Can Museums Find Male or Female Audiences Online with YouTube?[1]

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Purpose: This article investigates if and why audience gender ratios vary between museum YouTube channels, including for museums of the same type.

Design/methodology/approach: Gender ratios were examined for public comments on YouTube videos from 50 popular museums in English-speaking nations. Terms that were more frequently used by males or females in comments were also examined for gender differences.

Findings: The ratio of female to male YouTube commenters varies almost a hundredfold between museums. Some of the difference could be explained by gendered interests in museum themes (e.g., military, art) but others were due to the topics chosen for online content and could address a gender minority audience.

Practical implications: Museums can attract new audiences online with YouTube videos that target outside their expected demographics.

Originality/value: This is the first analysis of YouTube audience gender for museums.

Keywords: YouTube; gender; museums; art galleries; social web; audiences.

Introduction

Public museums and art galleries conserve collections of artefacts, often related to a theme, such as art, culture, history and science. They employ a variety of strategies to attract visitors (e.g., O'Reilly and Lawrenson, 2014). A web presence may be used to advertise, provide richer detail for visitors, or give alternative access to those unable to attend in person (e.g., Coleman and Nankervis, 2015). Three quarters of 982 UK arts and cultural organisations believed that digital technologies helped them to fulfil their missions in 2015, with most (56%) using YouTube as part of this (Nesta, 2015). Moreover, 29% of museums and art galleries posted their own content to YouTube in 2016 (Visit Britain, 2016). Nothing is known about whether online content can help to attract new audiences, however, such as those from demographics that rarely visit.

Whilst many museums aim to serve the whole public (Quinlan-Gagnon, 2012), others target social issues such as gender and class inequalities (Spring, Smith, and DaSilva, in press). A museum may therefore wish to attract a demographic because it would not normally visit or because it is the target of an exhibition (e.g., Merriman, 2018). This paper focuses on gender and assesses whether YouTube museum videos can attract gendered audiences.

YouTube contains limited implicit public gender information for the traditional binary genders (male/female), although not for non-binary genders. Since this information is public it can be used to compare female/male audience ratios between museum videos. Public social media has been previously used to investigate museum-related online activities (Facebook questionnaires: Sundjaja, Gaol, Abdinagoro, & Abbas, 2017), but not for YouTube on a large scale. The current paper investigates videos posted by 50 large museums for insights into their audience genders. It exploits the publicly available information in their comments for evidence that the proportions of females and males watching videos varies between museums. A positive result would suggest that museums could reasonably target audience genders on YouTube.

Museums and gender

For many people, attending a museum is a choice unless they visit as part of an organised trip or at the behest of friends or family members. When made, this choice is influenced by a person's interests, which is in turn influenced by their socialised gender identity. To compare museum videos online by audience gender it is therefore useful to understand why there are gender differences in the visitors to different types of museums. This review focuses on binary genders with apologies to non-binary genders, for which more research is needed.

Gender and interests

There are substantial (binary) gender differences in interests that may be primarily due to social pressures (e.g., Halpern and Perry-Jenkins, 2016; McHale, Kim, Dotterer, Crouter, and Booth, 2009; Kornienko, Santos, Martin, and Granger, 2016) and media gender stereotypes (e.g., Matthes, Prieler, and Adam, 2016). In psychology, gender differences in interests have been studied most in terms of toy choices by children. For example, one study showed that babies exhibited sharply gendered reactions to toys even prior to their development of gender identities (Alexander, Wilcox, and Woods, 2009). Together with human-like gendered toy choices in some primates (Hassett, Siebert, and Wallen, 2008) and pre-natal testosterone levels moderating gendered preferences (Hines, 2011; Swan, Liu, Hines, Kruse, Wang, Redmon, and Weiss, 2010), this gives evidence of a biological sex component to gendered interests. In particular, boys' interest in toys associated with spatial movement, such as wheeled trucks, appears to be a generic, but variable, human masculine trait (Hines, 2011). These initial tendencies then seem to be exacerbated by social processes, creating substantial gender divides in adulthood. Nevertheless, greater male interest in museums for things that move (e.g., cars, aircraft, spacecraft) may have a partially biological explanation.

More generally, social psychologists argue that for adults there seems to be a greater male interest in 'things' and a greater female interest in people (Su, Rounds, and Armstrong, 2009). Thus, museums and art galleries that naturally or deliberately relate to people or human dimensions may tend to attract more female visitors. Similarly, greater levels of male aggression (Bettencourt and Miller, 1996) and greater involvement in military careers may partly explain a greater male interest in military museums. Specialist museums for topics closely tied to other gendered careers (e.g., nursing) can also be expected to attract a corresponding gendered audience.

