INTERNATIONAL SCHOOL FOR ADVANCED STUDIES

Neuroscience Area

Cognitive Neuroscience Curriculum

How perceived sexual objectification shapes low and high level cognitive processes: a multi-level and multi-method investigation.

Supervisor

Dr. Giorgia Silani

Co-supervisor

Dr. Andrea Carnaghi

Author

Carlotta Cogoni

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy in Cognitive Neuroscience

January 23rd, 2017

JURY

Externals

Anne Maass

Dipartimento di Psicologia dello Sviluppo e della Socializzazione
Università degli studi di Padova, Italy

Leonhard Schilbach

Independent Max Planck Research Group for Social Neuroscience
Max Planck Institute of Psychiatry, Munich, Germany

Internals

Domenica Bueti

Neuroscience Area
International School for Advanced Studies (SISSA), Trieste, Italy

Davide Zoccolan

Neuroscience Area
International School for Advanced Studies (SISSA), Trieste, Italy

Marilena Aiello

Neuroscience Area
International School for Advanced Studies (SISSA), Trieste, Italy

ACKNOWLEDGEMENTS

This work is supported by PRIN (2012)-20123X2PXT grant to A.C and G.S.

“Senza spiegare nulla, senza dirti dove,

ci sarà sempre un mare, che ti chiamerà.”

Alessandro Baricco

Contents

General Overview of the Thesis

Philosophers, sociologists and psychologists agree about the existence of a prominent plague of the western society known under the term of objectification. Such a phenomenon has been initially theorized by Kant (1780), described as the denial of humanity to objectified people and their use as a means for others' desires. In 1995, Nussbaum extended this definition by highlighting other problematic aspects such as similar denial of autonomy and agency. Besides these philosophical analyses, extensive work has been done by psychological research in order to investigate the phenomenon from the objectified person perspective and from the point of view of the 'objectifier'. The second perspective is the focus of the present work.

Although in principle any person can be objectified, women are mostly the targets of this phenomenon. Specifically when women are evaluated solely for their physical appearance, excluding other non -physical characteristics, they are victim of a precise form of objectification which falls under the banner of '*sexual objectification'* (American Psychological Association, 2007). In general, sexual objectification is operationalized by portraying women with revealing clothes with appealing bodily parts such as hip and breast prominently displayed. The consequences of the sexual objectification are huge, varying from the perception of the woman as less human (Loughnan et al., 2010), less moral (Loughnan et al., 2013), to the perception of being less competent (Heflick & Goldenberg, 2009), and less agentic (Gray et al., 2011) as compared to non-sexualized female targets.

Moreover objectified women can also be dehumanized when associated with animals (Vaes et al., 2011) or assimilated to objects (Bernard et al., 2012; Bernard et al., 2015). However, the literature regarding the assimilation of objectified women to objects is still incomplete.

First, it is still controversial whether objectified women are visually processed as objects, namely whether the processing style recruited with non-living entities is similarly to the processing style involved when objectified women are the perceptual target. This idea was only recently experimentally investigated with the *sexual body part recognition bias hypothesis* (Gervais et al., 2012) and with the *sexualized body inversion hypothesis* (Bernard et al., 2012). Using a parts versus whole body recognition paradigm, which is a robust indicator of local (underlies object recognition) versus global processing (underlies person recognition), Gervais and colleagues showed that women's bodies, but not men's bodies, are reduced to their sexual body parts in perceivers' minds. On the other hand, using an images recognition task assessing the inversion effect (impaired recognition of the stimuli in the inverted orientation as compared to the upright orientation). Bernard and colleagues showed that sexualized women are perceived analytically (like objects) whereas sexualized men are perceived configurally (like human beings). Both lines of research represent the first attempt to provide empirical evidences on the way in which the objectification likely shapes spontaneous perceptual processing styles, albeit they suffer from some limitations. This empirical effort have not directly compared the processing styles of objectified and personalized women, thus not ascertaining whether women per se or only objectified women trigger analytic processing style. Moreover authors failed to include a crucial control condition that allowed for a direct comparison of the processing style associated with objectified women to the processing style employed when perceiving objects.

Second, research concerning the neural mechanisms associated with the empathic reactions for objectified and personalized women who experience social pain is elusive. In light of the gender-based violence, together with the perception of sexualized targets from a visual point of view (low level cognitive process), it is of particular interest to understand the negative consequences of the objectification phenomenon and how it affects the social cognition (high level cognitive process). The tendency to violently act is in fact likely connected to a dampen of the empathic feeling of the perpetrator toward the victim of the violence (Baron-Cohen, 2011), but the supposed lack of empathy toward sexualized targets has been only theorized.

The purpose of the work presented in this thesis is to address these two points.

Indeed this work comprises three chapters describing experiments that seek to determine how objectification modulates the visual perception and the social cognition of objectified and personalized women.

In Chapter 1 we investigate the visual perception of objectified women, using an image recognition paradigm. We challenge the validity of the sexualized-body inversion hypothesis through 4 sets of experiments. Specifically, we extend previous evidence in literature testing a direct comparison between sexualized and personalized (less sexualized) women using also real objects and human-like objects (mannequin) as control conditions. In addition, we test the mediating and moderating role of the symmetrical features of the stimuli, to avoid that the visual features of the stimuli, other than the sexualization, could shape the sexualized body inversion effect.

