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Article in Journal of Sexual Medicine · October 2016
DOI: 10.1016/j.jsxm.2016.07.013

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Homophobia is related to a low interest in sexuality in general: An analysis of pupillometric evoked responses.

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Running Head: HOMOPHOBIA AND PUPILLOMETRIC EVOKED RESPONSES

Word counts: 2691
Number of table: 1
Number of figures: 2

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Homophobia is related to a low interest in sexuality in general: An analysis of pupillometric evoked responses.

Abstract

Introduction. A recent study by Cheval et al. (2016) revealed that individual high in homophobia look significantly less long at sexual-related photographs, regardless of their nature (i.e., homosexual or heterosexual). As viewing time is under some conscious control, this result may indicate that individuals high in homophobia may either have a low sexual interest in any sexual stimuli or either be consciously motivated to avoid sexual material in line with their conscious values.

Aim. To determine the mechanism underlying shorter viewing time of sexual-related photographs in individuals high in homophobia using pupil dilatation, which is considered to be a spontaneous, unconscious, and uncontrollable index of sexual interest.

Methods. Heterosexual men ($N = 36$) first completed a questionnaire assessing their level of homonegativity and then performed a picture-viewing task with simultaneous eye-tracking recording to assess participants’ pupillary response to the presentation of sexually-related or neutral photographs.

Main outcomes measures. Non-Linear Mixed Models were carried out to fit the individual non-linear trajectories of pupillary reaction. Different parameters were obtained including the final asymptote of the pupillary response.

Results. Results revealed that the final pupil size of men high in homophobia increases significantly less to the presentation of sexual-related images (i.e., heterosexual and homosexual), than the pupil size of men low in homophobia. By contrast, no significant difference in the final pupil size reaction toward homosexual images (as compared to heterosexual images) emerged between men high vs. low in homophobia.
Conclusions. Theoretically these findings reinforce the necessity to consider that homophobia may reflect concerns about sexuality in general and not homosexuality in particular.

Keywords: homophobia, eye-tracking, pupillary responses, sexual interest.

Take Home Message: The final pupil size of men high in homophobia increases significantly less to the presentation of sexual-related stimuli than the pupil size of men low in homophobia. These findings indicate that men high in homophobia have a low interest in sexuality in general.
Introduction

Homophobia is defined as negative attitudes or behaviors toward homosexual as well as an aversion or a fear toward interacting with gay individuals [1-4]. Accordingly, homophobia involves cognitive, affective, and behavioral negative reaction towards homosexuality. Yet, homophobia is also correlated with attitudes not directly linked to homosexuality concerns. For instance, previous correlational studies revealed that homophobia in men is related to negative attitudes towards women [5], sexual anxiety and sexual guilt [6, 7], fear of femininity [8, 9], and erotophobia [10-12], which is the disposition to respond negatively to information of a sexual nature. Therefore, in this study, we are particularly interested in testing if homophobia influences homosexual interest in particular or sexual interest in general.

The use of explicit measures (self-reports obtained by questionnaire completion) are not particularly well suited to capture processes inaccessible to introspection, hard to report, or that the person may want to conceal [13]. For instance, self-reports have frequently been shown to deviate from more objective measures of sexual interest [1, 14]. Using a behavioral measure of sexual interest (i.e., the picture viewing time), a recent study by Cheval et al. [15] revealed that individual high in homophobia looked significantly less long at sexual related photographs, regardless of their nature (i.e., homosexual or heterosexual). This result may indicate that individual high in homophobia may have a lower sexual interest in sexual material in general, and not only in homosexual material in particular. Nevertheless, it is also possible that the sexual nature of the photographs may conflict with the consciously held values and beliefs of men high in homophobia, leading to their disengagement of the task. For example, homophobia has been shown to be associated with religiosity and conservative values [16], which indicates the endorsement of ideologies that generally promote a reduction
in sexual expression [17, 18]. Indeed, even if viewing time may be less controllable than self-reported measures, it could still be argued that viewing time is under some conscious control and that its decrease could reflect motivated strategic avoidance of sexual-related images [19, 20]. In other words, this decrease in viewing time may represent nothing more than a conscious form of self-regulation. Therefore, another measure, even more difficult to control, is needed to examine if men high in homophobia have a general low sexual interest or are instead consciously motivated to avoid sexual material in line with their conscious values.