Museum attendance and gender

There is little public information or academic research about museum attendance by gender, and no systematic comparisons of museum audiences by type. This is a strange omission, given that there is extensive research into other gender issues within museums, including staffing (Callihan & Feldman, 2018), as well as representations of gender and sexuality, gendered reactions to exhibits, and cases where non-male artists or traditions are ignored (Levin, 2010). Prior research has typically been qualitative, focusing on a single case, and theory-driven, interpreting that case in the light of a general sociological theory.

The little public information that exists about museum visitor genders suggests that a female majority is the norm. A survey of European museums found that most visitors were female (58%), including for most individual museums. The gender breakdown varied from the National Museum of Estonia (63% female) to the National Historical Museum of Athens (45% female) (Bounia, Nikiforidou, Nikonanou, and Matossian, 2012). All six Northern Ireland museums in another survey had mostly female visitors, with the highest being 70% at the F.E McWilliam Gallery & Studio (ANI, 2016). In New Zealand, women were the majority (58%) of visitors to 37 museums and art galleries (Museums Aotearoa, 2017). Other

museums with mostly female visitors include Cambridge University (59% female) (TAA, 2014), Washington State History Museum in 2013 (64% female) (Morey Group, 2013), West Highland Museum (local and regional history, Scotland) Visitors Survey 2016 respondents (56% female) (OSSL, 2016), but not the Hong Kong Museum of History Permanent Exhibition (49% female) (Actrium Solutions, 2016). There is less data on science museum visitors but females (47%) had a lower attendance than males at Smithsonian science museums (Smithsonian, 2004, p.7).

Females often dominate art gallery attendees. Females were a majority (66%) of Minneapolis Institute of Arts attendees in 2001 (Cincinnatus, 2001, p.12) and of Smithsonian arts museum attendees in 2004 (59%) (Smithsonian, 2004, p.7). Surveys of citizen participation in the arts 2002-2012 in the United States showed that the majority had visited an art gallery or museum at least once as a child. In 2012, a fifth (21%) of adults had visited art galleries or museums in the previous 12 months (Silber and Triplett, 2015: Figure 1-13). Of these visitors, 57% were female (Silber and Triplett, 2015: Figure 1-15). Females were the majority of attendees at all arts events in the survey, including almost two thirds of ballet and book reading attendees (Silber and Triplett, 2015: Figure 1-10).

In summary, the above analyses of visitor data suggest that females seem to attend general museums and art galleries the most, but males may be more likely to visit science museums. Due to the lack of public evidence of museum attendances by gender for the many different types it is impossible to be sure of the audience gender balances at a finer grained level of detail. Nevertheless, likely gender imbalances for other museum types can be inferred from other information about gendered interests. From data about gendered participation rates in academic specialisms (Tellhed, Bäckström, & Björklund, 2017), it seems likely that males would be the majority for physical (but not biological) science, technology, space, aircraft, and vehicle museums (the latter two because of their engineering associations). Males would also be more likely to attend aircraft and vehicle museums because of their hypothesised interest in things, as discussed above. Males also seem to be more likely to attend military museums because of greater interest in the military as a career, as well as recreational violence (e.g., DiPietro, 1981). From academic specialism participation rates (Tellhed, Bäckström, & Björklund, 2017), females may be more likely to attend museums focusing on humans (e.g., social history, occupational-focused museums) or biological sciences (e.g., natural history). From the hypothesised people-orientation of female interests, they may also be more likely to attend living history museums. In addition, there may be a general gender bias over all types of museums if, for example, females are more likely to attend as part of a family group.

Gendered activities within museums

Gendered behaviour has been noticed within museums for children, giving evidence of the pervasiveness of gender socialisation and the difficulty of combatting it within a museum experience. A review of early research found that girls cooperated more at science museums whereas boys were more willing to explore alone (Diamond, 1994). At the Center of Science and Industry (COSI) in Columbus, Ohio, 419 children were observed playing with five exhibits, with overall gender differences in the ways that they interacted with them that followed gender stereotypes. For example, some girls used paint as makeup and displayed behaviour classed as nurturing (in the Animal Lab) whereas some boys engaged in play fighting with the water jets (Kremer and Mullins, 1992). The authors argued that museums need to work to ensure that both genders have a reasonable chance of picking up useful skills, such as nurturing.

A study of how boys and girls talked about animal exhibits found many similarities but with boys being more concerned with formal naming whereas girls were more likely to

express opinions (Tunnicliffe, 1998). At a cultural heritage museum in Australia, boys and girls tended to interact differently with the exhibits (Sutcliffe and Kim, 2014). Such museums can encode gender biases in the exhibits are selected and described, which may alienate or mislead visitors (Heitman, 2017; Anderson and Winkworth, 2014; Machin, 2008). Removing gender bias stereotyping is not enough, however (see also: Ramey-Gassert, 1996; Dancu, 2010; Haliliuc, 2013).