In Chapter 2 we investigate the effects of the perceived sexual objectification on the high level cognitive processes, using an empathy for affective touch paradigm. Given the hypothesizes diminished empathic feeling as a negative consequence of the objectification, we assess how the empathy for positive and negative emotions, can be modulated according to the degree of sexualization of the target of the empathic judgment.

In Chapter 3 we investigate how the perceived sexual objectification modulates high level cognitive processes using an empathy for social exclusion paradigm. Specifically we test at behavioral and neural level whether the degree of sexualization of a target shapes the empathic feeling during a social exclusion event.

Chapter 1

Visual Perception of Objectified women[1]

[1] This research is in preparation for the publication in a peer-reviewed journal: Carlotta Cogoni, Andrea Carnaghi, Aleksandra Mitrovic, Helmut Leder, Carlo Fantoni, Giorgia Silani. Are women really processed like objects? Visual processing styles can also be a measure of the objectification processes.

Abstract

Sexually objectified women (i.e., with a focus on the body) are supposed to be perceived in a way that resembles the visual processing of inanimate objects (analytical processing vs. configural processing). The current study aims at extending the understanding of the mechanisms behind visual processing of sexualized women by comparing them with non-sexualized (personalized) women, and real objects. Female and male participants performed a visual matching task in which they had to recognize images of objects (i.e., houses) and targets. Images consisted of sexualized women, personalized women or human-like objects (i.e., mannequins). Extending the work of Bernard et al. (2012), we observed the "inversion effect" (i.e., images are harder to recognize when presented upside-down compared to when they are shown upright), a major indicator of the configural processing style, for the images of personalized women and mannequins, but not for sexualized women and houses (Study 1 and 2). This result suggests that sexualized women are processed in a more analytical way than the personalized ones, with an effect comparable to the processing of objects, such as houses, which are not affected by the inversion effect. In addition, we demonstrated an association between a specific modus of visual exploration of the images (through the analysis of the eyes' movements) and an analytical or configural processing style, resulting in the lack or the presence of the inversion effect respectively (Study 3). Finally, we provide the first direct evidence that not only the sexual attributes of the images modulate the inversion effect in human entities, but also that other perceptual features of the stimuli such as the asymmetry, play a moderating role in shaping the inversion effect (Study 4).

Introduction

Far from being new, the idea that (especially) women can be considered similar to objects, as a function of their sexual attributes, has increasingly attracted the attention of the media and of the general public (Monro & Huon, 2005). Bartky (1990) defined this phenomenon as sexual objectification: a condition in which the individual´s sexual parts or sexual functions are separated out from the person, reduced to the status of mere instruments, as if they were able of representing her/him. In the last decades, the scientific community has begun to investigate the cognitive mechanisms and consequences associated with such a phenomenon. It has been observed that when a female target has been sexually objectified, the target is likely to be deprived from her mind, moral status (Loughnan et al., 2010) and agency (Cikara et al., 2011), which are core characteristics that distinguish humans from animals and nonliving things (Haslam, 2006). As a consequence, the social feelings toward the objectified target are negatively modulated resulting in diminished empathic reactions (Cogoni et al., 2016). Interestingly not only high level cognitive processes seem to be affected by the level of the sexual objectification of the targets, but also more basic cognitive processes are likely to be modulated. As far as the processes involved in face recognition are concerned, Gervais and colleagues (2012), showed for example that women´s sexual-body parts were visually recognized equally well regardless of whether they were presented in the context of the entire body or in isolation, whereas men's sexual-body parts were recognized better when they were presented in the context of the entire body rather than in isolation. The authors interpreted this pattern of results as an indicator of different cognitive processing styles: local, part-based (or analytical) versus global (holistic or configural) processing, which have been found to be associated with the object and person recognition, respectively (Tanaka & Farah, 1993). In other words, the authors suggested that female-sexual-body parts could be processed in an analytical fashion, mimicking the elaboration of objects (i.e., *sexual body part recognition bias hypothesis*).

In a similar vein, Bernard and colleagues (2012) measured the size of the inversion effect in order to ascertain the processing style associated with the perception of sexualized targets. The inversion effect indicates that visual stimuli which are processed in a configural way, such as faces and bodies, are more difficult to be recognized upside down than right side up (Köhler, 1940; Dallett et al., 1968; Yin, 1969; Tanaka & Farah, 1993; Leder & Bruce, 2000; Maurer et al., 2002; Leder & Carbon, 2006). In a visual matching task, participants were presented with pictures of sexualized (portrayed in swimsuit clothes) women and men, both in the upright and inverted orientation. Participants (independently of their gender) performed better when sexualized men were presented in the upright compared to the inverted orientation, but this difference was not found for the sexualized women. The authors interpreted the data as evidence in favor of the *sexualized-body inversion hypothesis* (i.e., SBIH): since the body of sexualized women, but not of sexualized men, was recognized equally well when upright and when inverted, the body of sexualized women were likely to be processed in an analytic fashion, namely more similar to objects than persons, thus impeding the occurrence of the inversion effect (Bernard et al., 2012).

