statistical differences were discerned between female and male professional anatomists for Image 4. Furthermore, for both female and male anatomists, differentiation between positive, neutral and negative views of gender issues could not be established statistically for this image. In addition, statistically significant differences between the mean scores for medical students and anatomists could not be discerned ( $0.56 \pm 1.14SD$  and  $0.41 \pm 1.04SD$  respectively).

For Image 5 (Leonardo da Vinci sketch of vulva and anus), the Paris students considered this to be more sexist than did the Cardiff students overall ( $p = 0.00$ ) (Figure 17A). Furthermore, for both Paris and Cardiff student cohorts, statistical differences between the data for males and females overall could not be found. However, the Cardiff students differed from the Paris students in that, combining males and female data, differences across the spectrum of opinion for gender politics were seen ( $p < 0.01$ ). Generally, female and male students with positive attitudes were most concerned, although surprisingly the Paris females with negative attitudes were similar in their response to the females with positive attitudes. Figure 17B summarises the findings for the professional anatomists with respect to Image 5. Again, statistical differences could not be found for the data for female and male anatomists nor for differing views on gender issues. However, statistical analyses showed that the students showed more concern than the professional anatomists ( $p = 0.000$ ) with mean scores of  $0.9 \pm 1.48SD$  and  $0.55 \pm 1.1SD$  respectively.

Image 6 (von Hagen's *Reclining Pregnant Woman*) was considered to be the second most sexist image in the series according to both Cardiff and Paris groups of students (Figure 18A), there being no differences statistically between these groups overall. Furthermore, no differences were seen between males and females and within the Paris cohort, no statistical differences were found between groups having different attitudes towards gender issues. For the Cardiff students, those who had positive attitudes to gender issues were more concerned than those with neutrality ( $p=0.00$ ) as well as those who had negative attitudes ( $p = 0.00$ ). For the professional anatomists (Figure 18B), male anatomists statistically showed greater concern ( $p = 0.05$ ) and within this group those with positive attitudes toward gender issues were more concerned than those with negative views ( $p = 0.03$ ). However, statistically no differences were found between those anatomists with neutral or negative attitudes and no difference were established when mean scores from the medical students ( $1.49 \pm 1.65SD$ ) and from the professional anatomists ( $1.45 \pm 1.78SD$ ) were compared for Image 6.

Figures 19 to 21 illustrate differences between students and professional anatomists who hold positive, neutral or negative views about gender issues when, for each respondent, the scores for images 1 to 6 are added together to produce an 'overall' score. From a total possible score of 35 indicating great concern for all 6 images, most scores regardless of attitude towards gender issues ranged from 0 to 10, indicating no perception of 'sexism' in the set of images presented. High scores expressing concern (21 to 35) were only rarely found (in those with negative views in a few female students in Paris, occasionally in those with neutral views and, with the exception of female anatomists, more frequently in those with positive views

regarding gender issues. Differences between males and females and between students and anatomists were found to be not significantly different. However, the data for the UK and French students was significant ( $p < 0.05$ ). For further statistical analysis, Figure 22 shows the mean aggregate scores for images 1 to 6 for those with different views concerning gender issues. Statistically significant differences were discerned between those with positive versus neutral or negative attitudes ( $p < 0.001$ ) but not between those with neutral versus negative views.

With regard to the extra images presented to the professional anatomists for evaluation (see Figures 7 - 11 and 23 - 27), excepting for Image 8 (surface anatomy from the *Epitome of Vesalius*), none showed statistical differences between female and male anatomists. For Image 8, greater concern was expressed by the female anatomists ( $p = 0.01$ ). Comparing those anatomists who expressed positive, neutral or negative attitudes toward gender issues, no statistical differences were found for the female anatomists' assessment of the extra images. For the male anatomists, however, Image 8 (Figure 8) showed statistical differences between those with positive versus neutral and negative views ( $p = 0.004$ ). Also for Image 10 (Figure 10; Photographic depiction of surface anatomy of the female from *The Anatomical Basis of Medical Practice*), for the male anatomists statistical differences were discerned between those with positive versus neutral and negative views ( $p = 0.000$ ). Comparing Images 8 and 9 (Vesalius' surface anatomy drawings vs the Latou Dickinson anatomical mannequins known as Normman and Norma) the Vesalius images caused more concern ( $p = 0.000$ ). Additionally, comparing images 10 and 11 within the textbook of Becker et al., greater concern was expressed for the female image ( $p = 0.000$ ).

## DISCUSSION

Whilst our findings support our hypothesis, which suggests that the medical students and anatomists we surveyed were unaware of the possible negative aspects of sexism within the culture of anatomy, their reactions to the anatomical images produced some complex findings that were unexpected. It was possible to discern varying (and sometimes subtle) differences within, and between, the cohorts of medical students and the professional anatomists. Statistically, a few images prompted marked differences between the Cardiff and Paris students. Generally, however, more awareness of gender imbalance or evidence of sexism was expressed by the students as compared to the professional anatomists, with the female students from Paris conveying most concern. Nevertheless, it is clear that most images were not perceived as sexist and that most respondents were unaware of the negative aspects of sexism in anatomy relating to imagery that is based upon anatomical iconography.

As in our previous paper (Morgan *et al.*, 2014), we note the complexity of students' perceptions and attitudes to sexism within anatomical imagery. It is our contention that those differences as do exist are informed by a range of factors including race, class, ethnicity, sexuality and nationality, as well as students' perceptions of what is expected of them in their chosen profession. Perhaps the fact that the students expressed slightly more concern as compared to the anatomists might be related to changes in education and society that have enabled them to become more visually

literate or that, as the children of parents who lived through second wave feminism, they are more aware of gender issues and are consequently more idealistic.

The finding that few differences were discerned between those anatomists and medical students who showed little or no sympathy with gender issues and those who claimed moderate sympathy accords with a pattern that we previously observed (Morgan *et al.*, 2016) whereby there was a gradual shift from awareness to unawareness as one moved from positive attitudes to gender issues through to neutral attitudes and then negative attitudes. This finding could also be related to the difference between 'explicit' and 'implicit' attitudes towards equality and diversity. Parker (2016) has drawn attention to the possibility that sexist attitudes can exist at both explicit and implicit levels, explicit attitudes being consciously held and requiring intentional activation while implicit attitudes are unconscious and are activated automatically (Greenwald and Banaji, 1995; Hofmann *et al.*, 2005; Gawronski and Payne, 2010). In this context, it may be argued that, if societal attitudes and educational strategies have made it unacceptable to hold views opposed to equality and diversity, those in our survey who expressed moderate views could be echoing such sentiments while implicitly still holding views that are no different from those who express explicit negative attitudes. In a straw poll conducted with academics, we asked the question whether, on a scale of 0 to 5, they supported gender equality and also on the same scale whether they would act, or change their behaviour, to ensure gender equality. Markedly different responses were obtained, with higher (more positive) scores being recorded for the first question. This accords with our previous findings (Morgan *et al.*, 2014, 2016) where both medical students and anatomists (particularly males) expressed a reluctance to intervene in class when



sexist gender transgressions were observed. Bruce *et al.* (2015) cite examples of medical students and residents choosing not to report incidents involving sexual abuse for fear that such reporting might lead to further psycho-social difficulties and even poorer outcomes in their careers. They also describe the way that students learn to adapt their behaviours, by not showing emotion in male-dominated teams even when discriminated against. By the time they graduate they have become desensitized to discrimination and male bias, having learned to tolerate it as a fixed aspect of medical culture that cannot be challenged or changed. In our previous study (Morgan *et al.*, 2016), we found that female students expressed the least concern regarding possible sexism, regardless of the degree of sympathy with gender issues that they professed to have. It could be that female students at the start of their careers perceive the need to hide feminist-orientated views because of a fear that such views will work against them. Stratton *et al.* (2005) argue that, despite changes in the overt discrimination of women, informal remnants of stereotyping and gender bias within the culture of medicine remain, with implications for males as well as females as regards their experiences of education and their subsequent career pathways.

Readers of this article might question why we chose the images we did in our survey. We wanted to assess the extent to which our respondents were aware of implicit or explicit attitudes towards gender in works of art that featured the anatomical body and which, in our view, represented a gendered view of science. Images 1 – 3 and 6 – 7 contain human figures in poses that we found to be highly evocative of ideological significations regarding gender. Image 2 ( works by D'Agoty), Image 3 (the Anatomical Wax Model of Venus) and Image 6 (von Hagen's

*Reclining Pregnant Woman*) portray female figures as eroticised objects of display, as well as passive objects of scientific intervention. Image 1 (Saliger's *Der Arzt*) and Image 7 (*And she had a heart!* by Simonet Lombardo showing an autopsy of a prostitute) explicitly code female gender to conform to patriarchal sensibilities. The naked female figure is represented as a carrier of disease and/or a passive victim of death, while the clothed male doctor, surgeon or pathologist is shown adopting a stance that suggests high status respectability and authority. His role as an expert involved in the pursuit of science legitimizes his proximity to the naked female and acts as a foil to counter any accusations of voyeurism. Image 5 (*The external genitalia and vagina, with anal sphincter*, by Leonardo da Vinci) and Images 10 and 11 (photographic depictions of female and male surface anatomy from *The Anatomical Basis of Medical Practice* by Becker *et al.*) were, to our eyes, crude and suspect in terms of gender representation. Images 10 and 11 are reminiscent of illustrations in the earliest anatomical textbook, Charles Estienne's *De dissection partium corporis humani* (1545) and its appropriation of erotic prints. That Leonardo da Vinci used the word 'repulsive' when describing sexual activity and female anatomy has been cited as a possible reason for the lack of research and paucity of accurate detail regarding sexual anatomy (Tubbs, 2015). As regards Image 9 (anatomical mannequins known as *Normman and Norma* for a textbook by Robert Latou Dickinson and Abram Belskie), in our view they represent the most gender neutral images in the series, while in Image 8 (male and female surface anatomy from Vesalius's *Epitome*) gendered conceptions and assumptions are revealed, the male body being seen as the standard norm displaying classical standards of perfection, symmetry and proportion, while the female, in accordance with the statue of the goddess of love upon which it was based, adopts the *Venus Pudica* pose,

symbolic of a culturally perceived need for modesty given an awareness of shame, as if the female body signifies imperfection.

Although across the totality of the images little concern was expressed by the medical students and professional anatomists in relation to gender bias, some images elicited slightly more concern than others. For both the students and anatomists, Image 1 (Saliger's *Der Arzt*) elicited most (though admittedly moderate) concern, while Image 4 (the Hunter drawings of the human gravid uterus) and Image 5 (da Vinci's depiction of female external genitalia) prompted least concern. Nevertheless, a pattern emerged suggesting that those students with positive gender attitudes were most concerned and those with negative attitudes were least concerned. This finding indicates that, although those students with pro-feminist views are smallest in number, they are, perhaps unsurprisingly, more sensitive about gender transgressions within anatomical imagery and their views, although in a minority, deserve careful consideration.

We did find that there were some minor differences between French and UK medical students, the French students showing slightly more concern for the D'Agoty paintings and for the Da Vinci drawing. This again accords with our previous study (Morgan *et al.*, 2014) where the French students, although claiming to be less sympathetic to gender issues than the UK students, were more responsive to questions and situations that could have sexist implications. The reasons for the differences between the students at Paris and Cardiff are not entirely clear but, as discussed earlier and in our previous papers, it is our contention that they relate to

cultural and societal differences between communities of medical students even within Europe.

While some differences were found between male anatomists with pro-feminist views and those unsympathetic to gender issues, the female anatomists were uniformly lacking in concern regardless of their professed degree of sympathy with gender politics. That female professionals who have succeeded in rising up the career ladder (and who therefore represent positive role models for female students) expressed so little concern towards imagery containing elements that could be deemed sexist or which reflected gender bias, was unexpected, given that in our previous study (Morgan *et al.*, 2016) we found that experiences of overt sexism and gender transgressions were reported by female anatomists who expressed positive attitudes towards gender issues. It is possible that some female anatomists perceive the need to comply with a male-centric culture in order to succeed in their chosen profession. Perhaps, as suggested earlier, sexist attitudes exist at both explicit and implicit levels. While there may be an explicit perception amongst female anatomists that more should be done to develop initiatives within medical education in order to promote equality and diversity, in order to succeed in a culture that is highly male-centred, it is conceivable that they have become desensitized to (if not blind to) discrimination and gender bias. It is our contention that most female anatomists have learned not to question definitions and illustrations of male and female anatomy as promoted by existing institutional structures of medical education. That their responses to our questions relating to the images are complex, however, is evidenced by the finding that, despite female anatomists expressing sympathy with gender issues being less sensitive than the males to the possibility of

sexism within the imagery, three images (the Vesalius drawing and the two photographs from Becker *et al.*: *The Anatomical Basis of Medical Practice*) showed female anatomists expressing greater concern! That male anatomists expressing sympathy with gender issues were more sensitive than females to the possibility of sexism within the imagery was also unexpected but is a hopeful sign that awareness of gender and equality issues is understood to be relevant to males as well as females.