Museums with a focus that appeals more strongly to one gender may not provide an engaging experience to other visitors. Observations of adults at a baseball museum in the United States suggested that females tended to find exhibits less personally relevant (Blinde and McCallister, 2003). Art galleries fit awkwardly in this context. Despite the majority female attendances at art galleries, their collections tend to be dominated by male artists, whose works tend to be more valued (Christensen, 2016). There is no gender difference in the average amount of time (21 seconds) spent viewing each artwork, however (Smith, Smith, and Tinio, 2017). A feminist pedagogy initiative for gender-based consciousness raising based around an art gallery in Canada (Spring, Smith, and DaSilva, in press) shows that gender issues can be addressed in museums that attract mostly female visitors.

Bulstrode Park in the UK is an eighteenth-century example of a female-oriented museum. It was designed by a woman to appeal to (rich) women of the time, with an emphasis on artistic considerations and handicrafts (Pelling, 2018). Although museums of that period were largely operated by and for men, women played an increasingly important role in British museums over the next two centuries, exerting increasing influence (Hill, 2016). Gender biases in museum professionals and leadership nevertheless remain an important contemporary concern (Baldwin and Ackerson, 2017).

For science, a historically male-associated interest, an investigation into the long-term impact of visiting the UK National Space Centre found that both girls and boys experienced increased positivity towards science in the short term but that that its impact was longer term for girls (Jarvis and Pell, 2005). Participation in an educational programme at a science museum also apparently had a more positive impact on female attendees (Price, Kares, Segovia, and Loyd, in press), raising the possibility that museums can help to address the current gender divide in some areas of science (STEM subjects).

Overall, then, there is evidence of gender differences in museum-related interests and visiting by type and in behaviour within museums but nothing is known about gender in the context of museum web presences.

Museums, YouTube and gender

From a cultural perspective, videos and films are essential to provide a record of activities that naturally involve motion or integrated sound and vision (Pietrobruno, 2014), such as the Chogān horse-riding game with music and storytelling[2]. Placing such videos online in a public space, such as YouTube, helps to fulfil a museum's public access mission. Videos can also enrich online museum presences when they are not needed as a public record of an activity. For example, a video can rotate perspective to give a three-dimensional impression of an object for online visitors. Even an intrinsically flat artefact, such as a photograph, could be enriched by a video describing the creation process or an interview with the artist. Whilst high quality videos are expensive and time consuming to create, YouTube offers a free long-term hosting solution. An investment may therefore have long term benefits, especially if the content can attract new demographics, such as gender(s) that rarely visit offline.

Video view counts can be used as evidence of audience size (Fernandes, 2018) and comments posted to these videos as feedback about which videos or artefacts are interesting

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[2] https://ich.unesco.org/en/RL/chogan-a-horse-riding-game-accompanied-by-music-and-storytelling-01282

as well as information about how the public reacts to them. Like web crowdsourcing, YouTube comments have the dual benefits of participation and feedback (e.g., Eccles, 2018; Oomen, Gligorov, and Hildebrand, 2014; Eccles and Greg, 2014). Nevertheless, they have rarely been used to analyse audience demographics and never to compare different museum audiences. Although one study has claimed that a museum YouTube channel had a surprisingly high proportion of male viewers (Fernandes, 2018), there are no prior gender analyses of YouTube for museums. This section gives a brief overview of museum-related YouTube research for additional background, followed by some unrelated studies of gender on YouTube.

An old analysis of Portuguese museum social web presences found YouTube to be one of the most popular (Pedro, 2010), confirming that YouTube is not a novelty for museums. A qualitative investigation of comments on videos about a Cambodian genocide museum that were not created by the museum showed that these can give insights into visitors' reactions and locals' disagreements with visitors' interpretations (Benzaquen, 2014). A paper about Australians forcibly removed from their parents compared comments on the National Museum of Australia website to YouTube videos. It showed, for example, that museum-based content is implicitly framed by its context within the museum (Adkins & Hancox, 2014). An analysis of the Guggenheim Foundation's YouTube Play Biennial competition investigated the 25 submitted art videos (with over 25 million views in total) selected by a Guggenheim jury (López Martín, & Morgado Aguirre, 2015). This showed that a high-profile art gallery could generate huge attention through YouTube, although in this case for video works submitted by (professional) artists. Overall, however, these studies give little insight into good practice in YouTube for museums or gender differences for museums within the site.

