Female sexual response to audiovisual stimuli in 2D/3D modality and first/third person perspective stance

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Abstract

The study investigates the effect of sexually explicit video stimuli displayed in a different modality (3D vs. 2D) and perspective (first vs. third person) on female sexual arousal, both subjective and genital, valence ratings, and sexual and general presence. We exposed 47 heterosexual female participants to four stimuli, two displayed on a flat screen and two using a VR headset. We used almost identical videos in both modalities and perspectives, thus eliminating any confounding variables caused by using different videos. We measured genital arousal via vaginal photoplethysmography (VPG) and subjective responses using questionnaires. We did not find any differences in modality or perspective in genital arousal. 2D videos were considered more subjectively arousing than the 3D videos ($d = 0.33$, $p = 0.02$). 2D videos and third-person perspective videos elicited stronger feelings of sexual (2D/3D: $d = 0.86$, $p < 0.001$; first/third person: $d = 0.50$, $p < 0.001$) and general presence (2D/3D: $d = 1.09$, $p < 0.001$; first/third person: $d = 0.75$, $p < 0.001$) than 3D videos and first-person perspective videos. Our findings are in discord with the previous studies. We discuss the possible causes of the observed differences.

1. Introduction

Virtual reality (VR) technology is rapidly advancing and finding applications in diverse markets, the pornography industry included. According to annual statistics of the pornography website Pornhub, terms related to VR porn regularly rank amongst the most searched categories in recent years [1–4]. The popularity of VR porn lies in its ability to capture real pornographic scenes with three-dimensional (3D) cameras with 180-degree or 360-degree views of the environment. In 180-degree VR porn, the camera captures a half-circle view of the scene, while in 360-degree VR porn, the camera captures a full-circle view. By putting on a VR headset, the user is transferred into the 3D scene. Typically, the camera is positioned in a way that makes the user feel as though they are a participant in the scene and witnessing the sexual activity from the viewpoint of a person involved. This category is denoted as "point of view" (POV) and is designed to provide a more realistic and immersive experience compared to the third-person perspective (3PP). In 3PP, the camera is typically positioned outside the scene. It provides a traditional view of seeing more of the performers and the setting, used primarily in two-dimensional (2D) modality, which may be less immersive than POV.

Despite the widespread popularity of 3D porn, only four studies employing experimental design to study its impact on sexual response were published [5–8]. Most of them explored the feeling of (sexual) presence and subjective sexual arousal. The concept of presence, as used in psychological literature, is described as the subjective impression of being in the virtual environment ("being there") [9]. Sexual presence is its extension that arises from the use of technology to mediate an experience of sexual arousal [10]. Subjective sexual arousal refers to a self-reported assessment of feeling sexually aroused and is usually aligned with the stated sexual preferences of participants [11]. Two studies [5, 8] compared the responses of male participants to presentation modality: 2D (on a desktop monitor) vs. 3D (in a VR headset). Both studies used POV videos depicting consensual heterosexual activities from a male perspective. Simon & Greitemeyer [8] reported that 3D modality induced higher physiological response
(measured via skin conductance), subjective sexual arousal (both continuous and retrospective), general and sexual presence with medium to large effects (\( R^2 = .12; .35; .47; .82; .78 \), respectively) compared to 2D modality. The authors also reported a positive correlation between the sexual presence and subjective sexual arousal in both modalities (2D and 3D). Dekker et al. [5] focused on the emotional and relational dimensions of each modality. They reported that men felt higher subjective sexual arousal, and desire for the actresses, felt more desired, flirted with, looked into the eyes, and felt a greater urge to interact with the actresses in 3D compared to 2D modality.

In addition to the presentation modality (2D vs. 3D), Elsey et al. and Milani et al. [6, 7] tackled a perspective stance (POV vs. 3PP) and added female participants to their sample. Both studies used VR headsets for all conditions, but in the 2D modality, participants did not have an opportunity to look around the scene. In line with the studies mentioned above, men reported greater subjective sexual arousal and presence in 3D modality, and those feelings heightened in POV [6]. Female participants also reported increased general and sexual presence [6, 7] in the 3D modality, but the results were ambiguous regarding subjective sexual arousal in both conditions.