Some comment needs to be made regarding the importance of imagery within the anatomical sciences relative to verbal descriptions. Although it is commonly said that “a picture is worth a thousand words”, philosophers have been much engaged about the ‘truthfulness’ of imagery versus the written word versus speech (for example, in modern philosophy, Bruno Latour, Jacques Derrida and Pascale Quignard.) In our view, anatomists are iconophilic (in love with images) and consequently, if images are the main means of communication in the anatomical sciences, care must be taken not just with respect to their scientific accuracy but also to any hidden bias that stands in the way of equality and diversity.

## RECOMMENDATIONS

Previously (Morgan *et.al.*, 2014 and 2016), we suggested that it might be helpful to include a short course on the history of anatomy that incorporated an understanding of gender issues in medical training so as to raise awareness and improve students' critical skills. Brenner and Pais (2014) suggest that "anatomical education should not only provide knowledge, but also skills and attitudes, which can be fostered by the involvement of anatomy in medical humanities." Transformation of the culture of medicine to encourage the formation of an inclusive organizational and educational climate, and the embedding of teaching content related to socio-cultural and biomedical aspects of diversity into preclinical and clinical teaching programmes, is recommended by Muntinga *et al.* (2016). Even when gender issues are not formally taught, they can be embedded within the anatomy course if the teachers themselves have sufficient training, understanding and motivation. Given that universities increasingly these days are required by law to observe good practice regarding equality and diversity, one would hope that teachers of anatomy are vigilant in terms of inequity in the classroom, lecture theatre and dissecting room. Such vigilance, we would argue, should extend to the use of imagery, which might inadvertently have a negative effect on the culture of medicine within education.

We consequently recommend that teachers of anatomy and authors of anatomical textbooks should be aware of the possibility of adverse effects on professional matters relating to equality and diversity issues when using imagery. Even historical anatomical images that were not necessarily intended for, and are not currently used for, didactic or research purposes can act as part of the hidden curriculum (which implies outcomes that are learned but not intended). Thus, teachers should be

aware, not only of the possibility of adverse effects on professional matters relating to equality and diversity when using such imagery, but also of their potential usefulness when raising awareness of gender issues. Image 3 in our survey (*Wax Model of a reclining female figure*, Clemente Susini), for example, was produced for display in a science museum to disseminate scientific knowledge for the public good (Messbarger, 2012). Nevertheless, because its pose is erotically charged (a London-based anatomical museum was closed and its anatomical Venus figure destroyed because of its perceived eroticism (Bates, 2008)), it can be seen to reflect a cultural construction of the female body that privileges symbolic significations while purporting to be objective and neutral (Ciobanu, 2014). We would argue that, with appropriate contextualization, such images could serve as valuable prompts for discussion and debate in order to develop visual literacy and understanding of gender issues. As the doctors of tomorrow, students would then be better equipped to critically assess contemporary anatomical images, including the products of medical technology imaging that might tacitly reinforce societal values. We would argue that, being able to ‘read’ images critically, contributes to training better scientists.

**Author contributions:** Susan Morgan and Bernard Moxham devised the project and the initial questionnaire. Odile Plaisant translated the questionnaire into French. Susan Morgan, Bernard Moxham and Odile Plaisant were responsible for running the survey amongst medical students and anatomists. Baptiste Lignier conducted the data analyses. All authors provided critiques of the findings and were responsible for the writing of the paper. There is no conflict of interest.

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## FIGURES

Figure 1 Image 1 - *Der Arzt (The Doctor)* by Ivo Saliger, 1920



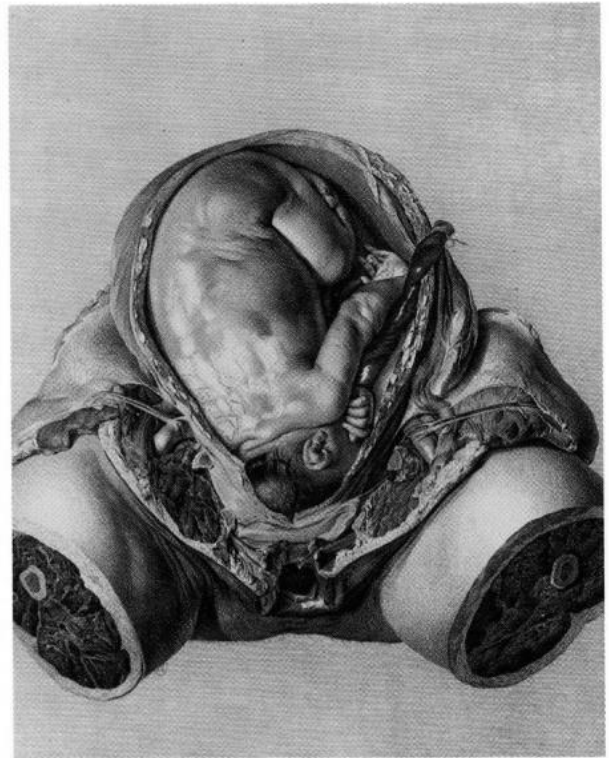
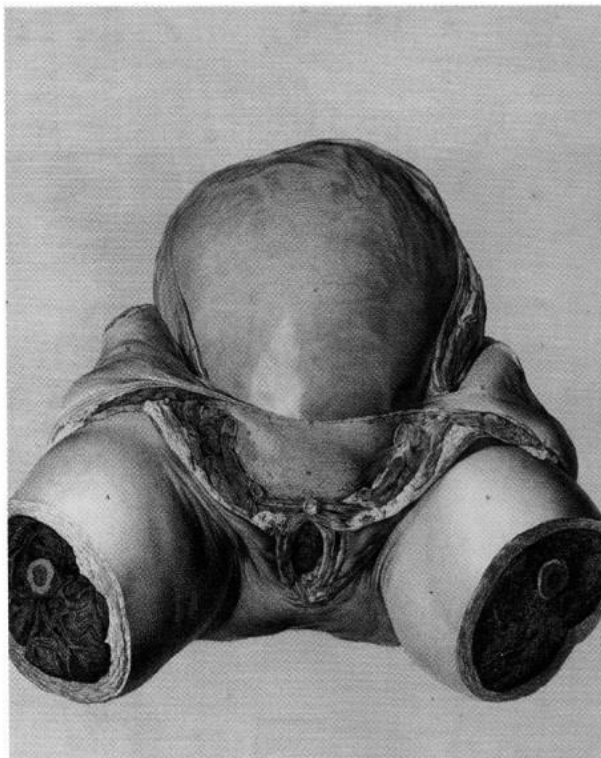
**Figure 2** Image 2 - *A Pregnant Woman, Dissected, Lateral View, with Arms Upraised, Accompanied by Separate Sections of the Body and A Seated Woman, Dissected, Holding a Dissected Baby, Accompanied by Separate Sections of the Body*, by Jacques-Fabien Gautier D'Agoty 1764/5



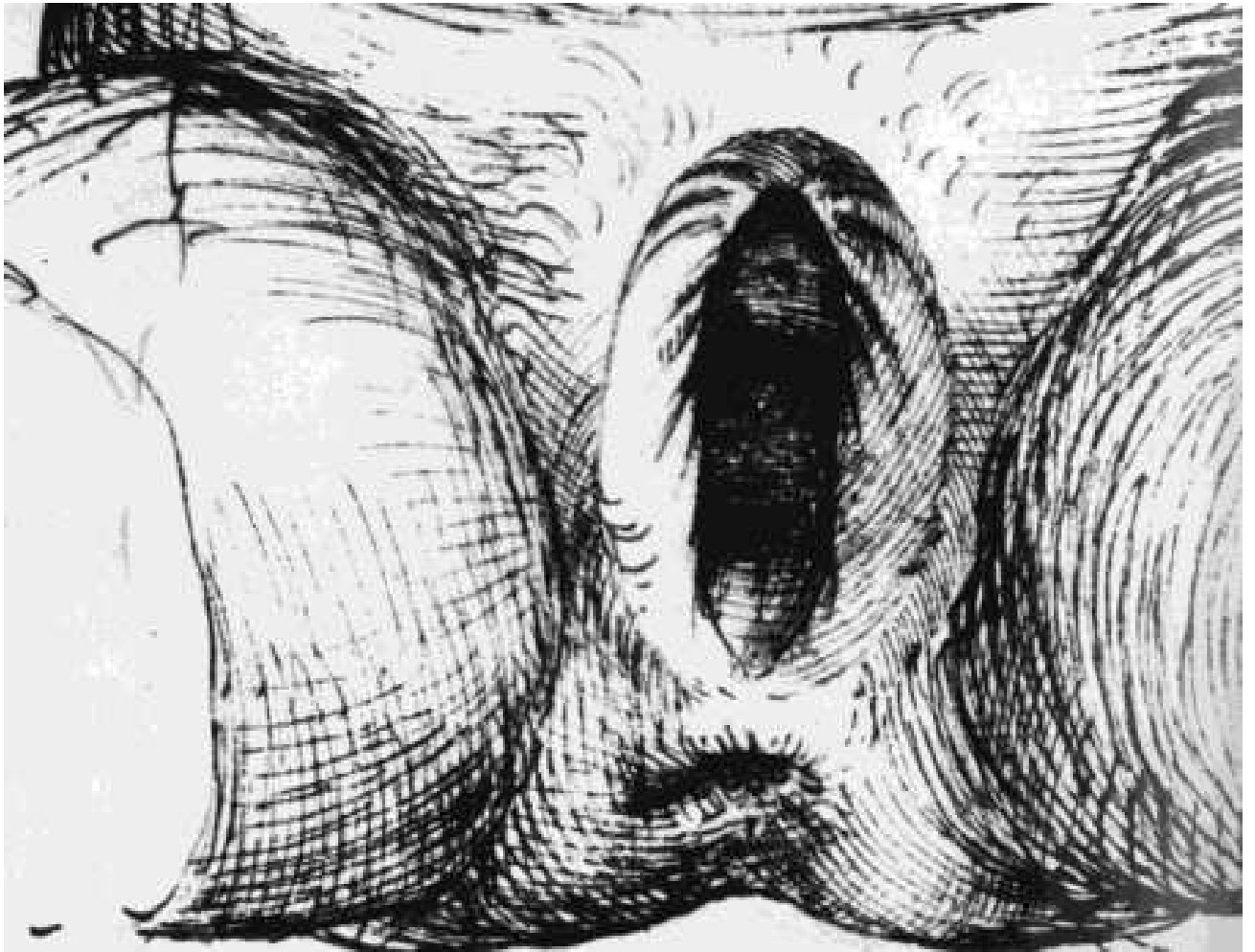
**Figure 3** Image 3 - *Wax Model of a reclining female figure, Clemente Susini, late 18<sup>th</sup> century*



**Figure 4** Image 4 - Engraving after drawings by Jan van Rymsdyk , from *The Anatomy of the Human Gravid Uterus Exhibited in Figures*, Dr William Hunter, 1774



**Figure 5** Image 5 - *The external genitalia and vagina, with anal sphincter,*  
Leonardo da Vinci, 1508 - 9



**Figure 6** Image 6 – Gunther von Hagen's *Reclining Pregnant Woman* (plastinated preparation of dissected pregnant cadaver, 2000).