Away from museums, gender has been investigated on YouTube in many different contexts. A quantitative analysis of comments on videos related to different dance styles showed that audience genders varied greatly by style and there were also gender differences in the types of comments made. For example, females were more likely to post supportive messages in comments (Thelwall, 2018). An investigation of gender differences in comments on YouTube science channels (with similar methods to the current paper) confirmed the positivity bias of female commenters and the potential for substantial gender differences in audiences for YouTube channels with similar themes (Thelwall & Mas-Bleda, 2018). A much larger scale similar analysis of science channels found that female presenters were more likely to be the subject of sexual comments and negativity (Amarasekara & Grant, in press), although the prior study had found males to be the more likely target of criticism (Thelwall & Mas-Bleda, 2018). Negativity towards female presenters was also found by a comparison of two YouTube comedy channels (Döring & Mohseni, in press). In summary, prior quantitative studies have found gender dimensions to YouTube commenting and audiences, but suggest that hostility to females may sometimes be a problem.

Research Questions

This study assesses whether museums can attract gendered audiences through YouTube, in the sense of viewers that are substantially more from one gender than average of the museum type on YouTube. This is primarily addressed through the first research question. The second research question investigates *why* gender differences might be possible by identifying topics of interest that differ between males and females. The Discussion section following the results analyses whether the answers to the research questions are largely determined by the theme of a museum. If not, then museums might be able to target audiences by gender through YouTube.

- RQ1 (quantitative): Are there substantial differences between YouTube museum channels in the ratio of females to males that they attract, and is this also true for similar museums?
- RQ2 (mixed qualitative/quantitative): Are there gender differences in the topics discussed by YouTube museum channel video commenters overall (RQ2a) and within museums (RQ2b)?

Methods

The research design was to identify a set of popular museum YouTube channels, download the comments on the videos in each channel and analyse commenter genders and gender topics for each one. A relatively large-scale comparison is essential for investigating audiences because YouTube has its own demographic biases so that face-value interpretations of its statistics can be misleading (Haran and Poliakoff, 2011). A quantitative-led mixed methods triple text analysis approach was used: a qualitative investigation of the output from three complimentary quantitative analyses. The first method concerns the comment authors and the next two involve the comment text. Video commenters were analysed rather than video viewers because no public information is available about most video viewers. The methods are an adapted subset of those outlined in a recent article (Thelwall, 2018). The analysis steps were as follows.

- **Comment authors genders**: The ratio of female to male commenters was calculated for each museum YouTube channel so that audience genders could be compared (RQ1).
- **Overall gendered terms**: The individual words that are most likely to occur in female comments compared to male comments across *all* museums were found, and vice versa. This can point to the overall museum-related topics that are most interesting to these two genders (RQ2a).
- **Within museum gendered terms**: The individual words that are most likely to occur in female comments compared to male comments within *individual* museums were found, and vice versa. This can point to gender differences that tend to be cross-museum and could include narrower topics, themes or issues (RQ2b).

Data

Museum set

Lists of visitor numbers for museums in English speaking nations were used as a starting point to identify a suitable collection of popular museums to analyse. English speaking was a requirement for common ground with the gender and topic detection methods. Popular museums were chosen because these are more likely to have extensive YouTube collections, allowing more powerful and extensive analyses. Museum names from the lists were searched in YouTube to find associated channels. Channels were rejected if significant numbers of comments were not in English (for the text content analysis steps) or if there were less than 50 comments in total (for the statistical comparisons). To find additional museums with popular channels even if they are not popular offline, the term "museum" was searched in YouTube and matching channels investigated. Only museums with a physical presence were accepted. This step was chosen because there were YouTube-only museums, such as the Museum of Working Miniatures, for which the name "museum" seemed to be a marketing choice rather than an accurate description. There are some genuine virtual museums with a digital preservation and curation mission, such as Rhizome, but none were identified during the YouTube searches.

The above process identified 50 YouTube museum channels owned by physical museums with comments mainly in English. They were from the USA, UK, Canada, Australia and New Zealand.

Comment collection

The free software Mozdeh (http://mozdeh.wlv.ac.uk) was used to download a complete set of videos from each channel with the YouTube API. For each video, Mozdeh downloaded all available comments during February 14-15, 2018. For videos with many comments, only the most recent approximately 150 can be downloaded with the YouTube API and the older comments were ignored. This is a limitation but also an advantage because it prevents individual popular videos from dominating the results. In practice, the 150 restriction is unavoidable because it originates with YouTube and the only alternative, manually copying and pasting comments from the YouTube website, is impractical for the volume of comments gathered here.

Each comment has associated metadata, such as its author username and creation date. When the same person had commented multiple times on a video, only their first comment was retained to avoid their opinions dominating the results (an option in Mozdeh). The final dataset had 262,466 comments from unique commenters on videos from the YouTube channels of 50 museums.

Gender detection

YouTube does not report the gender of viewers or commenters but it is possible to infer the gender of some commenters from their usernames. This information was used as a proxy for audience gender information.