Milani et al. [7] reported an increase of subjective sexual arousal in 3D over the 2D modality (although with a small effect, \( R^2=0.11 \)), whereas Elsey et al. [6] did not. A study by Milani et al. [7] used high-quality, women-centered erotica, while Elsey et al. [6] used videos aimed more at male viewers. The selection of appropriate videos is very important in measuring women's sexual responses [12, 13]. Stimuli used by Milani et al. [7] may enable women to enjoy more the arousing aspects of the videos in 3D modality than male-centered videos [6]. Additionally, Elsey et al. [6] employed between-subject design (participants were exposed either to 2D or 3D modality), whereas Milani et al. [7] within-subject design, which may also account for discrepant results.

The second inconsistency was an increased subjective sexual arousal to POV porn reported by Elsey et al. [6] and no significant difference in perspective stance by Milani et al. [7]. Previous studies used traditional sexual stimuli, such as erotic imagery, stories, images, or sexual videos. They found that women's subjective sexual arousal amplifies with the ability to attend to their own sexual feelings besides sexual stimuli [14, 15] and to imagine themselves as a participant in a sexual stimulus [16–19]. These findings suggest that allocating attention to erotic stimuli and emotional reactions intensifies subjective sexual arousal. Study participants [6, 7] did not receive any instruction on how to attend to the stimulus, so we can only speculate whether POV mediates the feeling of being an actress or is somewhat off-putting as participants do not see the reactions of the female actress, which can hinder their excitement.

Taken together, the impact of the presentation modality of perspective stance on female sexual arousal is rather unclear. Also, none of the studies utilizing VR technology have yet measured the genital arousal of participants. Although genital arousal can be elicited reliably in heterosexual women presented with sexual stimuli in laboratory settings, such arousal does not often correspond to their subjective sexual arousal as it does in men [20, 21]. The discordance shown by heterosexual women between genital and subjective sexual arousal likely reflects the difference between automatic and controlled processes.
According to an information processing model (IPM) [22] of sexual response, genital and subjective sexual arousal are mediated by two cognitive pathways. Genital response largely depends on quick, automatic processing and subjective sexual arousal on slower, controlled processing of sexual cues. The presence or absence of sexual activity appears to be the primary factor influencing genital arousal in women when exposed to sexual stimuli [23, 24] [25]. However, female genital arousal is, to some degree, sensitive to the intensity of the sexual activity depicted in stimuli, e.g., videos depicting sexual intercourse elicit greater genital arousal compared to videos depicting solo masturbation, caressing, or kissing [26]. Nevertheless, once the stimulus is of high intensity, the genital response seems to be unaffected by a perspective stance [16, 19]. For the same reason, it may be unaffected by presentation modality.

While 3D modality, and especially POV, seems to offer a more immersive sexual experience, the impact of VR porn on the female sexual experience is somewhat ambiguous. To unfold this puzzle, we compared presentation modality (3D vs. 2D) and perspective stance (POV vs. 3PP) on women's subjective sexual arousal, pleasantness ratings, feelings of sexual presence, and genital arousal while watching sexual audiovisual stimuli. We expected sexual presence and subjective sexual arousal to be higher in 3D compared to 2D modality [7] and in POV compared to 3PP [6]. Further, we expect genital arousal to be unaffected by either condition, as all the stimuli are of high intensity across all conditions [16].

2. Materials and Methods

2.1. Participants

We recruited 47 female participants through a pool of volunteers (sexlabnudz.cz) and social networks. To be eligible for the study, women had to be between 18–45 years old, fluent in the Czech language, sexually active, have experience with sexually explicit materials, predominantly heterosexual (1–2 on Kinsey scale [27]), and without stated sexual, endocrinological or psychiatric problems. Data from one participant were lost because of a technical issue, leaving 46 participants (M$_{age}$ = 28.96, SD$_{age}$ = 6.84). All participants received a reimbursement of 500 CZK (approx. 21 EUR) for participation. On the testing day, women could not be in the menstrual phase of the cycle due to hygienic reasons.