However, several criticisms have been raised following Bernard and colleagues' conclusions. In particular, Tarr (2013) pointed out that non-social perceptual factors could have explained the *sexualized-body inversion effect* (i.e., SBIE). Specifically, the visual properties of the stimuli, such as complexity, distinctiveness and asymmetry, were not controlled in the original study. For example, pictures could have differed for their asymmetry, with a higher percentage of more asymmetric postures in the stimuli depicting women, which might have resulted in an easier recognition of these stimuli in the inverted orientation. Another factor could have been related to attention, with participants attending more to the female images than to the male images. This would have resulted in a performance for inverted female images closer to ceiling, with a corresponding absence of inversion effect. Finally, a non-sexualized condition was not included, preventing from concluding that the sexualized nature of the stimulus accounted for the observed pattern of results. All these uncontrolled factors prevent therefore a clear conclusion on the origin of the SBIE. These criticisms were followed by a series of experiments aiming at replicating original Bernard's findings, by controlling for possible confounding variables (see Schmidt et al. 2015 and Bernard et al., 2015 for opposite results). These studies left the debate on the social and perceptual variables accounting for the absence of invertion effect in sexually objectified targets (Bernard et al. 2012) still open, with a lack of a general consensus on the SBIH. The aim of the present set of studies is therefore to bring the research on sexual objectification a step further by addressing three different, albeit related points.

First, differently from previous research, we tested the core assumption of the SBIH that puts forward a similar cognitive processing style of sexualized female targets and objects, by including two object-control conditions (i.e., human silhouettes, such as mannequins, and houses). Second we intend to ascertain whether the SBIE is mainly driven by differences in stimulus asymmetry, by testing the mediating role of this visual feature in determining (or not) the SBIE (i.e., asymmetry as *mediator* variable). Third, we addressed the boundary conditions of the SBIE, by analyzing whether systematic variations in stimulus asymmetry selectively enhance or suppress the recognition accuracy of sexualized (vs. non-sexualized) female targets in the visual matching task (i.e., asymmetry as *moderator* variable). Lastly, we extended the knowledge on the recognition strategy adopted in the image recognition task by tracking the eye movements during the performance, allowing specifying the relationship between the SBIE and the presence of attentional biases. To this aim, four different experiments were carried out on completely independent samples.

Testing the core assumption of the SBIH

A core assumption of the SBIH is that sexualized women and objects are processed in a similar analytical manner. However, no direct test of this claim has been carried out so far, thus precluding any conclusion on the similarity of the perceptual processes involved in the perception of sexualized women and objects. To address this issue, we assessed the extent to which analytical processing varied with different types of objects and different types of women. Indeed, in Experiment 1 and 2, two control conditions were employed, consisting of houses and human-like objects (mannequins).

We selected these two kinds of objects for two distinct, albeit related reasons. We included houses since they: (1) have been extensively used in previous research when comparing objects versus person recognition (Scapinello & Yarmey, 1970; Haxby et al., 1999; Reed et al., 2003; Reed et al., 2006); (2) are generally not affected by the inversion effect (Tanaka & Farah, 1993); and (3) are shapes with minimal asymmetry as measured, following Schmidt et al. (2015), by the deviations of the shape-axes from the horizontal. Second, we included mannequins with a woman-like shape to investigate how objects that have a silhouette similar to females are processed, but hardly be personalized. Interestingly, it has been already shown (Krach et al., 2008) that the more human-like features are displayed by an entity, the more the perceiver humanizes that entity (i.e., he/she constructs a model of its mind); at the same time, mannequins are likely to be perceived as deprived of sexual characteristics. Both features (i.e. the human-like shape and the lack of sexual characteristics) may have an impact on the inversion effect.

Furthermore, a sexualized and less-sexualized conditions (sexualized and personalized conditions from now on) were used, by selecting pictures that represent women in real-life clothing. The same women were shown either wearing a swimsuit (sexualized condition) or casual clothes (personalized condition; see Vaes et al., 2011 for a more detailed definition of sexualized and personalized women). The selection of this type of stimuli assures the comparability of the two stimulus categories, without introducing artificial manipulation of the pictures (i.e. opaque skin color or pixellation techniques used instead in Schmidt et al. 2015 and Bernard et al., 2015 respectively), and allows for gaining a more ecological picture setting.

In line with the results by Bernard and colleagues (2012, 2015) and Schmidt and colleagues (2015), in Experiment 1 and 2 we expected to find no difference in terms of accuracy when participants have to recognize both sexualized women and houses in the upward or in the inverted orientation. By contrast, participants are expected to be less accurate when recognizing personalized women in the upward than in the inverted orientation. As for mannequins, if mannequins' human-like features, deprived of sexual attributes, trigger a humanized representation of this type of stimuli, then one would expect participants to adopt a configural processing style, with better recognition in the upward than in the inverted orientation. Alternatively, if mannequins are not processed as human entities, then their recognition will be similarly to the recognition of houses, with no inversion effect indicating a more analytical processing style.