Note to editor: since this image has been given permission to publish by the copyright holders the requirement is to place the following text “right next to the image”

Gunther von Hagens' BODY WORLDS, Institute of Plastination, Heidelberg, Germany, [www.bodyworlds.com](http://www.bodyworlds.com)

**Figure 7** Image 7 - *And she had a heart!* Oil painting by Enrique Simonet Lombardo showing an autopsy of a prostitute (1898)

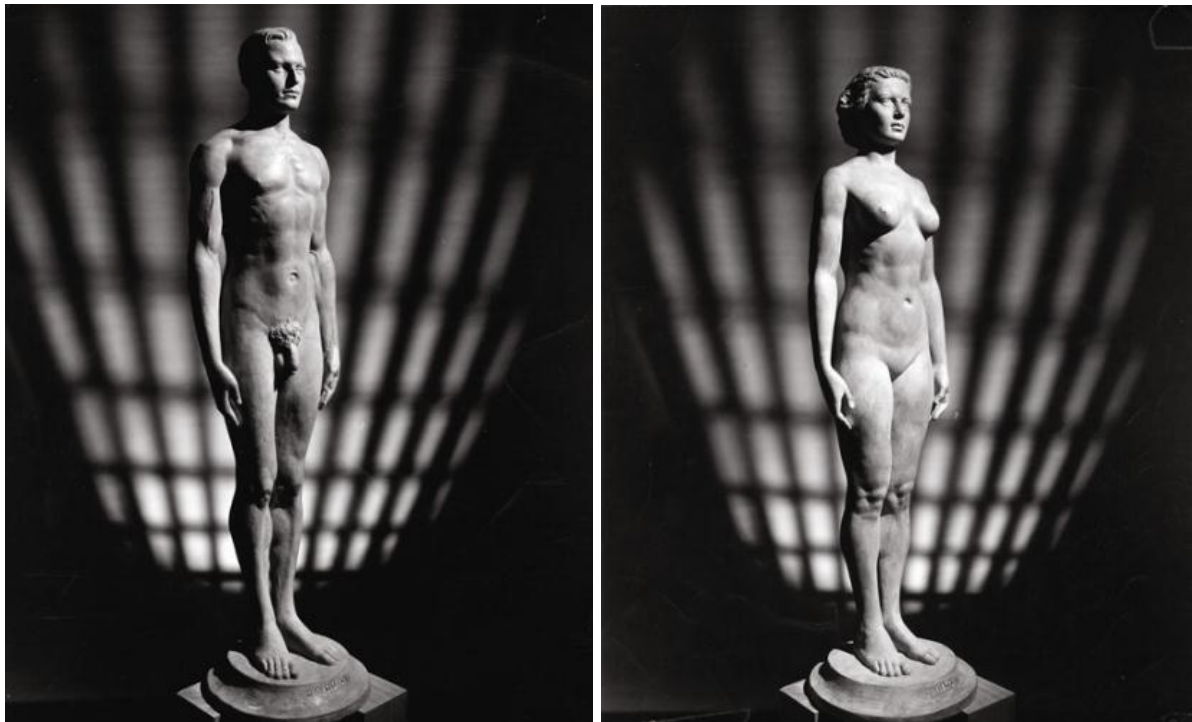


**Figure 8** Images 8 - Male and female surface anatomy, from the Epitome of Vesalius, 1543

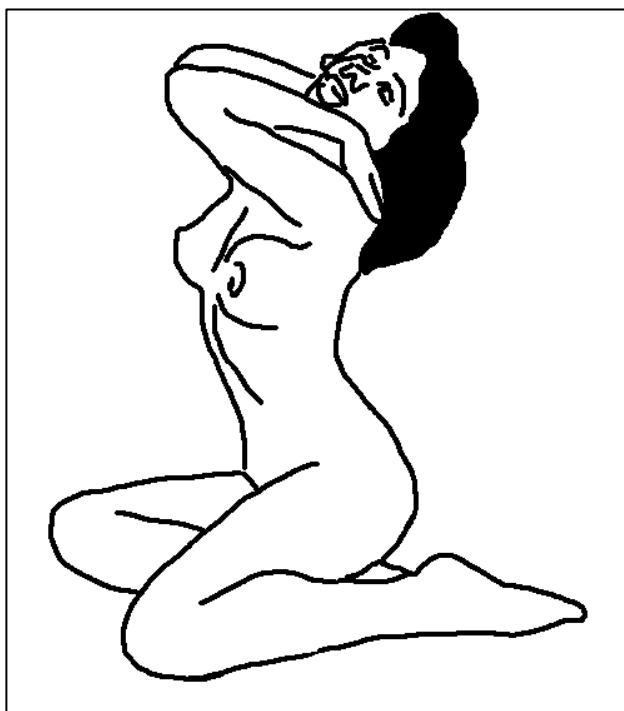




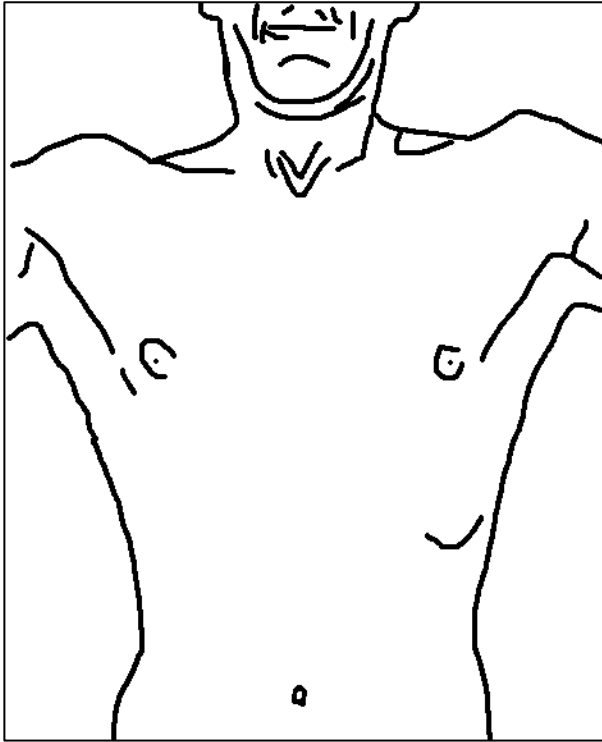
**Figure 9** Image 9 - *Normman and Norma*, Robert Latou Dickinson and Abram Belskie, 1943 (courtesy of “The Archives of the Cleveland Museum of Natural History”)



**Figure 10** Image 10 – Outline drawing suggesting the surface anatomy of the female originally depicted as a full tonal image within *The Anatomical Basis of Medical Practice* (Becker, Wilson and Gehweiler, 1971).



**Figure 11** Image 11 – Outline drawing suggesting surface anatomy of the male originally depicted as a photographic image within *The Anatomical Basis of Medical Practice* (Becker, Wilson and Gehweiler, 1971).



**Figure 12 Assessment of the perception of gender bias for the first 6 images in the survey (see Figures 1- 6). A Likert score of 0 indicates no concern in terms of gender bias while a score of 5 indicates great concern. The data are for the population of medical students and professional anatomists combined.**

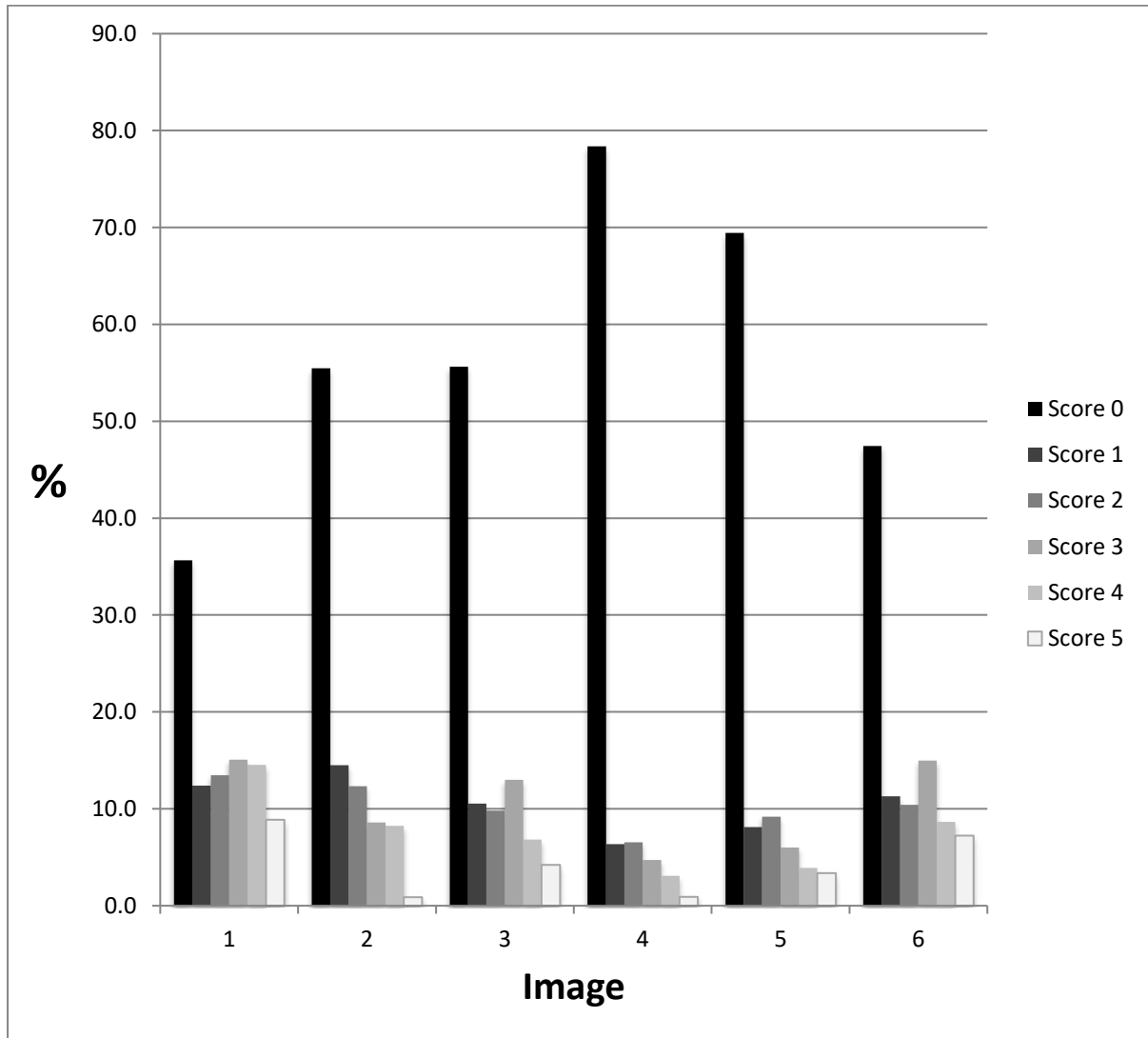
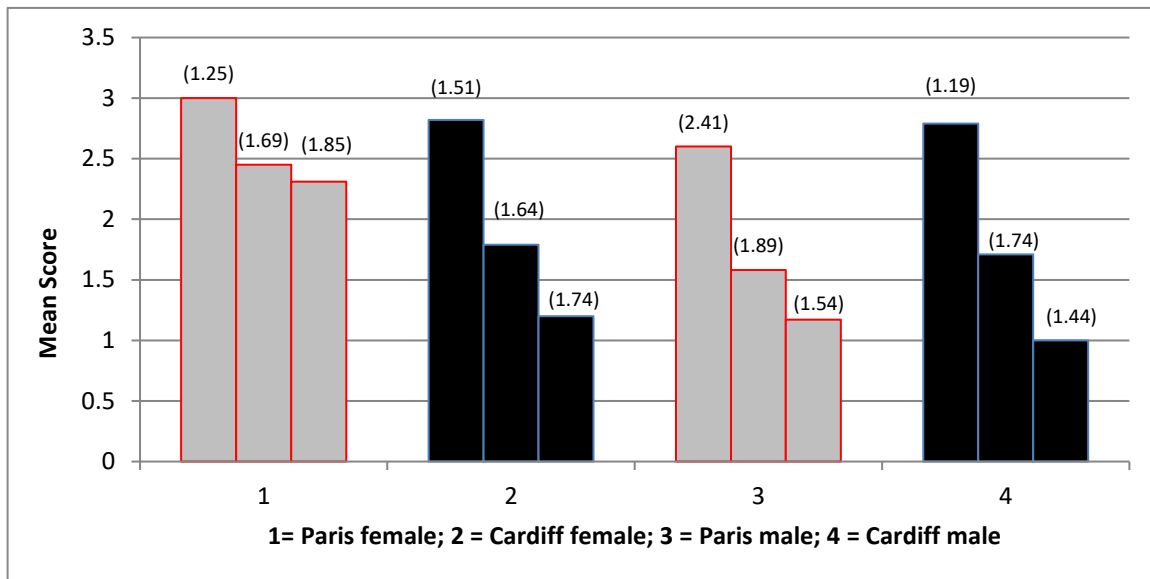