2.2. Demographic questionnaire

We used a short demographic questionnaire to assess the age, relationship status, and sexual orientation (via Kinsey scale [27]) of female participants, see Table 1).
<table>
<thead>
<tr>
<th>Table 1</th>
<th>Sociodemographic characteristics.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
</tr>
<tr>
<td>Sexual orientation (Kinsey scale)</td>
<td></td>
</tr>
<tr>
<td>Exclusively heterosexual</td>
<td>25</td>
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<tr>
<td>Predominantly heterosexual</td>
<td>21</td>
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<tr>
<td>Highest level of formal education</td>
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<tr>
<td>Primary education</td>
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<tr>
<td>Secondary education</td>
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<td>Master’s university degree</td>
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<tr>
<td>Relationship</td>
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<td>Long-term relationship, living separately</td>
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</tr>
<tr>
<td>Long-term relationship, living together</td>
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<tr>
<td>Married</td>
<td>7</td>
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<tr>
<td>Single</td>
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</tr>
<tr>
<td>Pornography usage</td>
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<tr>
<td>Several times a year</td>
<td>12</td>
</tr>
<tr>
<td>Once a month</td>
<td>5</td>
</tr>
<tr>
<td>Several times a month</td>
<td>14</td>
</tr>
<tr>
<td>Once a week</td>
<td>6</td>
</tr>
<tr>
<td>Several times a week</td>
<td>9</td>
</tr>
<tr>
<td>Experience with VR pornography</td>
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<td>Yes</td>
<td>2</td>
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<tr>
<td>No</td>
<td>44</td>
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<tr>
<td>Menstrual cycle</td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>43</td>
</tr>
<tr>
<td>Irregular*</td>
<td>3</td>
</tr>
<tr>
<td>Anticonception</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1: Anticonception and Abstinence

<table>
<thead>
<tr>
<th>Method</th>
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<tr>
<td>Condom</td>
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<td>39</td>
</tr>
<tr>
<td>Oral hormonal anticonception</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Other**</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>No anticonception</td>
<td>18</td>
<td>39</td>
</tr>
</tbody>
</table>

### Table 2: Smoking and Alcohol Usage

<table>
<thead>
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<th>Smoking</th>
<th>n</th>
<th>%</th>
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<tbody>
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<td>5</td>
<td>11</td>
</tr>
<tr>
<td>No</td>
<td>41</td>
<td>89</td>
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</table>

<table>
<thead>
<tr>
<th>Alcohol usage</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes***</td>
<td>28</td>
<td>61</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>39</td>
</tr>
</tbody>
</table>

Note. N = 46. *irregularity because of health issues and/or anticonception usage. ** hormonal/nonhormonal intrauterine device. *** light or mild usage

## 2.3. Experimental stimuli

We purchased two high-quality audiovisual stimuli for 3D modality (180-degree) a production company that focuses on VR porn (30 minutes each). The first stimulus depicted a scene from the POV of a female actress, and the second was from the 3PP. The selection of stimuli was mainly based on their similarity with regard to actors, environment, and sexual activities. We found stimuli depicting the same heterosexual dyad in the same room engaging in similar consensual sexual activities, which gradually increased in intensity: kissing, touching, oral, penetrative sex, and climax. Stimuli did not include the depiction of fetish, degradation, or violence. We cut the original 30 minutes long stimuli down to 4 minutes based on the content analysis carried out by the research team. We then converted the 3D stimuli to the 2D modality. Participants were presented with all four audiovisual stimuli (3D POV, 2D POV, 3D 3PP, 2D 3PP).

We presented the 3D stimuli using the HP Reverb VR3000 G2 VR headset with a resolution of 2160 x 2160 pixels per eye, a refresh rate of 90 Hz, and inbuilt headphones. For the 2D stimuli, we used the HP Z27s (27” or 69 cm) monitor with a resolution of 3840 x 2160 pixels, a refresh rate of 60 Hz, and external headphones.

## 2.4. Assessment of genital arousal

Genital arousal was measured using a vaginal photoplethysmograph (VPG; BIOPAC Systems, Inc., Santa Barbara, CA) and the software AcqKnowledge version 4.4.0 [28]. We used the Biopac MP150 system with the PPG100C module. The VPG comprises the transducer (TSD204) and interface (TCIIPPG2). One end of the transducer connects to the Biopac system; the other is the probe itself. The probe is a transparent,
tampon-sized acrylic device that consists of a light-emitting diode that illuminates the capillary part of the vaginal wall and a photocell that responds to light reflected from the vaginal wall and the blood in which it circulates [29]. Although it is an invasive probe, its size and shape allow participants to insert the diode by themselves. The depth and orientation of the diode are standardized by an acrylic plate placed on a plastic band to the diode. The diode and the acrylic plate were disinfected following the standard procedure after each use. VPG data were recorded continuously throughout each stimulus. The resulting signal for analysis was vaginal pulse amplitude (VPA), which reflects the cyclical changes in vaginal blood volume with each heartbeat. Higher amplitude reflects an increase in vaginal vasocongestion. The received signal was set in the 0.5–30 Hz band interface. We detected the movement artifacts through visual inspection and removed them before analysis. We calculated the mean VPA for the full length of each stimulus using peak-to-peak amplitude.