Each username was segmented into two parts, where possible, at the first apparent word boundary. This was either a space, a number, or a transition from lowercase to uppercase (e.g., Sarah Smith, Nicki99, InderjeetUppal). The first segment was then compared with dictionaries of predominantly male or female names. First names in the female dictionary are employed at least 90% of the time by females in the US 1990 census. A similar rule was applied for males and the titles Mr, Mrs, Ms were added as surrogate first names. This process resulted in 29% of the commenters being assigned a gender. The remainder were ignored for the gender analysis, leaving 74,815 comments with author genders.

This process produces some errors. In addition to minority gender names (e.g., a male Andrea), people may adopt a cross-gender nickname, may be non-binary, or may use their last name as the first part of their username (e.g., Scott, Jackson). A prior investigation suggested that the method usually identifies gender correctly but if a set of commenters was 50% male then this method would estimate it at 53% male[3], giving a small male bias. This was factored out of the analyses, when possible, and, since it is the same for all museums, does not greatly affect comparisons between museums. Since the gender detection is usually correct, for the minority of cases where it detects a gender, the term frequency comparisons discussed below work but are less statistically powerful than for more accurate and/or comprehensive gender detection.

Analysis

RQ1: Museum channel commenter gender ratios

The ratio of male to female commenters was calculated for each museum channel. Genders were determined using the heuristics described above and counting each video commenter

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[3] https://doi.org/10.6084/m9.figshare.5688622

only once to focus on the number of participants of each gender. The likely over-estimation of males was corrected for by multiplying the number of male commenters by 50/53 before the calculation. Similarly, the likely under-estimation of females was corrected for by multiplying the number of female commenters by 50/47 before the calculation.

RQ2a: Overall gendered terms

Overall gendered terms were detected by finding words that occurred in a higher percentage of female comments than of male comments, and vice versa. For example, if "like" occurred in 5% of the female-authored comments and 3% of the male-authored comments then it would be classed a female-gendered term. Since these proportions can differ by chance, a 2x2 chi-square test was used to judge whether a gender difference was statistically significant. This process was conducted systematically as follows.

A list was made of all 56,618 words in all comments. For each word, the number of male-authored and female-authored comments containing it was deduced, and a 2x2 chi-square value calculated from these numbers. The words were then listed in decreasing order of chi-square value and the Benjamini-Hochberg method (Benjamini and Hochberg, 1995; see also: Holm, 1979) used to select statistically significant terms. The Benjamini-Hochberg method controls the risk of one or more false positives (i.e., falsely concluding that a term is gendered) when running multiple individual tests. It requires higher values of the test statistic (the chi-square value) to be significant, and uses an efficient procedure to maximise the likely number of true positive results, whilst controlling the likelihood of one or more false positives to, typically, 5%, 1% or 0.1%. For the current paper, terms were regarded as gendered if reported as such by the Benjamini-Hochberg test at the 0.1% level.

The above was achieved with Mozdeh by selecting the female filter and clicking the Mine Associations button. This was repeated for the male filter and the results of both copied to Excel. To investigate each individual term for context, it was entered as a query in Mozdeh to find comments containing the term and the Mine association buttons used to find other words that often occur alongside it in comments.

RQ2b: Gendered terms within each museum channel

The above procedure was repeated within each museum channel to find words that were gendered within it. For example, if 6% of the female authored comments and 4% of the male authored comments from a channel contained the term "husband" then it would be regarded as a female gendered term for that channel. As above, multiple comments from the same user and comments with unknown user genders were excluded. Multiple comments from the same user were excluded for two reasons. First, having a common factor in multiple comments (the same person) invalidates the statistical tests used. Second, allowing multiple comments gives the possibility that a single active user or troll would dominate the results, shedding no light on the underlying gender differences. The same justifications have been previously used for quantitative YouTube comment analysis (Thelwall, 2018).

To identify terms that tended to be gendered within the comments of *multiple* museums, the top 10 male gendered and top 10 female gendered terms were extracted from each channel. Next, the gendered term lists from the 50 channels were combined and the terms that occurred in the top 10 for at least 5 lists were retained as the within-channel gendered terms, using the chi-square statistic for the ranking. The figures of 10 and 5 were chosen heuristically to give the most informative results. This approach was used rather than a statistical test for each individual term (e.g., Benjamini-Hochberg) because the requirement for a term to be in the top 10 of 5 lists reduces the chance of false positives.

Results and discussion

RQ1: Comment author genders by museum

There is an enormous difference in the gender composition of audiences for YouTube museum channels in terms of estimated commenter genders (Table 1). The number of females for every male varies from 0.07 (14 males for every female) to over 6. In the extreme case, the number of female commenters per male commenter is 94 times higher for National Museums Liverpool than for The Tank Museum. It is clearly possible for museums to attract either a mostly male audience or a mostly female audience through YouTube.