On the mediating and moderating role of stimulus asymmetry in the SBIE.

Stimulus asymmetry can play a *moderator* and/or a *mediator* function in the SBIE. According to Baron and Kenny's (1996) theoretical and empirical efforts, a mediator variable represents the '*generative mechanism*' by which an independent variable affects the dependent variable. Said otherwise, the independent variable is able to impact on the dependent variable because it alters an intervening, third variable. Recasting this definition within SBIH research, the difference in terms of asymmetry (i.e., potential mediator) between the stimulus pictures, for example sexualized males vs. females (i.e. independent variable), might account for the different impact of these stimuli on the accuracy in the visual matching task (i.e., dependent variable).

The moderator variable refers to the division of an independent variable into subgroups that define its domains of maximal effectiveness on the dependent variable. Said otherwise, the moderator variable shapes the direction of the effects of the independent variable on the dependent variable. Recasting this definition within the SBIH research, the experimental manipulation of the difference in terms of asymmetry, having some stimuli with high asymmetry and others with low asymmetry (i.e., potential moderator), would allow us to specify the conditions under which the stimulus pictures (i.e. independent variable) might (or might not) exert a different impact on the accuracy (i.e., dependent variable) in the visual matching task.

Based on this rational, in Experiment 1 and 2 we relied on the experimental protocol outlined by Bernard et al. (2012), and used a completely new but comparable dataset of visual stimuli. More importantly, we let the level of asymmetry between stimuli co-varying with the level of sexualization of these stimuli, namely the higher the sexualization of the stimuli, the higher the asymmetry of the stimuli in question, and considering the houses as a relevant baseline condition in which at null level of sexualization corresponds almost null asymmetry. In so doing, we tested whether asymmetry *mediates* the SBIE, thus ascertaining whether the original findings reported by Bernard et al. (2012) were indeed driven by a stimulus artifact. To be noticed that, albeit Schmidt and colleagues (2015) assessed the level of stimulus asymmetry in the original dataset used by Bernard et al., 2012, no meditational analysis has been carried out to directly test Schmidt et al.'s claim.

In Experiment 3 we relied on the stimuli characteristics outlined by Schmidt et al. (2015), using a dataset of visual stimuli with different sexualization levels but equal asymmetry. In so doing, we test whether the SBIE holds when the stimuli are comparable for the visual properties.

Finally, in Experiment 4 we systematically varied the stimulus asymmetry, thus addressing whether this visual property of the stimuli can *moderate* the effect of the set of pictures on the accuracy in the visual matching task. Indeed, when high asymmetry stimuli are employed, it might be plausible that the accuracy in the visual matching task turns out to be easier than when low asymmetry stimuli are used in that task ('the more asymmetric the stimuli, the easier the task'; Schmidt et al. 2015, p.78). Two alternative hypotheses can be put forward. First, if the asymmetry plays a role by itself, then it should be found that upward and inverted pictures should be equally and accurately recognized when pictures are high asymmetrical than low asymmetrical, regardless of the type of pictures, being these more or less sexualized. This pattern of results would claim that a feature artifact mainly drives the SBIE.

Second, if the asymmetry moderated the recognition of the upward and inverted pictures differently for more and less sexualized pictures, then this would suggest that the artifact claim about the SBIE should be dismissed. In particular, if no difference in the upward and inverted position of more and less sexualized pictures occurred for high asymmetrical stimuli, this would confirm that asymmetry facilitated the recognition process. By contrast, and for low asymmetry pictures, if the sexualized stimuli would be accurately and equally recognized in the upward and inverted position, but less sexualized stimuli would be better recognized in the upward than inverted position, then the SBIH explanation, and not the asymmetry facilitation effect, could account for this observed pattern of results.

Addressing the mediating and/or the moderating role of the stimulus asymmetry within the SBIE would lead us to clarify *why* the observed effects occur (mediation) and *when* the effects hold (moderation). The combining findings on the mediation and moderation role of the asymmetry in the visual matching task would allow for either corroborating or dismissing the SBIH.

The role of the focus of attention in shaping the SBIE.

The SBIH claims a different recognition pattern (analytical and configural) adopted for each gender class of stimuli (women vs. men), possibly due to a different focus of attention during the visual exploration of the stimuli. It has already been shown that people tend to fixate more the chest and pelvic region compared to the face when scanning pictures representing naked people compared to dressed ones (Nummenmaa et al., 2012). Similar results have been found by Gervais et al. 2013, who reported participants focusing on pictures of women's chests and waists more, compared to the face, when asked to evaluate models' attractiveness. Moreover, this effect was particularly pronounced for women with more (vs. average and less) ideal body shape (pronounced breast and lower waist-to-hip ratios). However, to date, no direct measure of the SBIE resulting from an analysis of the visual exploration of the stimuli during the matching task has been performed, leaving the strategy behind the different recognition pattern been indirectly deducted solely from the behavioral performance.