2.5. Subjective ratings

**Subjective sexual arousal.** After the presentation of each stimulus, women rated their subjective sexual arousal ("Rate on a scale how strong sexual arousal the video evoked in you."). Women recorded their answers on a 7-point scale (1 - not at all sexually aroused, 7 - very sexually aroused).

**Subjective pleasantness.** The first scale was followed by a second to determine the subjective pleasantness ratings of each stimulus ("Rate on a scale, how did the video affect you.") Women recorded their answers on a 7-point scale (1 - very unpleasant, 7 - very pleasant).

**Sexual Presence.** To assess the sexual presence, we used the questionnaire by Fontanesi & Renaud [10]. Women had to rate ten items assessing two subscales: level of realism (e.g., "To what extent the visual quality of the sexual scenes appeared realistic to you?") and the level of involvement (e.g., "To what extent did you have the feeling of witnessing live sexual intercourse taking place in front of you?"). The scale ranged from 1 (not at all) to 7 (completely). The questionnaire was translated from English into Czech by two members of the research team (AM, MH) and back to English by one member of the research team (ON) and a professional translator.

**Presence.** Part of the Igroup presence questionnaire (IPQ, [9]) was used. The complete questionnaire consists of fourteen items, one item for general presence, and three subscales: spatial presence (five items), involvement (four items), and realism (four items). The questionnaire was developed for the VR environment. Therefore, we decided to use only the questions that could also be answered while watching the 2D modality. These are, namely, the general presence (e.g., *In the computer-generated world, I had a sense of 'being there'* and involvement (e.g., *I was not aware of my real environment*). Several questions contained words like virtual world or environment. These were substituted by the word "scene." All items were assessed on a scale from 1 to 7. The questionnaire was translated from German into Czech by a member of the research team (MH) and back to German by two professional translators.

2.6. Experimental procedure
Participants were invited to the Centre of Sexual Health and Intervention at the National Institute of Mental Health (NIMH) in Klecany, Czech Republic. Before coming to the NIMH, participants completed a short online sociodemographic questionnaire to screen for exclusion criteria. Upon arriving at NIMH, participants were informed about the study's goals and signed informed consent. Five trained female researchers with a background in psychology delivered the whole procedure. A researcher was in the room during the measurement, separated from the participant by a folding screen. Participants were instructed on how to insert a vaginal probe and sat in a sterilized chair. Presentation modalities were delivered differently: for the 2D modality, desktop monitor from approx. 1 m was used together with a set of headphones available to participants at hand. Therefore, no assistance from the researcher was needed. Before the start of each stimulus presentation, the researcher informed the participant about the modality of the stimulus and provided her with instructions and enough time to get accustomed. For the 3D modality, the researcher placed the VR headset with integrated sound on the participant's head. Once the video was over, researcher took off the VR headset to minimalize the participant's movement.

First, the vaginal plethysmograph was calibrated, then participants solved sudoku for 3 minutes to calm themselves down. Each trial consisted of the following: (1) audiovisual stimuli screened for 4 min with continuous measurement of genital arousal; (2) a time window in which the participant filled questionnaires on tablet (subjective sexual arousal, ratings of pleasantness, sexual presence, presence); (3) a cognitive distractor in the form of sudoku solving on a tablet for 3 minutes to decrease sexual arousal. Every participant completed four trials in total. The order of the stimuli was randomized using Latin square. Participants had a short debriefing with a female researcher once the presentation ended. The whole procedure took around 50 minutes.

The research was performed in accordance with the Declaration of Helsinki and was approved by the Ethics Committee at the Faculty of Humanities, Charles University (no. 092022/Kli).

2.7. Statistical Analysis

Two researchers cleaned the data using AcqKnowledge 4.4.0. Their inter-rater reliability was computed using the Pearson correlation coefficient. The inter-rater reliability was very high, with $r = 0.99$, $p < .001$.

For genital arousal, vaginal pulse amplitude (VPA) was calculated.

For the subjective feelings, scores for sexual presence, general presence, and general involvement were calculated. Internal consistency of sexual presence and general involvement subscales was very high (Cronbach's $\alpha = 0.89$ and 0.93, respectively). Subjective sexual arousal ratings and ratings of pleasantness were not altered.