In contrast to the female majority of museum visitors, only 6 of the 50 channels have mostly female commenters. Four of these are art galleries, but there are many art gallery channels with a male commenter bias. The most male gendered museums cover traditionally male topics, including military history, space, and computers. Thus, in general, museums may attract genders online that correspond to the genders that they attract offline, except with a male bias.

Table 1. The number of comments from commenters with an inferred gender and the ratio of female to male commenters for 50 popular YouTube museum channels. Data from February 2018. Museums are in the USA unless stated or clear from the name.

Name	Gendered comments	F/M
National Museums Liverpool, UK	1716	6.59
Smithsonian NMAfA (National Museum of African Art)	38	2.45
Fine Arts Museums of San Francisco	97	1.43
MCA Australia (Museum of Contemporary Art)	27	1.08
Museum of Fine Arts, Boston	219	1.07
National Museums Scotland	45	1.05
Guggenheim Museum (art)	166	1.02
Newfields: A Place for Nature & the Arts (Indianapolis)	336	0.93
National Gallery of Victoria, Australia	48	0.85
Museum of Modern Art (Manhattan)	1411	0.84
National Museum of African American History and Culture	88	0.69
Getty Museum (Western art)	324	0.69
The National Gallery, London, UK	381	0.64
The Art Institute of Chicago	183	0.63
National Museum of American History	343	0.63
Imperial War Museums, UK	298	0.60
National Gallery of Art, UK	77	0.57
Saatchi Gallery (art, UK)	25	0.56
Australian Centre for the Moving Image	128	0.56
Corning Museum of Glass	2281	0.56
Courtauld Institute of Art, UK	34	0.55
Museums Sheffield, UK	49	0.53
Victoria and Albert Museum (London, UK)	692	0.53
LACMA — Los Angeles County Museum of Art	92	0.51
SAAM/Renwick Gallery [Smithsonian American Art Museum]	154	0.50

Natural History Museum, London, UK	374	0.49
Brooklyn Museum (art)	478	0.48
Tate (art, UK)	2243	0.47
Cooper Hewitt, Smithsonian Design Museum	167	0.45
Horniman Museum and Gardens, UK	13	0.44
Museum of Contemporary Art LA MoCA	3568	0.43
Museum of London, UK	73	0.43
National Portrait Gallery, UK	39	0.39
The Metropolitan Museum of Art, New York	995	0.38
San Francisco Museum of Modern Art	113	0.38
Walker Art Center	592	0.37
Royal Ontario Museum, Canada	114	0.37
Museum of the Bible, Washington DC	315	0.36
Queensland Art Gallery/GoMA, Australia	182	0.35
Penn Museum (Archaeology and Anthropology)	858	0.32
The British Museum	3339	0.32
Science Museum Group, UK	404	0.27
Smithsonian (group of museums)	31899	0.27
Museum of New Zealand Te Papa Tongarewa	1940	0.21
Royal Museums Greenwich (space, maritime, art), UK	78	0.20
American Museum of Natural History	9922	0.19
Computer History Museum, California	1719	0.16
Smithsonian National Air and Space Museum	992	0.12
National Museum of the Royal Navy, Portsmouth, UK	42	0.11
The Tank Museum, Bovington, UK	5104	0.07

RQ2a: Overall gendered terms

The terms that were female gendered at the 0.1% level for all museum channels combined were grouped into themes by reading comments containing the terms and conducting follow-up word association tests on them (Table 2). The themes partly reflect traditionally female interests, and perhaps the recent success of vampire romances. Personal expression (including personal pronoun use: Newman, Groom, Handelman, and Pennebaker, 2008) and positive sentiment (Thelwall, Wilkinson, and Uppal, 2010) are female-associated communication behaviours.

Table 2. Themes extracted from terms that were female gendered at the 0.1% level by exploring their context in comments. The data is the combined comment set from all videos. Singular and plural terms are merged.

Theme	Gendered terms within the theme
Clothes	dress, layer, pocket, dressed, clothe, wear, corset, dresses, jeans, knicker, clothing, wearing, century, bra, outfit, gown, summer, boob, wore, Victorian, pant, fashion, skirt, hair, Dita, Eliza, Hamilton, bathroom, pee, uncomfortable, maid
Positive sentiment	beautiful, love, thank, cute, omg, so, loved, amazing, wonderful, gorgeous, adorable, aww, wow, fascinating, lovely, sharing
Personal	I, my, am, wish, watching
Females	she, her, women, girl
Art	art, artist, glass, Corey (painting instructor)
Baby lion	cub
Shop	Woodprix
Vampire bats	bats [How Vampire Bats Suck Blood for 30 Minutes Unnoticed]

Male comments (geometric mean 12.4 words per comment, 95% confidence interval: (12.3, 12.5)) were longer than female comments (geometric mean 10.6 words per comment, 95% confidence interval: (10.4, 10.8)), on average. Because of this, some general words were more likely to be male-oriented. The terms that were male gendered at the 0.1% level were grouped into themes in the same way as for female terms (Table 3). The themes follow traditional male interests as well as argument. Online bullying (Li, 2006) and negativity (Alonzo and Aiken, 2004) are male-associated behaviours.