In order to overcome this limitation, the visual-matching task of Experiment 3 was performed while participants' eyes' movement was recorded with an eye tracker. We predicted that the visual exploration of the personalized images would be more focused on the face as compared to the chest and the pelvic region. If this would hold true, the focus on the face would trigger a configural recognition style followed by a disruption of this recognition style during the processing of inverted stimuli and the consequent emergence of the inversion effect. On the contrary, we predicted higher focus on the chest and pelvic region during the exploration of the sexualized stimuli, associated to an analytic processing style resulting in an equal recognition of the images in both the orientations (absence of the inversion effect).

Experiment 1

Methods

Participants

One hundred forty-six healthy students (*N* = 87 men and *N* = 59 women; age *M* = 23.93, *SD* = 3.7 years) took part in the present study in exchange of monetary reward. The study was conducted at the SISSA. All participants gave written informed consent before participating in the study, which was approved by the SISSA ethical committee and treated in accordance with the Declaration of Helsinki. Participants were naïve to the aim of the study and had not participated in similar experiments before.

Stimuli

The experimental stimulus set consisted of 24 pictures of women wearing a swimsuit or underwear, with 86% of their body left uncovered (sexualized condition), 24 pictures of women wearing casual/classical clothes, with 28 % of their body left uncovered (personalized condition), and 24 pictures of female mannequins, with breast, and hip/waist that cued a human-female shape, without clothes (mannequins condition). Twenty-four pictures of houses were used as control condition. See Figure S1 for an exemplar house stimulus.

Stimuli were collected from free sources from the web. In particular, for the pictures of the women, pictures of the same model portrayed in the sexualized as well as in the personalized condition were selected, thus preserving identity across conditions. Pictures of houses were chosen from the "Pasadena houses dataset" (vision.caltech.edu).

Women and mannequins´ pictures were shown from head to knee, in a standing position, with eyes/face focused on the camera. All pictures were modified to have a white background, same luminance and the dimension of 397 x 576 Pixels (see Figure 1 for an exemplar of each stimulus´ category).

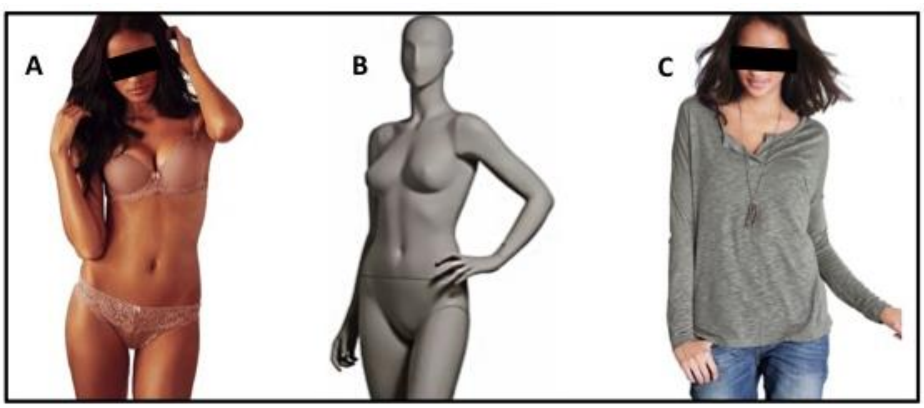

Figure 1. *Exemplar target stimuli.* Sexualized woman picture (A), Mannequin picture (B), Personalized woman picture (C). All stimuli were presented without covering black bars.

Furthermore, in order to confirm that the selected sexualized women were perceived as more attractive and sexy than the personalized women, and to gather information on the way mannequins were perceived on these dimensions, a pretest was conducted on an independent pool of 30 participants issued from the same population of the experimental sample. They rated the personalized women, sexualized women and mannequins on a 6-point scale, ranging from 1 (= not at all) to 6 (= completely) on the perceived level of attractiveness, sexiness, intelligence and familiarity. As expected, sexualized women were rated as sexier and attractive than the personalized ones and the mannequins; the personalized pictures were rated as more attractive than the mannequins. Also, the personalized women were rated as more intelligent than the sexualized ones and the mannequins, and the sexualized women as more intelligent than the mannequins. Also, the personalized women were rated as more familiar than the mannequins and the sexualized ones; no significant difference was found between sexualized women and mannequins (see Supplementary Results for the full statistic).

In addition, following the procedure introduced by Schmidt and colleagues (2015), an asymmetry index was calculated for each human-like picture. It was obtained as the average of the angles between each of the four body axes (i.e. shoulders, elbows, hands and hips) and the horizontal axis Importantly, sexualized women were found to be more asymmetric than the personalized ones and the mannequins' pictures (see next subsection).

Analysis of the symmetries of the stimuli

Following Schmidt et al. (2015) procedure, we chose to focus on the angles of four Body-Axes measured for the three Conditions (Personalized, Sexualized and Mannequins): shoulders, elbows, hands and hips. The angles were calculated by drawing a straight line connecting the right and left body-points of the picture. Schmidt (2015) took into consideration also the angle of the eyes but this measure was not applicable for all the three groups because pictures of mannequins didn't have eyes. Therefore, this parameter was not considered (note that an independent sample *t*-test revealed no differences in the eyes´ angles between the pictures of the sexualized (M = 6.85, SD = 9.55) and the personalized women (M = 9.80, SD = 11.18), t (46) = -.98, p = .33, d = .28.