ANOVA with repeated measures and two within-subject factors of modality (3D vs. 2D) and perspective (POV vs. 3PP) was calculated for all dependent variables. Statistical significance was set at $p < .05$. Effect sizes are provided as partial eta squared ($\eta^2_p$) for main effects and interactions and as Cohen's $d$ for post hoc comparisons.
3. Results

3.1 Genital response

No main effect of modality was found, $F(1, 45) = 0.95, p = 0.33, \eta^2_p = 0.02$. No main effect of perspective was found, $F(1, 45) = 0.75, p = 0.39, \eta^2_p = 0.02$. No interaction effect between modality and perspective was found, $F(1, 45) = 1.74, p = 0.19, \eta^2_p = 0.04$.

There was no effect of order in genital response, $F(3, 135) = 0.26, p = 0.86, \eta^2_p = 0.01$. See also Fig. 1.

3.2 Subjective sexual arousal

There was a main effect of modality, $F(1, 45) = 6.44, p = 0.02, \eta^2_p = 0.13$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 4.24$) elicited more subjective sexual arousal than VR stimuli ($M = 3.70$; $d = 0.33, p = 0.02$). No main effect of perspective was found, $F(1, 45) = 2.58, p = 0.12, \eta^2_p = 0.05$. No interaction effect between modality and perspective was found, $F(1, 45) = 0.26, p = 0.61, \eta^2_p = 0.01$.

There was a main effect of order in subjective sexual arousal, $F(3, 135) = 4.97, p < 0.01, \eta^2_p = 0.10$. Post-hoc tests with Bonferroni correction revealed that first stimulus ($M = 4.63$) was rated as more arousing than second ($M = 3.76; d = 0.53, p = 0.01$), third ($M = 3.76; d = 0.53, p = 0.01$), and fourth stimulus ($M = 3.72; d = 0.55, p < 0.01$). There were no differences between the second, third, and fourth stimuli ($p = 1, d = 0$).

3.3 Pleasantness

No main effect of modality was found, $F(1, 45) = 2.02, p = 0.16, \eta^2_p = 0.04$. There was a main effect of perspective, $F(1, 45) = 6.89, p = 0.01, \eta^2_p = 0.13$. Post-hoc tests with Bonferroni correction revealed that POV videos ($M = 3.54$) were rated more pleasant than 3PP videos ($M = 3.11; d = 0.31, p = 0.01$). No interaction effect between modality and perspective was found, $F(1, 45) = 0.32, p = 0.58, \eta^2_p = 0.01$.

There was no effect of order in ratings of pleasantness, $F(3, 135) = 0.04, p = 0.99, \eta^2_p = 0$.

3.4 Sexual presence

There was a main effect of modality, $F(1, 45) = 38.85, p < 0.001, \eta^2_p = 0.46$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 4.59$) elicited higher levels of sexual presence than 3D stimuli ($M = 3.60; d = 0.86, p < 0.001$). There was a main effect of perspective, $F(1, 45) = 21.24, p < 0.001, \eta^2_p = 0.32$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 4.38$) elicited higher levels of sexual presence than POV stimuli ($M = 3.81; d = 0.50, p < 0.001$). No interaction effect between modality and perspective was found, $F(1, 45) = 0.03, p = 0.85, \eta^2_p = 0$. 
There was a main effect of order in sexual presence, $F(3, 135) = 2.84, p = 0.04, \eta^2_p = 0.06$. Post-hoc tests with Bonferroni correction revealed that first stimulus ($M = 4.48$) elicited larger sexual presence than second stimulus ($M = 3.88; d = 0.47, p < 0.05$), but not larger than third ($M = 4.07; d = 0.32, p = 0.42$) or fourth stimuli ($M = 3.97; d = 0.40, p = 0.14$). There were no differences between the second, third, and fourth stimuli ($p = 1, d = 0$).

### 3.5 General presence

There was a main effect of modality, $F(1, 45) = 45.62, p< 0.001, \eta^2_p = 0.50$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 5.43$) elicited higher levels of general presence than 3D stimuli ($M = 3.68; d = 1.09, p< 0.001$). There was a main effect of perspective, $F(1, 45) = 44.88, p<0.001, \eta^2_p = 0.50$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 5.16$) elicited higher levels of general presence than POV stimuli ($M = 3.95; d = 0.75, p< 0.001$). No interaction effect between modality and perspective was found, $F(1, 45) = 0.55, p = 0.46, \eta^2_p = 0.01$.