Table 3. Themes extracted from terms that were male gendered at the 0.1% level by exploring their context in comments. The data is the combined comment set from all videos. Singular and plural terms are merged.

Theme	Gendered terms within the theme
Military	tank, gun, war, German, Tiger, round, force, plane, bullet, Soviet, aircraft, turret, Sherman, shot, Fletcher (name), Jingle (name)
Argument	nothing, say, shit, far, not, no, theory, if, point, likely, evidence, but, fact, fuck, argument
Universe history	year, simulation, earth, exist, hundred, speed, existence
Science	science, number, thousand, mile, light
Religion	evolution, bible
Space	space, universe
Men	man, guy
Cars	car
Engines	engine
Games	game
Geopolitics	Europe
Computing	system
Things	the, a, an, it, on, in, out [typically used to discuss an object]
Nothing – length-related	of, as, or, which, by, is, there, be, than, we, that, any, at, with, and, from, only, has, into, to, then, one, another, most

RQ2b: Within channel gendered terms

Within video channels, terms that were most often female associated relate to expressing positive sentiment or females (Table 4). The latter suggests that museum channels might attract more females by having content about women.

Table 4. Terms that are in the top 10 male or female gendered terms in at least 5 of the 50 YouTube channels, together with the percentage of these channels in which the term is female-oriented. Qualification: over 50% female channels.

Term	Channels	Female %	Comment
love	16	100%	Positive sentiment
thank	13	100%	Positive sentiment
beautiful	9	100%	Positive sentiment
amazing	7	100%	Positive sentiment
she	11	91%	Female-oriented
her	9	89%	Female-oriented
loved	6	83%	Positive sentiment
so	10	80%	Positive sentiment
go	5	80%	Positive sentiment (wish I could go)
interesting	5	80%	Positive sentiment
work	6	67%	Positive sentiment/Art (work of art)
make	5	60%	Multiple
see	7	57%	Multiple
video	9	56%	Multiple

Male-associated terms within channels are often about males or things or are associated with arguments (Table 5). More content about men and objects may therefore attract a larger male audience.

Table 5. Terms that are in the top 10 male or female gendered terms in at least 5 of the 50 YouTube channels, together with the percentage of these channels in which the term is female-oriented. Generic length-related terms are excluded. Qualification: under 50% female channels.

Term	Channels	Female %	Comment
on	8	0%	Thing-oriented
he	6	0%	Male-oriented
his	6	0%	Male-oriented
would	6	0%	Argument
one	5	0%	Mixed
what	11	9%	Argument
not	8	13%	Argument
we	7	14%	Argument (we can see…)
but	6	17%	Argument
people	5	20%	Argument (people demand…)
an	12	25%	Thing-oriented
art	6	33%	Art
your	10	40%	Argument (people demand…)
like	5	40%	Argument/positive sentiment

Discussion: Museum theme vs. online audience gender

This study is limited by exclusion of smaller museums and the focus on commenters, which are a small and biased subset of YouTube users. It is restricted to museums with English language comments in YouTube, but cultural practices may be different in non-English countries. It only investigates males and females, and is based on guessing their genders from their names. It also does not address the context in which the videos are viewed. For example, some videos might enhance the visitor experience whilst others might be watched by people that do not intend to visit. Low representation of one gender for a museum YouTube channel does not necessarily mean that the channel is unattractive to that gender. This is because one or more of its videos might instead be highly attractive to another gender, dwarfing the numbers for the remaining genders. The analysis is also limited by the lack of public museum audience demographics (Merriman, 2018), so that it is impossible to compare the YouTube audience to physical visitors by gender.

Whilst it is clear from Table 1 that there are huge gender differences in the viewers for museums on YouTube, some analysis is needed to decide if and why the same is true for museums with similar types. The rest of this section relates audience genders to museum themes, seeking evidence about how some museum videos have attracted viewers with a gender balance that is untypical for the museum type.

There are several examples in Table 1 of museum channels with unexpected gender balances amongst their commenters. The American Museum of Natural History attracted 5 male commenters for every female commenter, which seems to be a high proportion of males for a natural history museum, especially compared to the Natural History Museum, London (2 male commenters per female commenter). The greater American Museum of Natural History male orientation was driven by religion-vs.-science arguments and its coverage of space issues (e.g., The Known Universe by AMNH[4]). The Museum of New Zealand Te Papa Tongarewa, which incorporates natural, social and cultural history as well as art, also had a

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[4] https://www.youtube.com/watch?v=17jymDn0W6U

male commenter bias (5 to 1). Its comments included many religion-related arguments, with the term *evolution* occurring in 19% of all gendered comments. Thus, in both of these cases, the high proportion of males commenting was generated by an issue (religion) that may be seen as tangential to the role of the museum. Thus, these cases do *not* give evidence of an unusual gender balance for the museum topic.