The measure of pupil dilatation represents a valid technology to this purpose. Previous studies have revealed that pupil dilate more in response to stimuli that represent individuals reported sexual preferences [21-25]. For instance, heterosexual men’s pupils dilate more when they looked at pictures of half-naked women [22]. Importantly, pupil dilatation, unlike self-reported measures or viewing time, has the capacity to detect processes inaccessible to introspection or that the person would prefer to conceal [26]. For example, the pupil can react to motivational incentive that are not below the threshold of visibility [27]. In the domain of sexual interest, pupil dilatation was higher when women viewed photographs of their boyfriend during the ovulatory stage than at any other moment of their cycle, while their explicit evaluation did not change [28]. In addition, the pupillary responses that are provoked by external stimuli are considered to be impossible to control or to suppress as it is a quick and spontaneous reaction [29]. For example, pupil dilatation allows deviant pedophilic interests to be assessed with high diagnostic accuracy [30]. In sum, because pupillary changes in reaction to sexual material is an uncontrollable index of sexual interest, they can provide a suitable index to test whether the decrease in viewing time of sexual photographs among homophobic men reflects a general lower sexual interest, rather than a conscious form of self-regulation to avoid sexually related stimuli.
The present study

The purpose of the present study was to determine the mechanism underlying shorter viewing time of sexual-related photographs in individuals high in homophobia using pupil dilatation, which is considered to be a spontaneous, unconscious, and uncontrollable index of sexual interest.

Based on the aforementioned literature, we expected first that pupils dilate more for sexually-related photographs than for neutral photographs (H1). Second, we expected that pupils dilate more when heterosexual men looked at heterosexual photographs rather than at homosexual photographs (H2). Third, in line with the hypothesis about a generally low sexual interest, we expected that the pupil of individuals with a high level of homophobia dilate less when they looked at sexually-related photographs, than the pupil of individuals with a low level of homophobia. By contrast, no significant difference in pupillary responses to homosexual-related photographs (as compared to heterosexual photographs) should emerge between men low vs. high in homophobia (H3).

Method

Participants

Thirty-height heterosexual males (M_{age} = 22 years, SD = 4.74) recruited from the Psychology Department Research Subject Pool at the University of Geneva participated in exchange for course credits.

Procedure
Participants first completed a questionnaire including the Modern Homonegativity scale [16] and a question concerning their sexual orientation during large group testing at the start of the semester. One month later, participants came to the laboratory in order to perform a picture-viewing task. The design, methods, and primary results of the study have been described in detail elsewhere [15].

Measures

**Sexual orientation.** Participants were asked the following question concerning sexual orientation: “I consider my sexual orientation to be (choose only one)”. Participants had four response options: 1 = Straight (Heterosexual); 2 = Bisexual; 3 = Gay; 4 = Asexual. Only men who responded “Straight” were retained for this study (see [19] for a similar procedure).

**Modern Homonegativity scale.** The Modern Homonegativity scale was used to assess participants’ attitudes toward homosexuality [16]. This scale contains 12 items (e.g., “Gay men should stop complaining about the way they are treated in society, and simply get on with their lives”). Participants responded to each item on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

**Picture-Viewing Task.** Participants were asked to look at a total of 25 images to rate on how pleasant or unpleasant they believed these images were to view. Ten images represented homosexual couples, 10 represented heterosexual couples, and five represented neutral pictures. To control for visual features across stimuli, the contents of the images were matched across homosexual and heterosexual couples. In addition, all images were presented in black and white and at the same size (i.e., 200 x 500 pixels). Luminance was controlled throughout all trials. Participants’ pupillary reactions to the presentation of photographs were
continuously recorded every 16.6 ms using the Tobii T60 eye tracker (Tobii Technology, Inc., Danderyd, Sweden) and Tobii Studio Version 2.3.2 (Psychology Software Tools, Inc., http://www.pstnet.com/hardware.cfm?ID=107).

Data analyses. Two participants had to be excluded due to eye-tracker malfunctions. Data analyses were therefore carried out on 36 participants. Pupil dilatation was analyzed using Non-Linear Mixed Models (NLMM). Indeed, pupillary reaction to the presentation of specific stimuli is characterized by a non-linear pattern: a first period (300-500ms) characterized by a reflex constriction to accommodate to near visual stimuli [31] followed by an accelerating increase in pupil size early after the stimulus presentation until a plateau [32]. Such a pattern cannot ideally be estimated by a linear or polynomial function. Rather, a function of the exponential family can provide a good statistical adjustment to such data [33-35]. Rather than estimating a separate nonlinear regression for each individual, we followed the recommendation of Kret et al. [32] to use a mixed model, which is statistically superior. Basically, NLMM included functions that are nonlinear in their parameters, and may be therefore useful to parsimoniously fit the individual non-linear trajectories of pupillary reaction. NLMM separates the total variance in pupil reaction into intra-individual variance, which represents the individual trajectories, and inter-individual variance, which represents differences among individuals in the pupillary reactions trajectories.