Taking into consideration the Average Axes values (mean of the four different axes), a one-way ANOVA was conducted. Results showed a significant difference between Conditions (Sexualized, Personalized and Mannequins). Post-hoc analyses revealed that the sexualized women (M = 22.45, SD = 10.02) were less symmetric than the personalized women (M = 14.91, SD = 9.32), t (46) =2.70, p = .01, d = .78; and the mannequins (M = 8.96, SD = 4.47) were more symmetric than the sexualized women t (46) = 6.02, p < .001, d = 1.74 and personalized women t (46) = 2.81, p = .007 d = .81. See Table S3 for the separate axes values.

Note that a separate analysis for the pictures presented in the upward and downward orientations was not necessary given that every picture was randomly assigned to both conditions.

Procedure

Participant took part in a picture recognition task with a similar procedure as in Bernard at al. (2012), but with a novel set of pictures and in a between-subjects design. Participants were randomly assigned to one of the three experimental groups: sexualized women (N = 28 men and N = 19 women), personalized women (N = 28 men and N = 20 women), and mannequins (N = 31 men and N = 20 women). Each group was presented with a total number of 48 pictures: 24 target pictures (personalized women, sexualized women or mannequins, depending on the experimental group) and 24 pictures of houses used as a baseline condition. Twelve pictures from each condition were presented in the upright orientation while the remaining 12 were inverted on the x axis (top-down). Orientation and order of presentation were pseudo-randomized. For each trial, an picture appeared in the middle of the computer screen for 250 *ms*, followed by a blank screen for 1000 *ms*. Immediately after, participants were presented with two pictures, one on the left side of the screen and one on the right, in which one of the two was the original picture, and the other was its left-right mirrored version. Participants were requested to indicate which one of the two pictures they had previously seen (Figure S2) by pressing a right key (i.e., the “L” letter), or a left key (i.e., the “A” letter). Pictures were presented on a computer screen using Cogent Toolbox (http://www.vislab.ucl.ac.uk/cogent.php), running on Matlab 2011a. Before starting the experiment, participants completed 4 practice trials, in order to familiarize with the task. The individual pattern of responses were recorded and analyzed both for women/mannequins and houses, upright and inverted pictures. Following Knoblauch & Maloney (2012), individual standardized values of matching accuracy were analyzed encoding individual responses as a binary variable in term of correct (1) - incorrect (0) matchings and sending the whole pattern of binary responses to a generalized linear model (*glm*) with a probit link function. The *glmer* was performed using the *mixed* function of the package for Analysis of Factorial Experiments (afex, v.0.13-145), running on lme4 (v.1.1-7). To avoid derivative calculation, an optimizer (bobyqa) was chosen.

Accuracy analyses were performed using the 3.3.2 version of the RStudio software. As for the analyses on the mediating role of asymmetry for the SBIE, the boostrap Lavaan R software (Rosseel, 2012) was used with 1000 iterations for the implementation of a Structural Equation model without latent variables. The Analyses on asymmetry and pretest evaluations were instead performed using the IBM statistics software SPSS, version 21.

Results

Accuracy

Individual accuracy in the matching task was analyzed using a *glmer* model with 4 Condition (Houses, Sexualized, Personalized, Mannequins) x 2 Orientations (Upright, Inverted) x 2 Gender of the participant (Male, Female) as fixed effects. Participants were treated as random effects so to control for the individual variability of matching performance as signaled by accuracy. An outlier analyses was applied in order to exclude from the original sample all the subjects which had, among all conditions, a performance below the chance level (i.e., 75% correct) in more than 37.5% of tested experimental conditions resulting in 29 outliers' subjects and a final total number of 117 subjects (N = 77 men and N = 40 women). After the application of this exclusion criterion we removed those trials in which any one of the considered individual binary response deviated more than 4 SD from the individual best fitting *glmer* model, including all interaction terms as fixed factors, no trials were removed from the analyses (5616 trials in total) (For a similar outlier analysis see Ratcliff, 1993, Piccoli et al., 2016). We used type 3-like two tailed p-values for significance estimates of glme's fixed effects and parameters adjusting for the F-tests the denominator degrees-of freedom with the Satterthwaite approximation based on SAS proc mixed theory (Rigutti et al., 2015).

Figure 3 illustrates the average proportion of correct responses (and SEMs) together with the best as a function of condition for the two levels of orientation: inverted (light grey) vs. upright (dark grey). The analysis based on the *glm* model revealed a significant main effect of the Gender of the participants, with men collecting a higher accuracy than women (*glmer* estimated accuracy for men vs. women = .93 ± .011 vs. .90 ± .017, z = 38.06, p <. 001; F (1, 5615) = 10.09, p = .001). The Gender however did not significantly interact with any other variable p >.19. A main effect of the Orientation was found F (1, 5615) = 6.472, p = .01, which was further qualified by the interaction with the Condition F (2, 5615) = 6.19, p < .001. In order to clarify the origin of such an interaction we looked at the effect of Orientation on the accuracy separately for each condition and run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for each condition subsets. Analyses revealed that, pictures were better recognized in the upright than the inverted position in the personalized (*glmer* estimated accuracy for upright vs. inverted = .96 ± .024 vs. .90 ± .04, z = 3.13, p =. 002; F (1,791) = 9.81, p = .001) and in the mennequin condition (*glmer* estimated accuracy for upright vs. inverted = .96 ± .020 vs. .91 ± .03, z = 3.35, p <. 001; F (1, 1007) = 11.17, p < .001) but not in the sexualized condition (*glmer* estimated accuracy for upright vs. inverted =.96 ± .019 vs. .94 ± .024, z = 1.83, p =. 07; F (1, 1007) = 3.35, p = .07).