There was no effect of order in general presence, $F(3, 135) = 2.32, p = 0.08, \eta^2_p = 0.05$.

### 3.6 General Involvement

There was a main effect of modality, $F(1, 45) = 54.37, p< 0.001, \eta^2_p = 0.55$. Post-hoc tests with Bonferroni correction revealed that 2D stimuli ($M = 5.27$) elicited higher levels of general involvement than 3D stimuli ($M = 3.33; d = 1.30, p< 0.001$). There was a main effect of perspective, $F(1, 45) = 5.14, p = 0.03, \eta^2_p = 0.10$. Post-hoc tests with Bonferroni correction revealed that 3PP stimuli ($M = 4.48$) elicited higher levels of general involvement than POV stimuli ($M = 4.12; d = 0.24, p = 0.03$). No interaction effect between modality and perspective was found, $F(1, 45) = 0.38, p = 0.54, \eta^2_p = 0.01$.

There was no effect of order in general involvement, $F(3, 135) = 2.37, p = 0.07, \eta^2_p = 0.05$. See Fig. 2 and Table 2.
Table 2
Mean (SD) genital and subjective responses to all stimuli.

<table>
<thead>
<tr>
<th></th>
<th>Virtual reality (VR)</th>
<th>Two-dimensional (2D)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POV</td>
<td>3PP</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>VPA</td>
<td>0.037 (0.021)</td>
<td>0.035 (0.020)</td>
</tr>
<tr>
<td>Subjective sexual arousal</td>
<td>3.91 (1.67)</td>
<td>3.48 (1.72)</td>
</tr>
<tr>
<td>Pleasantness</td>
<td>3.48 (1.56)</td>
<td>2.96 (1.38)</td>
</tr>
<tr>
<td>General presence</td>
<td>3.01 (1.63)</td>
<td>4.35 (1.79)</td>
</tr>
<tr>
<td>General involvement</td>
<td>3.11 (1.52)</td>
<td>3.55 (1.77)</td>
</tr>
<tr>
<td>Sexual presence</td>
<td>3.31 (1.22)</td>
<td>3.90 (1.11)</td>
</tr>
</tbody>
</table>

Note. PPG: penile plethysmography. AUC: area under the curve. SD: standard deviation.

4. Discussion

4.1 Genital response

As predicted, we found no statistically significant differences between genital arousal across the stimuli. Our results support the previous findings that female genital arousal grows with the intensity of the stimuli, but only until some point. Once the intensity of the stimulus is high enough, one can no more observe any differences, such as in the case of the 3PP and POV stimuli [16, 19]. It seems that for the women in our sample, both the 2D and 3D stimuli were intense enough, so we could not observe any differences in genital arousal. To fully reveal if there are any differences in the perspective or modality in eliciting genital reactions, another study is needed. It should use stimuli of various degrees of intensity (e.g., kissing vs. penetrative sex) displayed across both perspectives and modalities.

4.2 Subjective responses

The studies performed on men [6, 8] found the 3D stimuli to be significantly stronger than 2D stimuli in eliciting sexual arousal, sexual presence, and general presence. Also, the POV stimuli scored higher in all aspects than the 3PP stimuli.

The two previous experimental studies on women reported higher sexual and general presence for the 3D stimuli than the 2D stimuli [6, 7]. One also found 3D stimuli more subjectively arousing than 2D stimuli [7], whereas the other study did not find any effect of modality on subjective arousal [6]. Our results are opposite to these findings. Women in our sample felt more sexually and generally present and more subjectively aroused while watching the 2D videos.
Elsey et al. [6] found the POV stimuli more subjectively sexually arousing than the 3PP stimuli. Milani et al. [7] found no differences in perspective on subjective sexual arousal but reported higher levels of general presence for POV stimuli. They also found higher sexual presence for POV, but only if the POV stimuli were displayed as first and in 2D. Our data are in accordance with the findings of Milani et al. [7] when subjective sexual arousal is concerned. However, our results are contradictory to both previous studies on sexual and general presence and general involvement. Our participants felt more present and involved when observing the 3PP videos. The POV stimuli scored higher only in pleasantness.

We also observed the order effect in the rating of subjective sexual arousal and sexual presence, where the first stimulus scored higher than the second (and the third and fourth in the case of subjective sexual arousal). Milani et al. [7] also reported the effect of the order on the subjective sexual arousal rating. Since we used four almost identical videos, it is unsurprising that sometimes the first one had the strongest effect. We solved this issue by randomizing the display order of the stimuli.