In the current study, different types of nonlinear functions were tested, and model fit was determined with the Bayesian Information Criterion (BIC) and likelihood ratio tests. Concerning the preprocessing of the pupillometric data, we first normalized the signal to a baseline period obtained using the average of the pupil size of the 83 ms preceding the appearance of the pictures on the screen. Then, for each participant data were averaged by the type of pictures (i.e., homosexual, neutral, and heterosexual). Given that the correlation
between the left and right pupil was near perfect \((r=.98, p<.001)\), we used a single average index of pupil size. Extreme values in each individual series were removed when exceeding a value inferior or superior to two standard deviations of the mean. Because the pupillary reaction in the first period is a constriction reflex that is completely independent from the content of the stimuli [36], the first 350-ms period was excluded from the analyses. The model that best fit the data was a four-parameter logistic model [35].

\[
Y_{ij} = f(TIME_{ij}, p_i) + e_{ij} = \frac{\phi_2 + \phi_1 - \phi_1}{1 + e^{-\frac{\phi_3 - TIME_{ij}}{\phi_4}}} + e_{ij}
\]

where \(Y_{ij}\) is the level of pupil size at time \(i\) for individual \(j\), \(\phi_1\) is the lower horizontal asymptote, \(\phi_2\) is the higher horizontal asymptote, \(\phi_3\) is the inflection point, \(\phi_4\) is the scale parameter, and \(e_{ij}\) is the error term. The parameters \(\phi_2\) and \(\phi_3\) displayed variability across individuals (hence their subscript \(i\)).

In model 1, the type of picture (neutral, homosexual, heterosexual) was included as predictor of the pupil dilatation trajectory. Specifically, we computed two contrast codes: The first contrasts the sexual related pictures vs. the neutral pictures (homosexual and heterosexual = -1, neutral = 2); The second contrasts the homosexual pictures vs. the heterosexual pictures (homosexual = -1, heterosexual = 1, neutral = 0). These two contrasts were included as predictors of the higher horizontal asymptote and the inflection point (\(\phi_{2i}\) and \(\phi_{3i}\), respectively). Finally, in Model 2, the explicit level of homophobia and its interactions with the two orthogonal contrasts were included to predict the final asymptote (\(\phi_2\)), to test whether the effect of the type of pictures on the final pupil size significantly varies depending on the explicit level of homophobia. The variable assessing explicit level of homophobia was mean-centered. All models was estimated with PROC NLMIXED in the SAS software [37].
Results

In line with H1, Model 1 (see Table 1) revealed a significant effect of the first contrast on the parameter $\varphi_2$ ($b = -0.555$, $t_{34} = -12.59$, $p < .001$, 95% CI [-0.645, -0.466]), indicating that the pupil size of the participants at the final asymptote of the pupillary response is higher for sexually-related images than for neutral images (see Figure 1). Furthermore, in line with H2, results also revealed a significant effect of the second contrast (i.e., homosexual-related images vs. heterosexual-related images) on the parameter $\varphi_2$ ($b = 0.263$, $t_{34} = 4.24$, $p < .001$, 95% CI [0.412, 0.001]), indicating that the pupil size of the participants at the final asymptote of the pupillary response is higher for heterosexual-related images than for homosexual-related images (see Figure 1).

In line with H3, Model 2 (see Table 1) revealed a significant interactive effect between the first contrast and the level of homophobia on the parameter $\varphi_2$ ($b = 0.224$, $t_{34} = 5.83$, $p < .001$, 95% CI [0.146, 0.303]), indicating that the effect of the sexual-related images, as compared with the neutral images, on the pupil size of the participants at the final asymptote of the pupillary response significantly varies depending on the level of homophobia. Specifically, for participants with a low score of homophobia, results revealed that the pupil size is significantly higher for the sexual-related images than for the neutral images ($b = -0.722$, $t_{34} = -13.96$, $p < .001$, 95% CI [-0.823, -0.617]). This difference remained significant but was reduced among participants with a high level of homophobia ($b = -0.39$, $t_{34} = -7.53$, $p < .001$, 95% CI [-0.497, -0.286]) (see Figure 2). In other words, the pupils’ sized increased when individuals looked at sexual-related pictures (i.e., as expected in H1), irrespective of the level of homophobia. However, this effect was significantly more pronounced for participants with a low level of homophobia (i.e., as expected in H3). By contrast, results revealed a non-significant interactive effect between the second contrast and the level of homophobia on the
parameter $\phi_2 (p = .38)$, indicating that the effect of the heterosexual images, as compared with homosexual images, on the pupil size of the participants at the final asymptote of the pupillary response did not significantly vary depending on the level of homophobia. In other words, the effect of homosexual-related images, as compared to heterosexual-related images, on the final pupil size of the participants was identical for participants with a high or low level of homophobia.

Discussion

The major finding of this study was that the pupil size of men high in homophobia increases significantly less to the presentation of sexual-related stimuli (i.e., for both heterosexual and homosexual pictures), than the pupil size of men low in homophobia. This result indicates that the lower viewing time of sexual-related images among individuals high in homophobia found in Cheval et al. [15] study probably resulted from a spontaneous, unconscious reaction, rather than a strategic, conscious form of self-regulation, given that pupil dilation cannot easily be controlled.