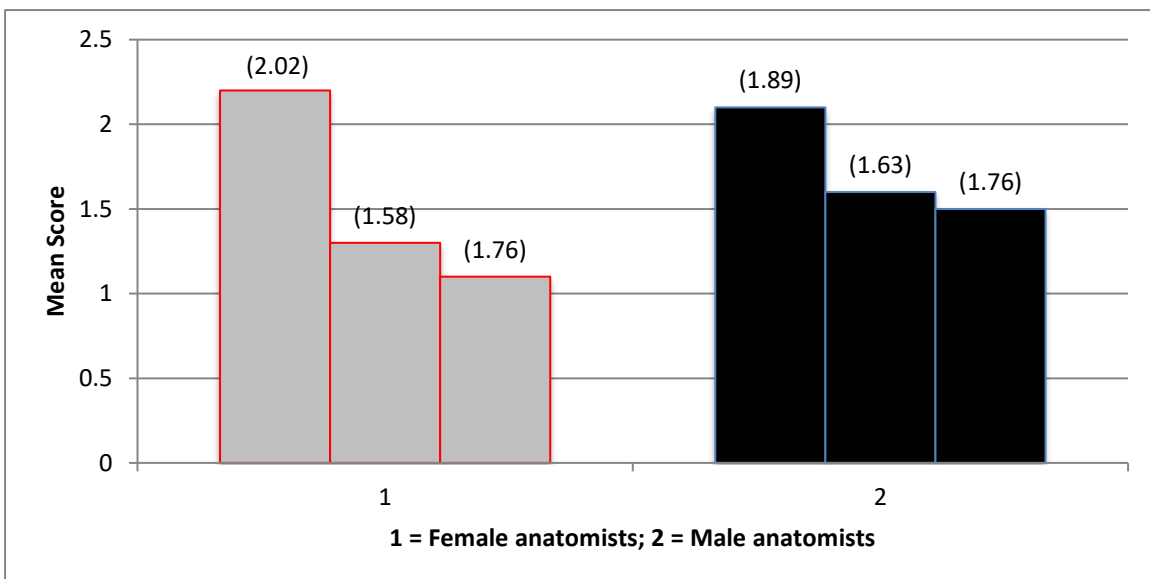
	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6
Score 0	35.6	55.5	55.6	78.4	69.4	47.4
Score 1	12.4	14.5	10.5	6.4	8.1	11.3
Score 2	13.5	12.3	9.8	6.5	9.2	10.4
Score 3	15.1	8.6	13.0	4.7	6.0	15.0
Score 4	14.5	8.2	6.8	3.1	3.9	8.6
Score 5	8.9	0.9	4.2	0.9	3.4	7.2

**Figure 13 Concerns relating to Image 1 (Figure 1).** Fig 13A Medical students at Paris and Cardiff; Fig 13B Professional anatomists.

**A**



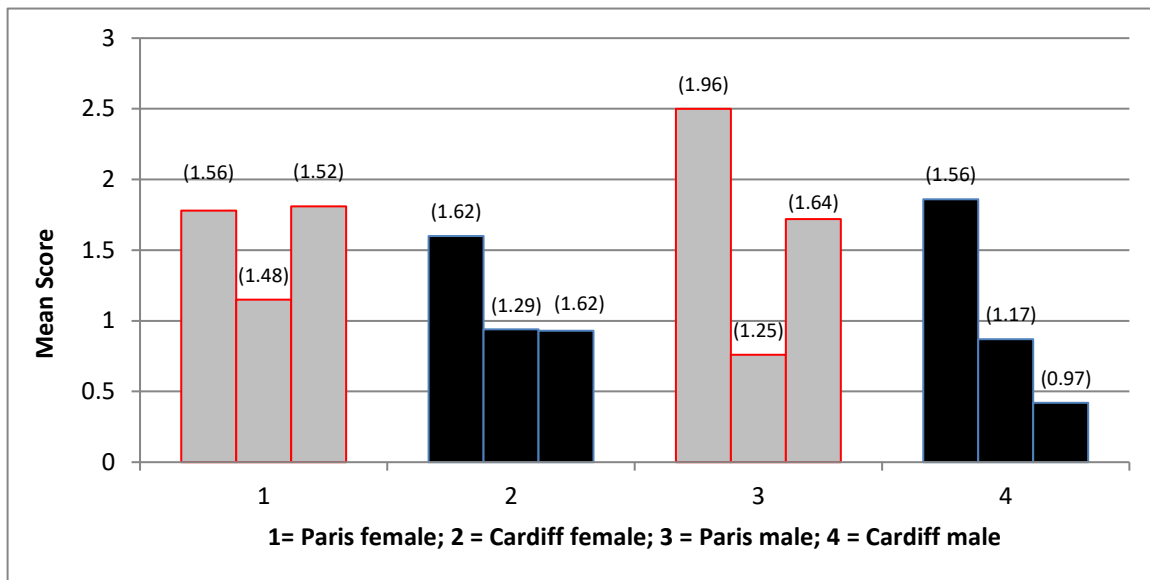
**B**



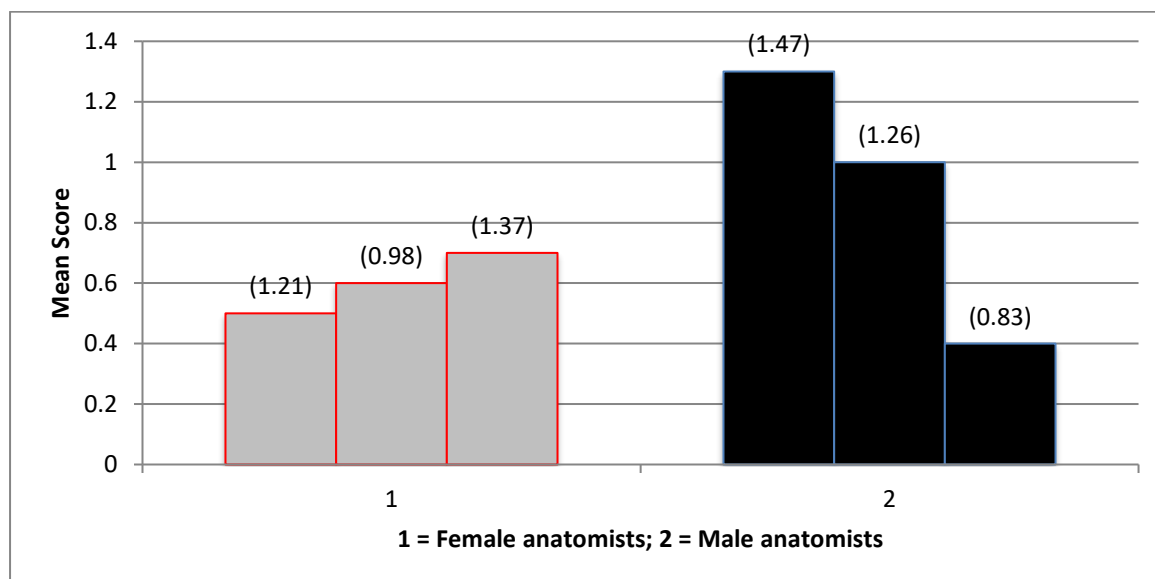
For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern

**Figure 14 Concerns relating to Image 2 (Figure 2).** Fig 14A Medical students at Paris and Cardiff; Fig 14B Professional anatomists.

**A**



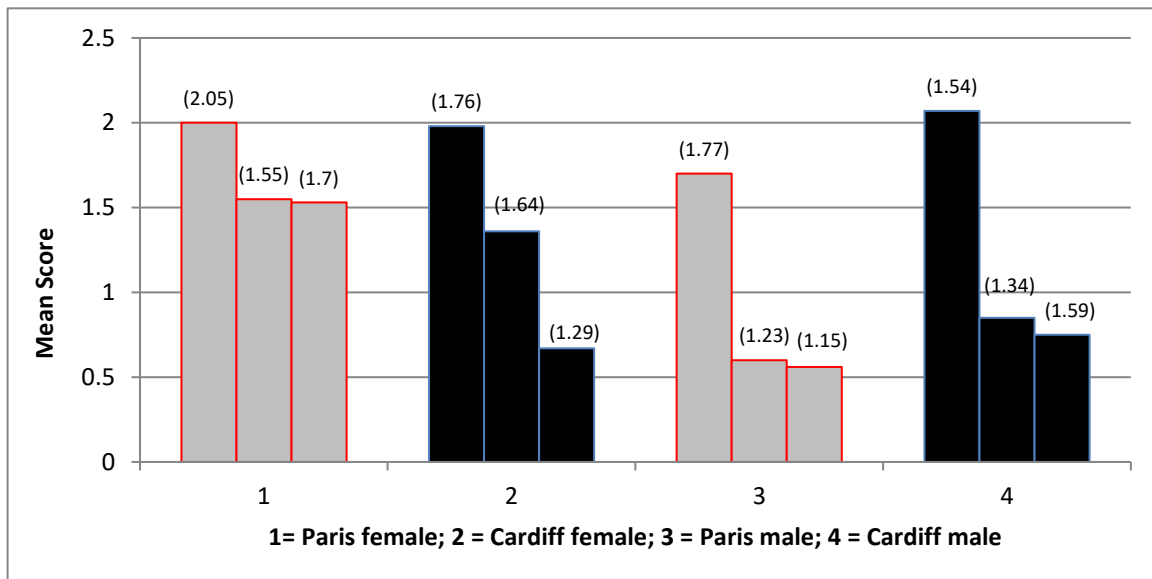
**B**



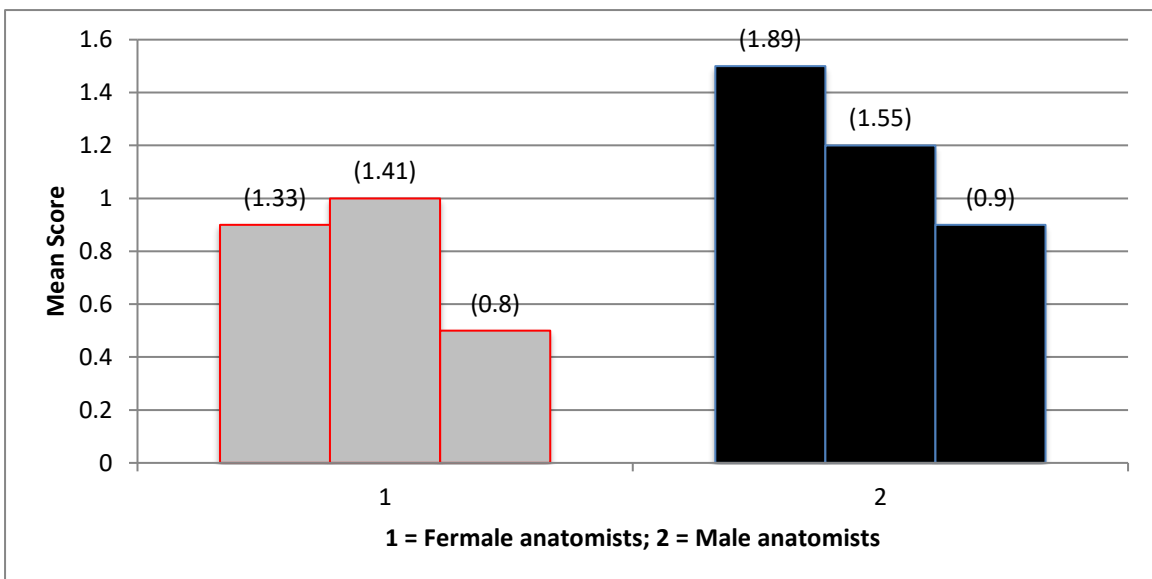
For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern

**Figure 15 Concerns relating to Image 3 (Figure 3).** Fig 15A Medical students at Paris and Cardiff; Fig 15B Professional anatomists.