Notably the pattern of matching accuracy resulting from the sexualized condition was strictly similar to the one resulting from the house-baseline condition with upright and inverted houses being almost equally recognized across the three groups (*glmer* estimated accuracy for upright vs. inverted = .90 ± .02 vs. .91 ± .02, z = .832, p = .41; F (1, 2808) = .69, p = .51).

In addition, to gather evidence that houses were equally well recognized in the upright and inverted Orientation and, most importantly for our purpose, that the recognition of the houses was similar for the three experimental groups, we also run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for the houses subsets of each Group. Data revealed that houses were recognized with a similar accuracy rate in the upward and in the reversed Orientation in the Personalized (*glmer* estimated accuracy for upright vs. inverted = .91 ± .03 vs. .91 ± .03, z =1.02, p =. 31; F (1, 1007) = 1.74, p = .19), in the Sexualized (*glmer* estimated accuracy for upright vs. inverted = .87 ± .03 vs. .90 ± .03, z = 14.34,

p <. 001, F (1, 1007) = 1.04, p = .30) as well as in the Mannequin group (*glmer* estimated accuracy for upright vs. inverted = .89 ± .03 vs. .91 ± .03, z =14.89, p <. 001; F (1, 1007) = .73, p = .39). Hence, this allowed us to rely on the accuracy score of houses as a proper baseline condition. See Figure 3.