Our results also confirmed the common finding that the pupil dilates more to sexual-related stimuli than neutral stimuli, as it does to stimuli that have a greater emotional intensity [38, 39]. Furthermore, given that all our participants declared themselves as heterosexual, results revealed that the pupil dilates more to heterosexual-related stimuli, than homosexual-related stimuli. This finding confirms that pupil dilatation appears to be a valid indicator of sexual orientations [25].

Interestingly, no significant difference in pupil size reaction toward homosexual images (as compared to heterosexual images) emerged between men high vs. low in homophobia. This
result suggests that men high in homophobia indeed have a lower sexual interest toward sexual-related stimuli in general, but not toward homosexual-related stimuli in particular (i.e., a specific reaction toward homosexuality). While these findings could be interpreted as indicating a form of erotophobia in homophobic men [10-12], we do not think that this interpretation is tenable in our study. As erotophobia implies a negative affect and a feeling of anxiety in reaction to information of sexual nature [40, 41], pupillary response should have increased in case of a feeling of anxiety and emotional response generated by the sexual materials [42, 43]. Because sexual photographs evoked a lower pupil size among highly homophobic in comparison to lowly homophobic men, our findings rather support a view of a low sexual interest associated with homophobia than a form of erotophobia, as no emotional responses seemed to be activated by the sexual materials.

The strengths of the current study include the use of (a) pupillary responses as an objective measure of sexual arousal that is not under voluntary control and (b) an innovative statistical method particularly suited to treat such data characterized by a non-linear pattern. At least three limitations should be noted, however. First, the sample was limited to male university students. Second, our study included a limited number of participants (N = 36). Although this small number of participants is not uncommon in studies examining pupillary reaction toward emotional stimuli [22, 23, 28] and appears to provide a sufficient level of power [44], future research should examine whether the results will generalize to a larger and more heterogeneous population. Third, the present study is carried out under laboratory conditions, which may limit the external validity of the current results.

To conclude, the originality of the present study was to examine differential sexual interest of men as a function of their attitudes toward homosexuality using a measure, namely, pupil
dilatation, that cannot be consciously controlled [26]. Using such unconscious and uncontrollable index of sexual interest, the present research suggests that men high in homophobia may have a lower sexual interest toward sexual-related stimuli in general, and not toward homosexual-related stimuli in particular. Theoretically these findings reinforce the necessity to consider that homophobia may reflect concerns in sexuality in general. Finally, the present findings further demonstrate that pupillometry could benefit to healthcare professionals. Indeed, this technique is particularly useful to overcome the limits associated with self-reported measures and may therefore improve the diagnosis and understanding of problematic sexual behaviors.
References


**Acknowledgments**

We would like to thank Adrianne Guerra and Gwendoline Peyratout for their help in the data acquisition.
Statement of Authorship

Category 1

(a) Conception and design
BC, RR

(b) Analysis of data
BC, RR, EG, PG

(c) Interpretation of the Data
BC, RR, EG, PG, FBD, JC

Category 2

(a) Drafting the article
BC, RR

(b) revising it critically for important intellectual content
BC, RR, EG, PG, FBD, JC

Category 3

(a) final approval of the version to be published
BC, RR, EG, PG, FBD, JC
Conflict of Interest

The Authors report no conflicts of interest.
Table 1. Influence of the type of pictures (i.e., homosexual, heterosexual or neutral) on the non-linear trajectory of pupil dilatation (model 1), depending on the level of homonegativity (model 2).

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Random effects
- Participants
  - $\varphi_2$: 11.91 11.60
  - $\varphi_3$: 109.12 111.88
- Covariance ($\varphi_2, \varphi_3$): -6.80 -6.73
- Residuals: 7.65 7.61
- Bayesian Information Criterion: 33850 33835

Notes. $\varphi_1$, $\varphi_2$, $\varphi_3$, and $\varphi_4$ represent the four parameters of the logistic function that best fits the data. $\varphi_1$ is equal to the lower horizontal asymptote, $\varphi_2$ to the higher horizontal asymptote, $\varphi_3$ to the inflection point, and $\varphi_4$ to the scale parameter; C1 contrasts the sexual related-pictures vs. the neutral pictures (homosexual and heterosexual = -1, neutral = 2); C2 contrasts the homosexual pictures vs. the heterosexual pictures (homosexual = -1, heterosexual = 1, neutral = 0); MHS = Modern homonegativity scale.
Figure 1. Pupil size change depending on the type of pictures (i.e., homosexual, heterosexual, or neutral)
Figure 2. Pupil size change depending on the type of pictures (i.e., homosexual, heterosexual, or neutral) and on the level of homophobia