**A**



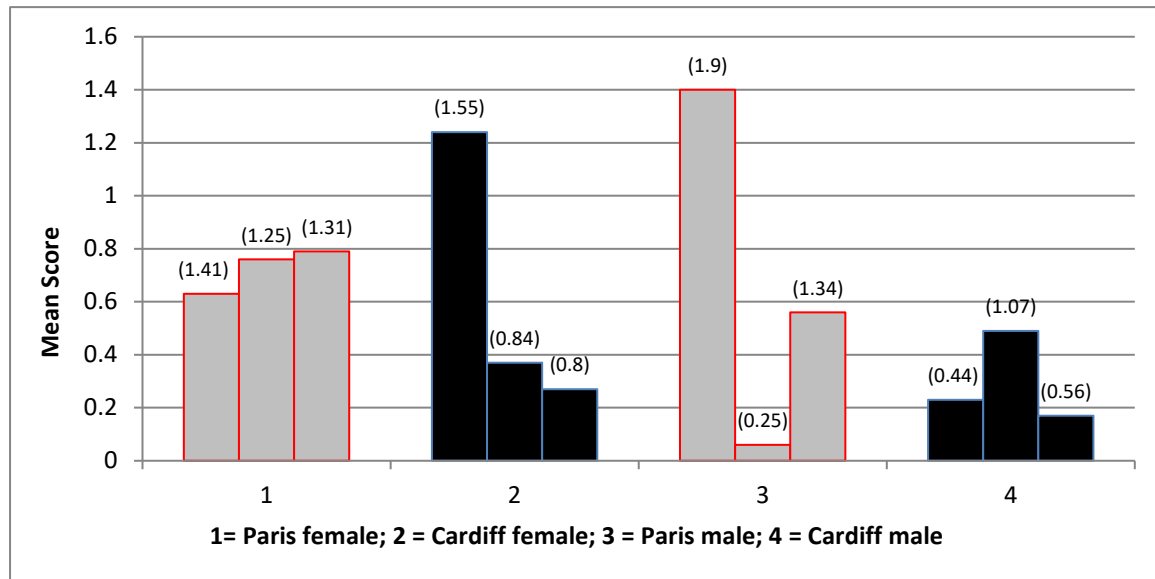
**B**



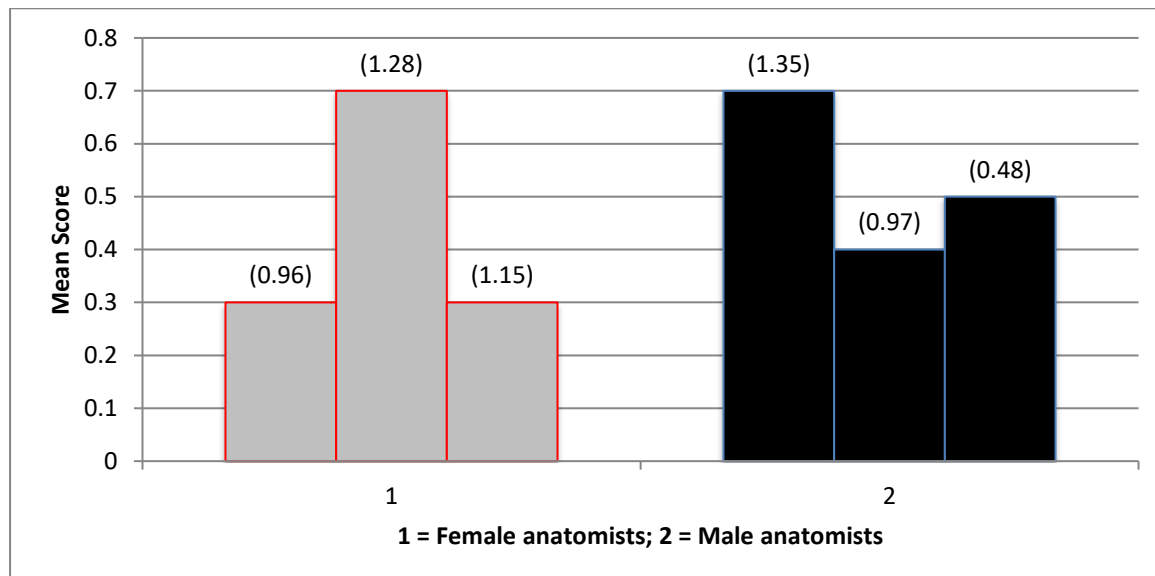
For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern

**Figure 16 Concerns relating to Image 4 (Figure 4).** Fig 16A Medical students at Paris and Cardiff; Fig 16B Professional anatomists.

**A**



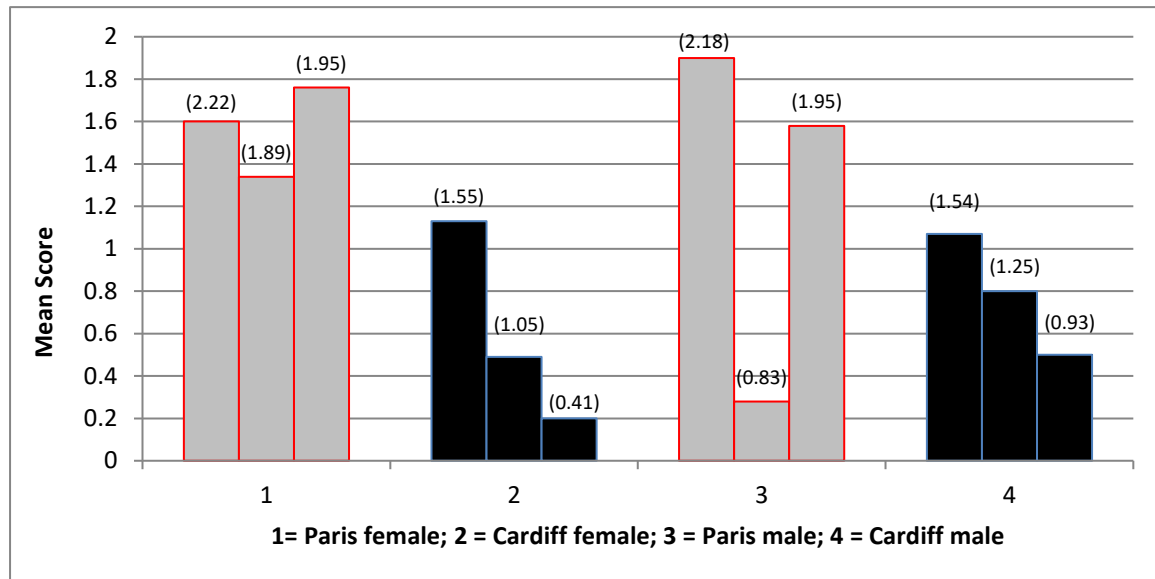
**B**



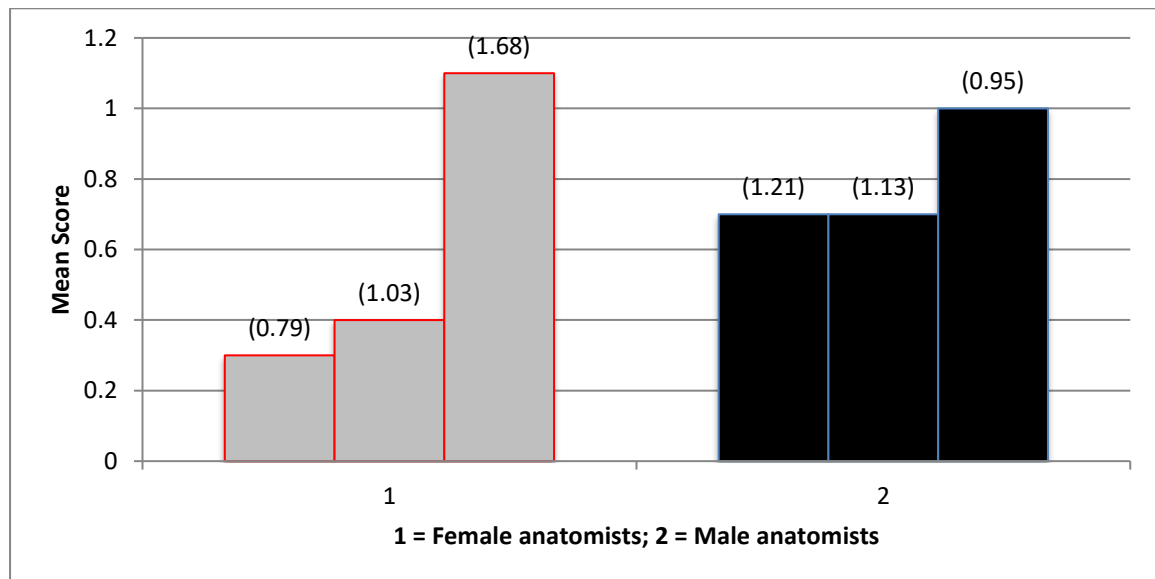
For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern.

**Figure 17 Concerns relating to Image 5 (Figure 5). Fig 17A Medical students at Paris and Cardiff; Fig 17B Professional anatomists.**

**A**



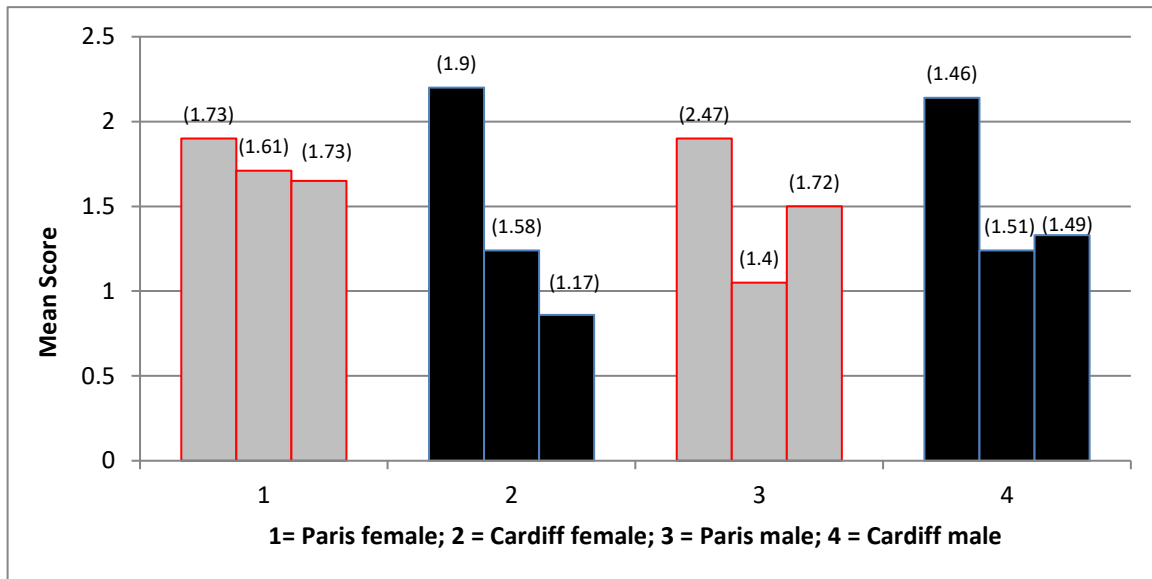
**B**



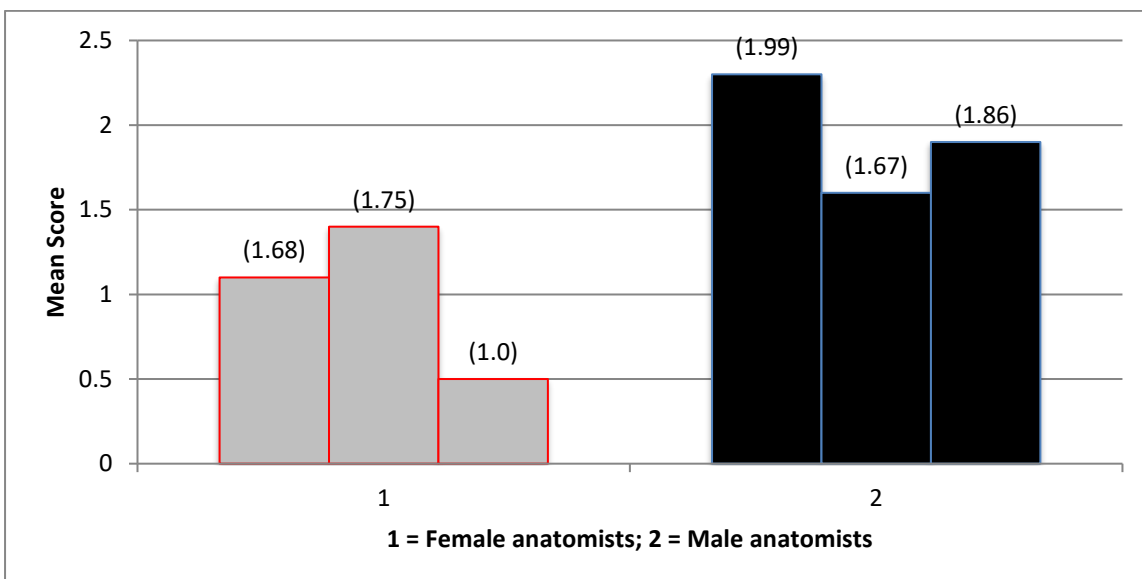
For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern



**Figure 18. Concerns relating to Image 6** (Figure 6). Fig 18A Medical students at Paris and Cardiff; Fig 18B Professional anatomists.