National Museums Liverpool attracted a large female audience through its video *Getting Dressed in the 18th Century*[5], with 3.6 million views. This was by far the most female gendered audience of any popular video in the dataset. This group of museums includes art galleries (Lady Lever Art Gallery, Sudley House, Walker Art Gallery), the presumably male-oriented Merseyside Maritime Museum, as well as the International Slavery Museum, the Museum of Liverpool and the World Museum. Thus, through this video, National Museums Liverpool has reached a particularly large online female audience for any type of museum, whether deliberately or not. Comments on this video were relevant and therefore the channel *does* give evidence of an unusual gender balance (a very high proportion of females) for the topic.

The Imperial War Museums channel has attracted a relatively high proportion of female commenters (although low in total) for a military museum. This seems to be due to its inclusion of content related to home life in war (e.g., Rationing In Britain[6]) rather than a focus on the machines of war, in contrast to those with machine-based themes, such as tank museums. The Imperial War Museums (see also: Loxham, 2015) explore "conflict and its impact on people's lives" (iwm.org.uk), indicating that the online content follows the offline strategy of engaging with the human side of war, which may be a deliberate attempt to appeal to a larger female audience. It has become normal for military museums to pay some attention to the ethical and wider dimensions of war (Watson and Massie, 2015), but the Imperial War Museums seem to go further than most. In this context, it is not clear whether its relatively female YouTube presence reflects its offline visitor demographics. Nevertheless, its YouTube presence is clearly female-friendly for its type. Thus, this case *does* again give evidence of an unusual gender balance (a relatively high proportion of females) for the topic.

Modern art museums had considerably different gender splits, again giving clear evidence that a museum's type does not fully determine its YouTube audience gender. The most female-oriented audience was for the Museum of Modern Art (Manhattan), which had a focus on painting. The Museum of Contemporary Art LA MoCA had one of the most male-oriented art gallery audiences. It had music themes in its *Art + Music* section, including a Bjork music video, with almost 4 million views[7], using "the earth's geology is a metaphor for human relationships". It also had a collection of videos, such as *The Art of Punk - Black Flag - Art + Music*[8] (300,000 views), analysing, through interviews with band members, the graphic art side of punk bands that presumably had mainly male audiences (Andrews, 2014). Other punk bands covered included *Crass* and *The Dead Kennedys*. Thus, this museum is addressing an aspect of art in a way that could be expected to attract a male audience and fits with the musical tradition of its host city. Videos about street art also attracted a male audience, "Where others see blight, these artists see a canvas"[9]. Again, this case *does* give evidence of an unusual gender balance (a relatively high proportion of males) for the topic.

In summary, whilst audience gender for a museum tends to be related to its topic overall (Table 1), it can be greatly influenced by decisions about the content to present in YouTube, or the individual museum collection or strategy. The evidence therefore suggests

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[5] https://www.youtube.com/watch?v=UpnwWP3fOSA
[6] https://www.youtube.com/watch?v=o9wNJ78S2GY
[7] https://www.youtube.com/watch?v=ZM80F_J-QHE
[8] https://www.youtube.com/watch?v=N0u04EqNVjo
[9] https://www.youtube.com/watch?v=fHF1huG-qZc

that a museum *can* find a predominantly male or female audience by generating suitable content.

Conclusions

The male majority of YouTube commenters for most channels contrasts with the apparent female majority of art gallery visitors, which form half of the museums analysed here. It is not clear whether this is due to a greater male tendency to comment on videos or whether it reflects a genuine online audience shift. If the latter is true, then YouTube is a good way for art galleries to reach a male audience. Nevertheless, the Liverpool example shows that YouTube can help a museum to reach an extremely large female audience, although it will be difficult to imitate the success of Liverpool. Two other examples show that museums can attract disproportionately many males or females for the museum type. Thus, museums are not constrained by their type about the audience genders that they can attract. The possibility to target online audiences by gender is an important practical implication of this research for science museums that seek to attract a larger female audience.

From a more theoretical perspective, the ability for museums to target genders online does not challenge theories about gender differences in interests that may lead to gendered museum attendances, as discussed in the literature review. Instead, as the individual YouTube examples show, and museum curators probably know offline, audience genders can be targeted by creating high quality content that addresses an aspect of the museum that is of greater interest to one gender.

In practice, good quality online content is expensive to create and does not always reach an audience because of competition for online attention. Nevertheless, since some museums have shown through their online presences that there is potential to reach new audiences and to target gender-related objectives, this option should be considered in the future when museums wish to target particular demographics.

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