Our results seem to be somehow intriguing. It is clear that there are substantial differences between men and women in their attitudes toward pornographic videos of different perspectives and modalities. Men prefer 3D videos and POV in all aspects, whereas women in previous studies expressed less straightforward preferences. However, when women found some modality or perspective more arousing or immersive, it was usually also the 3D or POV variant. On the other hand, our current study found the 2D and 3PP stimuli to be more subjectively sexually arousing and immersing than the 3D and POV stimuli.

Previous studies on women had a different design - both of them displayed several videos with different actors and actresses, whereas we used almost identical videos across both modalities and perspectives. Moreover, Elsey et al. [6] used a between-subject design, but we displayed all stimuli to all participants. We might therefore ask if the observed higher strength of 3D and POV stimuli in previous studies was caused by the modality and perspective, the content of specific videos, or a simple novelty effect. However, two studies with different stimuli reported similar trends, so the specific content of stimuli probably did not play a much important role.

Our results suggest that the 3PP perspective allowed women to better identify with the actress, as suggested by Janssen et al. [17]. Observing her facial expressions and pleasurable reactions might have helped our participants feel more present in the scene and more sexually aroused.

The preference for the 2D modality requires further inspection. Our participants might have felt more at ease and relaxed while watching videos on a flat-screen than when they had the VR headset. The VR headset puts extra weight on the head, and it also makes it more difficult for the person wearing them to know what is happening around them. This fact might increase the immersivity of the videos, but it might also cause some distress because the person can not fully control their surroundings (for example, do not see someone coming). The manipulation with the VR headset required the presence of a researcher, which might also have a disturbing effect. It is also possible that since most participants had no or minimal experience with the VR headset and VR pornography, it might feel unnatural or unexpected, hindering both the participants’ arousal and sense of presence.
Another important factor, which is often neglected, is the male actor. The importance of self-identification with the female actress was reported [17], but the actors are usually not taken into account. However, if the participants do not like the actor (e.g., they find him unattractive, intimidating, or annoying), they would not like to identify with the actress. It might therefore be more subjectively arousing and also realistic to see a different woman enjoying pleasurable moments with an unlikeable man than imagining oneself having sex with him. This might lead to the preference for 3PP and 2D videos because they allow the participants to keep a safe distance from what is happening in the scene. However, women in our sample also found the POV videos more pleasant, which might mean they found it more pleasant to identify with the actress or did not want to see her. In any case, it would be beneficial in future studies to ask the participants about their feelings towards the actors, actresses, and the scene in general.

4.3 Limitations and prospects

The fact that we used almost identical videos four times is our study’s greatest strength but also a weakness. We observed the effect of order in some of our measures, and the actor and actress might have also influenced the participants. It would be better to have more different videos (identical across perspectives and modalities), but it was impossible to find them. Also, the length of the measurement would be unbearably long. It would be beneficial to have a debrief interview with the participants, ask about their attitudes toward the actors and actresses and the scene in general, and investigate more deeply how they felt while watching the videos in each modality and perspective. To better understand the role of modality and perspective on the genital response, it would be interesting to conduct a study using stimuli of different intensity levels (kissing, masturbation, penetrative sex) across 2D and 3D, and 3PP and POV conditions.

5. Conclusion

Our results found that women are equally genitally aroused while watching pornographic videos of different modalities and perspectives. However, they express higher levels of subjective sexual arousal, sexual presence, and general presence and involvement when watching 2D stimuli. They also felt more present and involved when watching 3PP videos. On the other hand, they found the POV videos more pleasant. Our results are in discord with previous experimental studies, possibly due to a different study design. Further research is needed to address the observed differences. Our findings suggest that using 3D and POV stimuli in the research of female sexual arousal might be unnecessary or even counterproductive, and classical 2D videos might still present a better option.

Declarations

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Data availability

All data generated or analysed during this study are included in this published article [and its supplementary information files].

References


Figures
Figure 1

Mean genital response. Error bars represent standard errors of the mean.
Figure 2

Mean responses for subjective sexual arousal (top left), sexual presence (top right), general presence (bottom left), and general involvement (bottom right). Error bars represent standard errors of the mean.

Supplementary Files

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• 20230324datasetreadme.txt
• 20230324dataset.csv