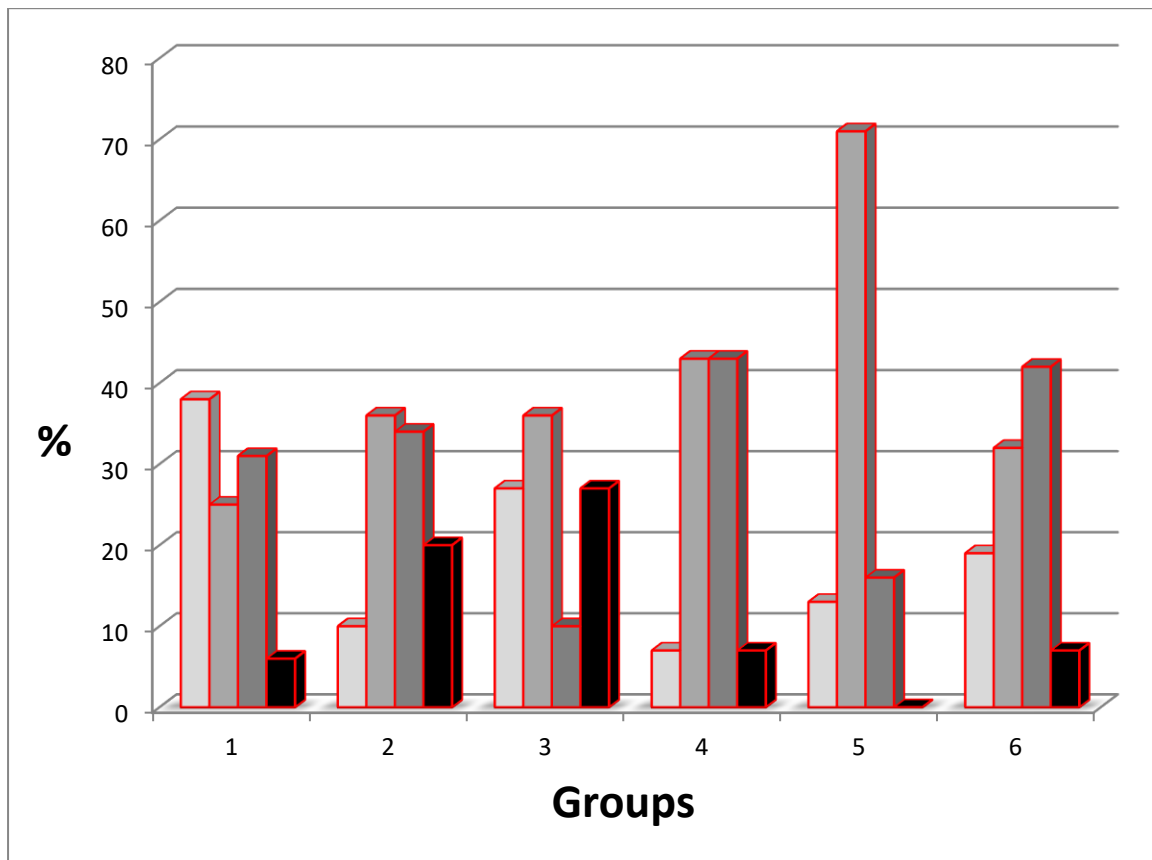


**B**



For each set of data, the first (left) column relates to respondents with positive attitudes to gender issues, the second (central) column relates to respondents with neutral attitudes, and the third (right) column relates to respondents with negative attitudes. The figures in brackets provide standard deviations from the means. Note that the mean score is calculated from a Likert Scale where 0 = no concern and 5 = marked concern.

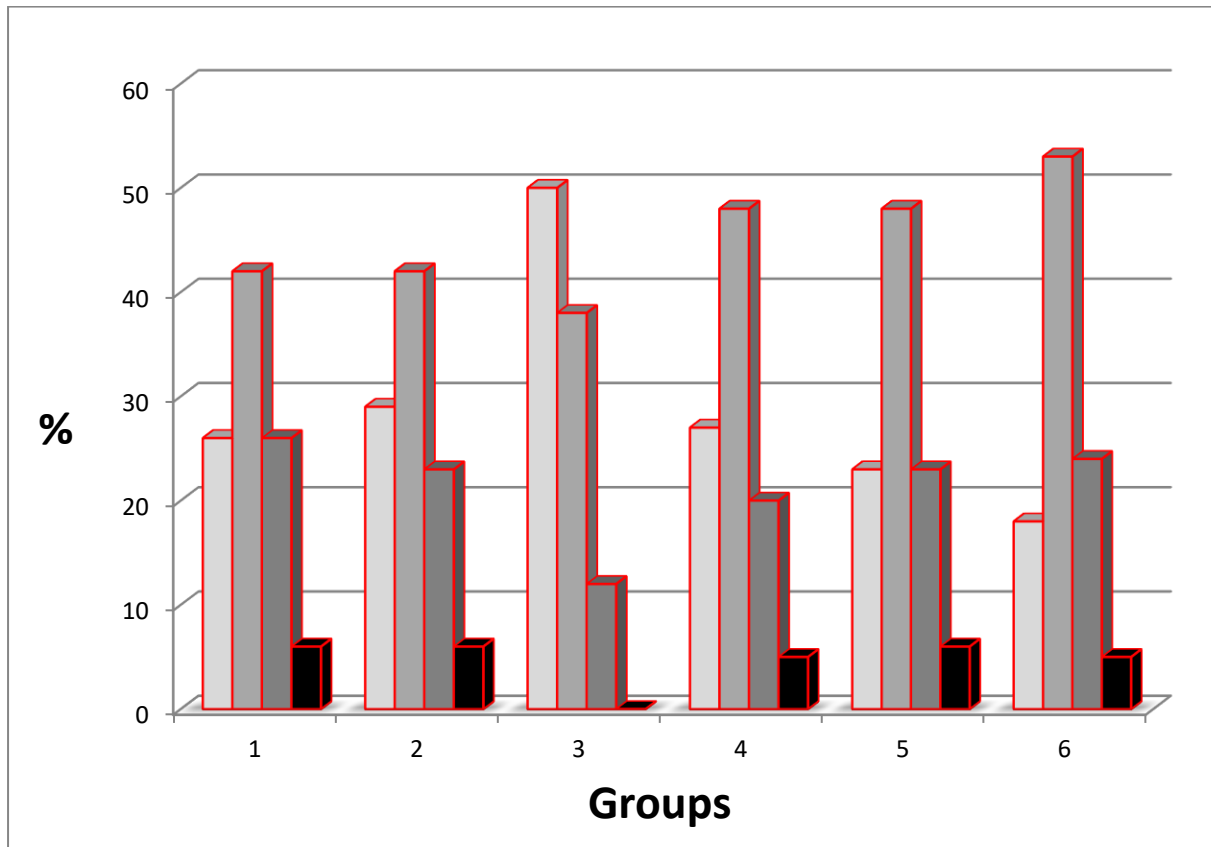
**Figure 19 Perception of gender issues within anatomical images (Figures 1 to 6) from those medical students and anatomists who expressed high sympathy with gender issues.** Group 1 shows the findings for French female students; Group 2 for UK female students; Group 3 for French male students; Group 4 for UK male students; Group 5 for female anatomists; Group 6 for male anatomists. For each group, from left to right, the first column provides data for a total score of 0 for the 6 images assessed, the second column shows scores between 1 and 10, the third column displays scores between 11 and 20 and the fourth column shows scores between 21 and 35.



	Female French students	Female UK students	Male French students	Male UK students	Female anatomists	Male anatomists
<b>0 scores</b>	38	10	27	7	13	19
<b>1 - 10 scores</b>	25	36	36	43	71	32
<b>11 - 20 scores</b>	31	34	10	43	16	42
<b>21 - 35 scores</b>	6	20	27	7	0	7

**Figure 20 Perception of gender issues within anatomical images (Figures 1 to 6) from those medical students and anatomists who expressed neutral views**

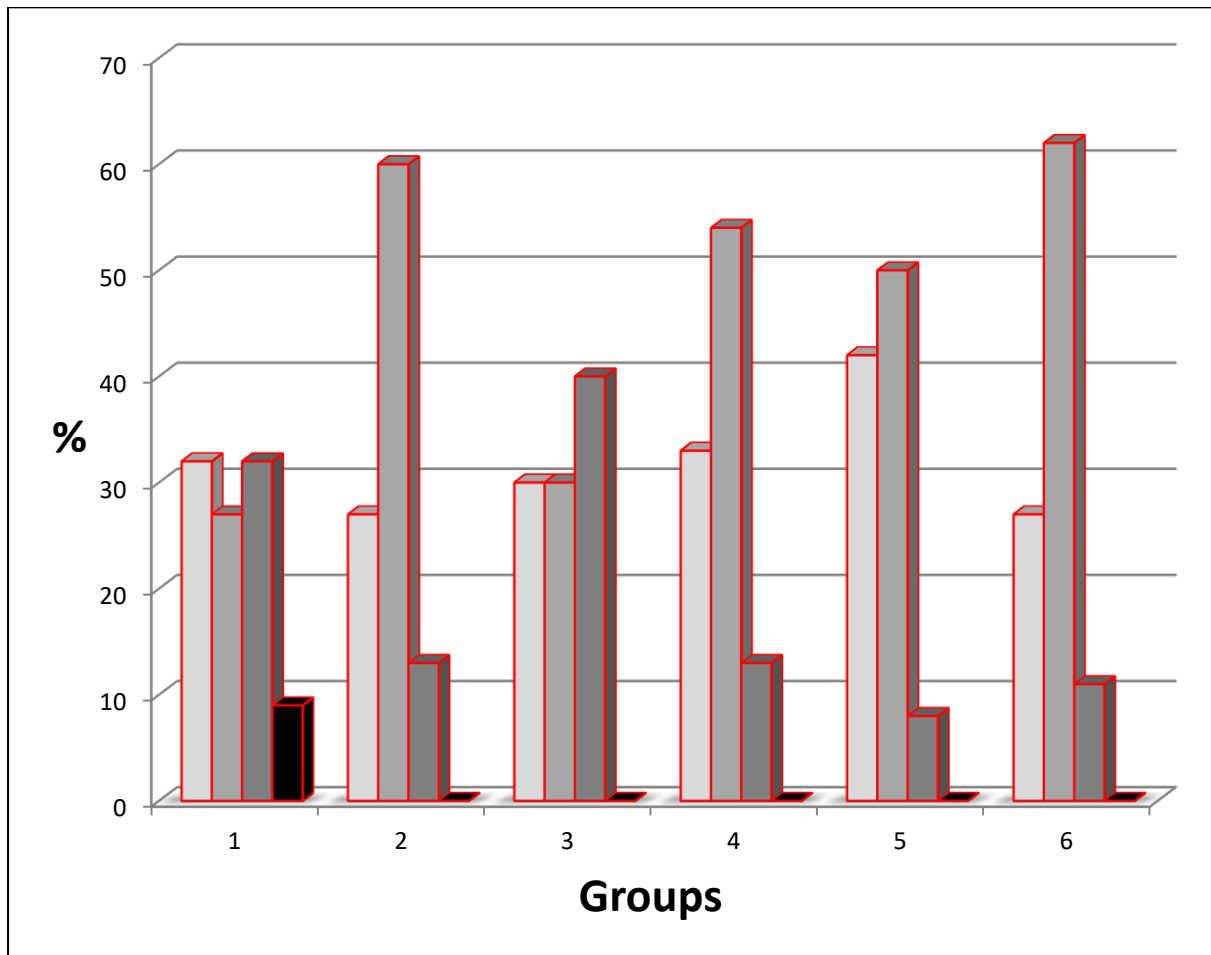
**concerning gender issues.** Group 1 shows the findings for French female students; Group 2 for UK female students; Group 3 for French male students; Group 4 for UK male students; Group 5 for female anatomists; Group 6 for male anatomists. For each group, from left to right, the first column provides data for a total score of 0 for the 6 images assessed, the second column shows scores between 1 and 10, the third column displays scores between 11 and 20 and the fourth column shows scores between 21 and 35.



	Female French students	Female UK students	Male French students	Male UK students	Female anatomists	Male anatomists
<b>0 scores</b>	26	29	50	27	23	18
<b>1 - 10 scores</b>	42	42	38	48	48	53
<b>11 - 20 scores</b>	26	23	12	20	23	24
<b>21 - 35 scores</b>	6	6	0	5	6	5

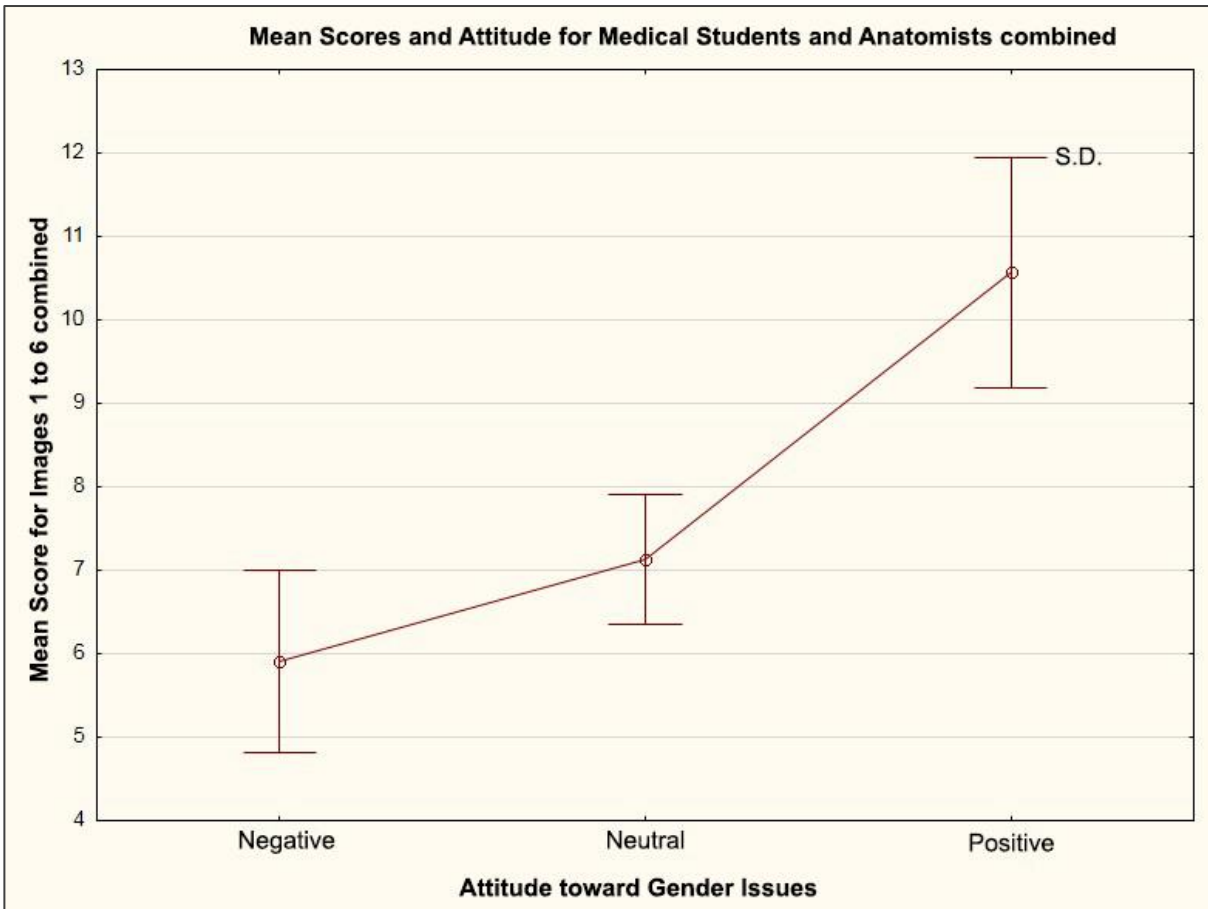
**Figure 21 Perception of gender issues within anatomical images (Figures 1 to 6) from those medical students and anatomists who expressed little sympathy with gender issues.** Group 1 shows the findings for French female students; Group 2 for UK female students; Group 3 for French male students; Group 4 for UK male

students; Group 5 for female anatomists; Group 6 for male anatomists. For each group, from left to right, the first column provides data for a total score of 0 for the 6 images assessed, the second column shows scores between 1 and 10, the third column displays scores between 11 and 20 and the fourth column shows scores between 21 and 35.

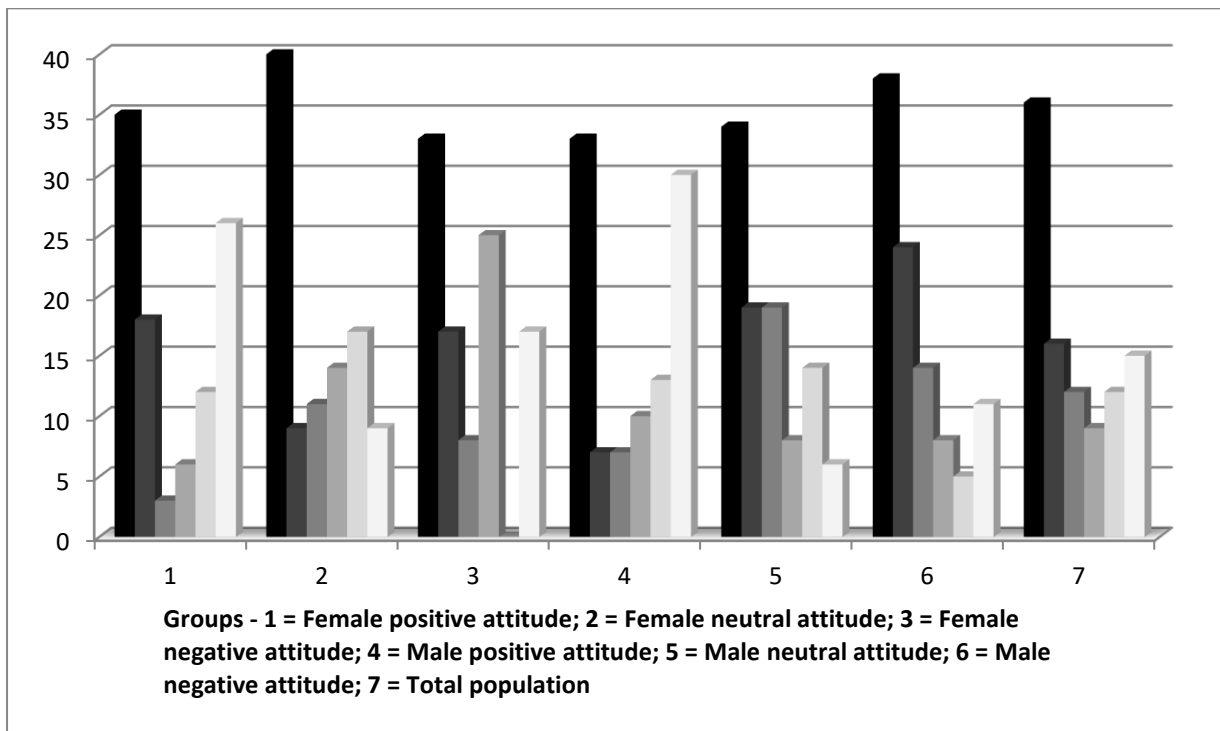


	Female French students	Female UK students	Male French students	Male UK students	Female anatomists	Male anatomists
<b>0 scores</b>	32	27	30	33	42	27
<b>1 - 10 scores</b>	27	60	30	54	50	62
<b>11 - 20 scores</b>	32	13	40	13	8	11
<b>21 - 35 scores</b>	9	0	0	0	0	0

**Figure 22 Comparisons between those medical students and professional anatomists combined who have positive, neutral and negative attitudes towards gender issues in relation to mean scores obtained for assessing gender bias across all images (Figures 1 to 6).**



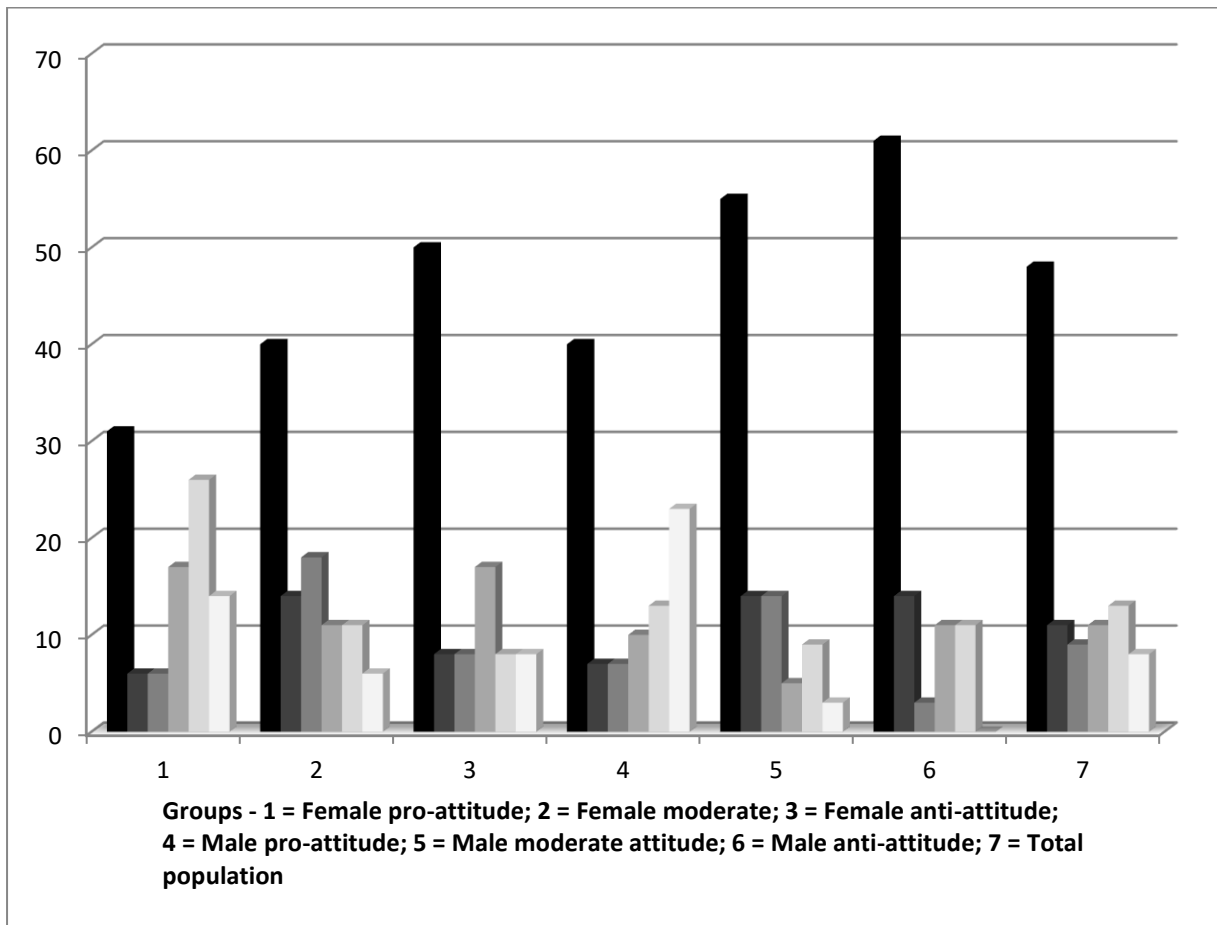
**Figure 23 The concerns of professional anatomists relating to Image 7 (Figure 7)**



Likert Score	Female positive	Female neutral	Female negative	Male positive	Male neutral	Male negative	Total Sample
0	35	40	33	33	34	38	36
1	18	9	17	7	19	24	16
2	3	11	8	7	19	14	12
3	6	14	25	10	8	8	9
4	12	17	0	13	14	5	12
5	26	9	17	30	6	11	15

**For each group in the histogram, the first (left) column relates to a Likert score of 0 (indicating no concern) while the last (right) column relates to a Likert score of 5 (indicating great concern).**

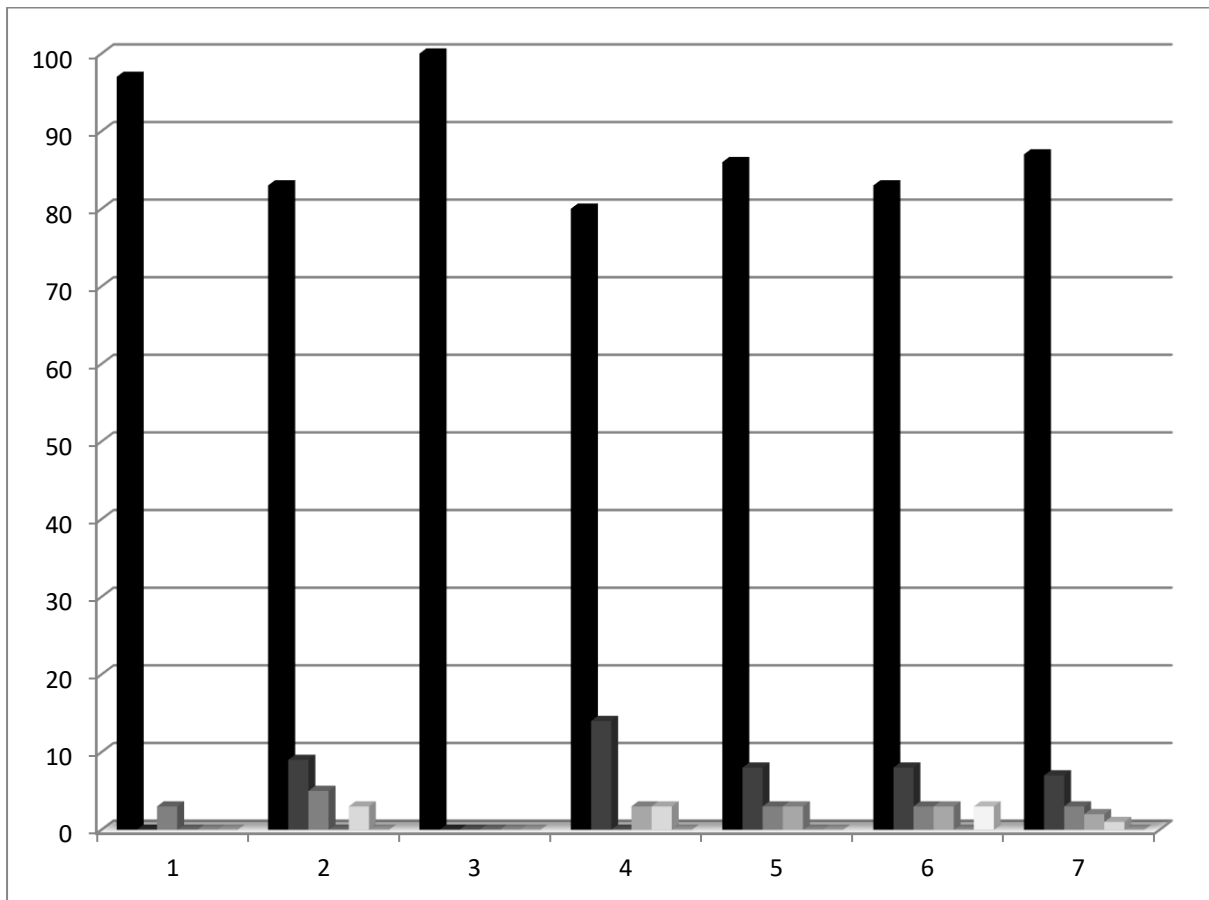
**Figure 24 The concerns of professional anatomists relating to Image 8 (Figure 8)**



Likert Score	Female positive	Female neutral	Female negative	Male positive	Male neutral	Male negative	Total Sample
0	31	40	50	40	55	61	48
1	6	14	8	7	14	14	11
2	6	18	8	7	14	3	9
3	17	11	17	10	5	11	11
4	26	11	8	13	9	11	13
5	14	6	8	23	3	0	8

**For each group in the histogram, the first (left) column relates to a Likert score of 0 (indicating no concern) while the last (right) column relates to a Likert score of 5 (indicating great concern).**

**Figure 25 The concerns of professional anatomists relating to Image 9 (Figure 9)**

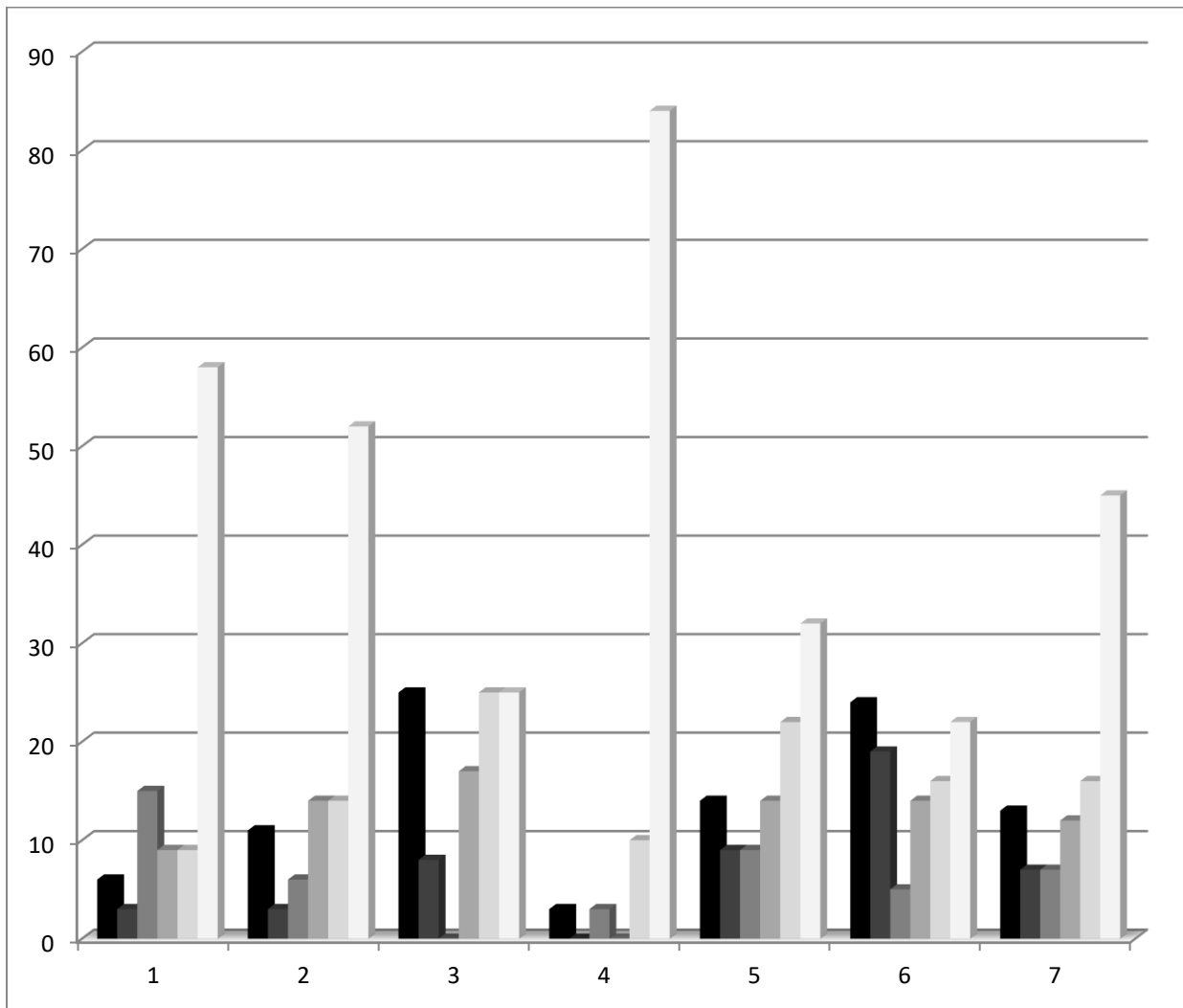


Likert Score	Female positive	Female neutral	Female negative	Male positive	Male neutral	Male negative	Total Sample
0	97	83	100	80	86	83	87
1	0	9	0	14	8	8	7
2	3	5	0	0	3	3	3
3	0	0	0	3	3	3	2
4	0	3	0	3	0	0	1
5	0	0	0	0	0	3	0

For each group in the histogram, the first (left) column relates to a Likert score of 0 (indicating no concern) while the last (right) column relates to a Likert score of 5 (indicating great concern).



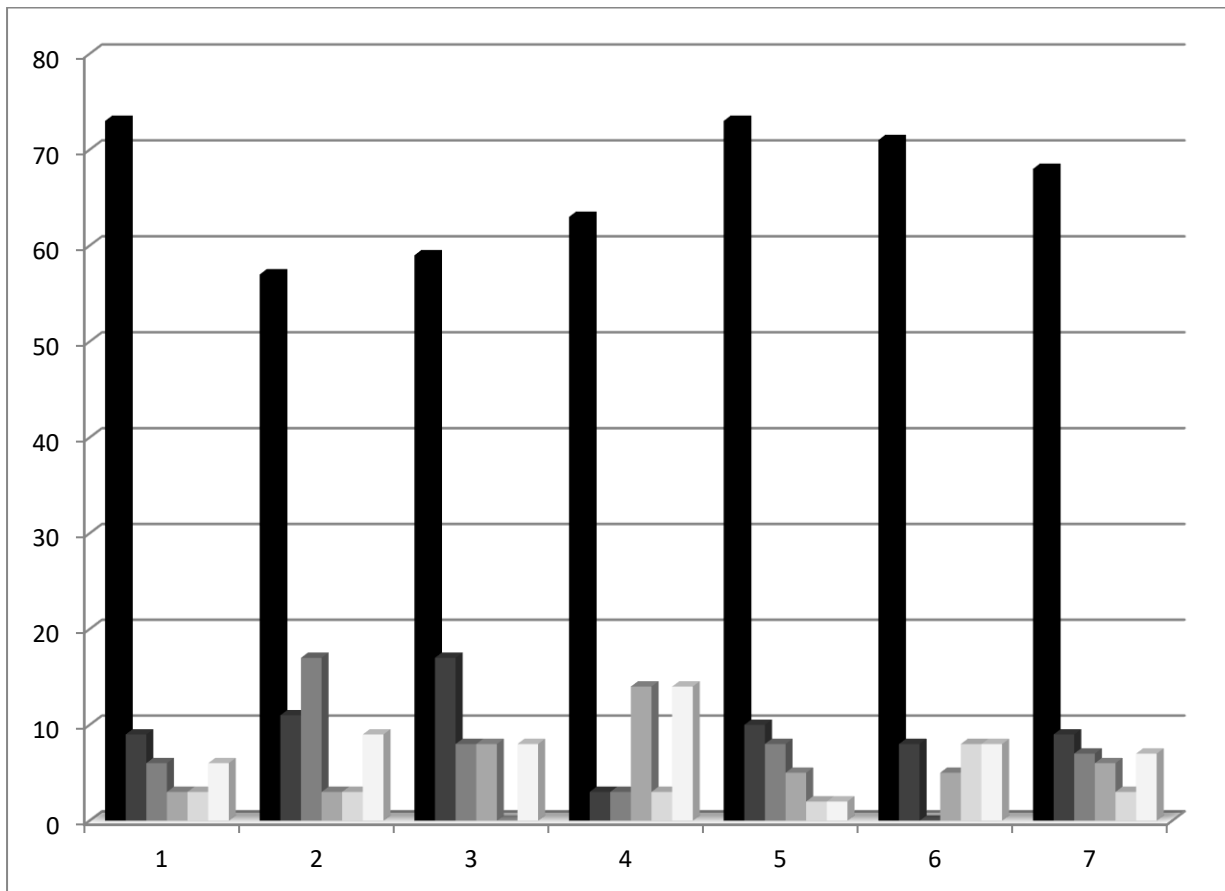
**Figure 26 The concerns of professional anatomists relating to Image 10 (Figure 10)**



Likert Score	Female positive	Female neutral	Female negative	Male positive	Male neutral	Male negative	Total Sample
0	6	11	25	3	14	24	13
1	3	3	8	0	9	19	7
2	15	6	0	3	9	5	7
3	9	14	17	0	14	14	12
4	9	14	25	10	22	16	16
5	58	52	25	84	32	22	45

For each group in the histogram, the first (left) column relates to a Likert score of 0 (indicating no concern) while the last (right) column relates to a Likert score of 5 (indicating great concern).

**Figure 27 The concerns of professional anatomists relating to Image 11 (Figure 11)**



Likert Score	Female positive	Female neutral	Female negative	Male positive	Male neutral	Male negative	Total Sample
0	73	57	59	63	73	71	68
1	9	11	17	3	10	8	9
2	6	17	8	3	8	0	7
3	3	3	8	14	5	5	6
4	3	3	0	3	2	8	3
5	6	9	8	14	2	8	7

For each group in the histogram, the first (left) column relates to a Likert score of 0 (indicating no concern) while the last (right) column relates to a Likert score of 5 (indicating great concern).

## TABLES

**Table 1 The numbers of respondents in various categories who participated in the survey.** In total there were 599 respondents, 130 of whom stated they had negative attitudes to gender issues, 318 of whom claimed moderate attitudes, and 151 expressed positive attitudes.

<b>Attitudes to gender issues</b>	<b>Female French students</b>	<b>Female UK students</b>	<b>Male French students</b>	<b>Male UK students</b>	<b>Female anatomists</b>	<b>Male anatomists</b>
Negative attitude	22	15	20	24	12	37
Moderate attitude	47	96	26	56	35	58
Positive attitude	16	44	11	14	35	31
<b>Totals</b>	<b>85</b>	<b>55</b>	<b>57</b>	<b>94</b>	<b>82</b>	<b>126</b>