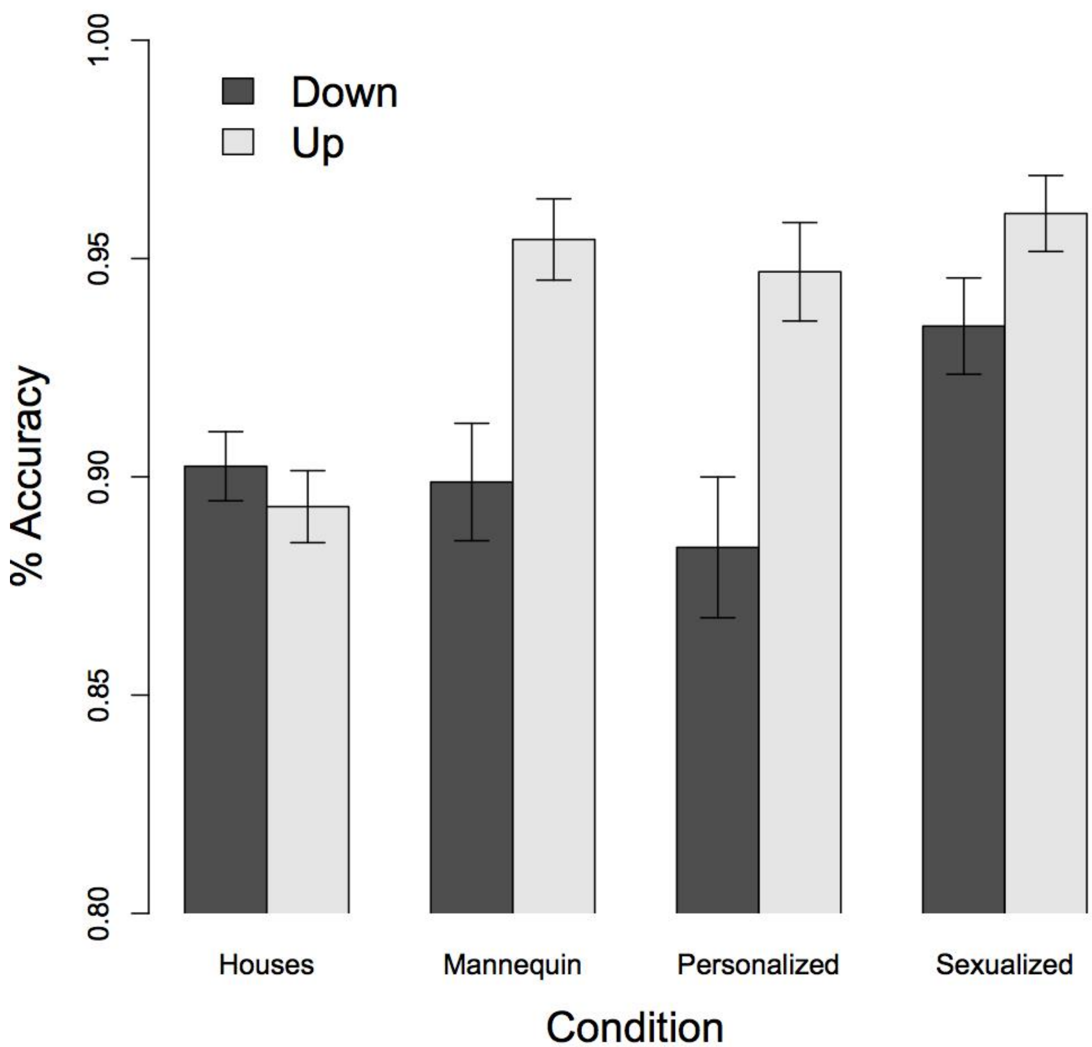

Figure 3. *Accuracy*. Mean values of the accuracy score split by Condition (Target pictures or Houses), Orientation (Up and Down), and Group (Sexualized, Personalized and Mannequins) are reported. Error bars ± *SE*.

Mediation analyses

In order to corroborate the results from the glmer and to test whether the SBIE was mainly driven by the different asymmetry of stimuli belonging to different experimental conditions (House, Mannequin, Sexualized or Personalized women) a causal mediation analysis was performed. In order to do that, we analyzed how the inversion induced by each image (calculated as the difference between the proportion of correct responses in upright vs. inverted orientation associated to each image), was accounted by the Condition and/or by the asymmetry. The analysis was thus performed on 96 inversion values (resulting from the combination of 4 condition × 24 image) contrasting linear models (*lm*) allowing to establish the mutual relationship between the causal variable (i.e., condition), the potential mediator (i.e., asymmetry), and the outcome (i.e., inversion effect).

Such analysis thus allowed us to investigate to what extent the way in which condition and orientation interact to systematically affect the performance (as revealed by the *glmer* analysis) can be accounted by the their effect on asymmetry as a mediator, which in turn affects the inversion effect.

Through contrasting multiple *lm* models we thus inferred: 1) the Total Effect (*c* path) of the condition on the inversion effect, 2) whether the condition contribute to the variance of either the asymmetry as a mediator (*a* path), 3) the Indirect Effect (*b* path) examining to what extent the mediator contribute to the variance of the inversion effect, 4) the Direct Effect (*c'* path) providing a measure of whether the condition continued to predict the inversion effect with the mediators in the model. Coefficients associated to meaningfull paths have been estimated using a Structural Equation model without latent variables and with condition as predictor, asymmetry as mediator, and inversion effect as outcome.

The analysis revealed a good fit of the model (Hu & Bentler, 1999) with the Comparative Fit Index (CFI) always larger than 0.95 (CFI = 0.98, 1st to 3rd quartile 0.992 to 0.999) and the Standardized Root Mean-square Residual (SRMR) always smaller than 0.08 (SRMR = 0.037, 1st to 3rd quartile 0.018 to 0.045). The model was characterized by a significant Total Effect (*c* path) (r^2= 0.162, $F_{3,\ 92}$= 5.929, p< 0.001) with a minimal though not different from zero inversion effect for the house condition (*lm* estimated inversion effect = -0.0129 ± 0.0147, *t*= -0.880, *df*= 92, *p* = 0.381), which was equally smaller than the inversion effect found in both the mannequin (*lm* estimated inversion effect difference from the house inversion effect = 0.0747 ± 0.0207, *t*= 3.603, *df*= 92, *p* < 0.001) and the personalized women condition (*lm* estimated inversion effect difference from the house inversion effect = 0.074 ± 0.02073, *t*= 3.589, *df*= 92, *p* < 0.001), but not from the one found in the sexualized women condition (*lm* estimated inversion effect difference from the house inversion effect = 0.037 ± 0.0207, *t*= 1.79, *df*= 92, *p* = 0.08). Notably the magnitude of the Total Effect calculated on the inversion effect values was of about the same statistical entity of the Condition × Orientation interaction revealed by the *glm* analysis on the individual pattern of correct responses. This demonstrated that the 96 inversion effect values here used to infer the mediating role of asymmetry on the performance provided a reliable synthetic measure of individual performance.

Furthermore, as the condition significantly contributed to the variance of the inversion effect it also contributed to the variance of the asymmetry (SEM estimated coefficient = 5.822 ± 0.794; *z* = 7.331, *p* < 0.001; r^2= 0.58, $F_{3,\ 92}$= 41.67, *p* < 0.001), with the asymmetry of the mannequin (*lm* estimated asymmetry = 8.96 ± 2.079, *t*= 4.313, *df*= 92, p <0.001) and of the personalized woman (*lm* estimated asymmetry = 14.91 ± 2.079, *t*= 7.172, *df*= 92, p < 0.001), been intermediate and the one of the sexualized woman (*lm* estimated asymmetry = 22.45 ± 2.079, *t*= 10.797, *df*= 92, *p*

< 0.001), been maximal relative to the asymmetry imposed in the present analysis to houses as a baseline (i.e., 0). This result corroborated the condition by asymmetry co-variation revealed by the preliminary analysis of the asymmetry of the stimuli used in our dataset.

The relation between asymmetry and inversion effect (*b* path) resulted to be only partially reliable (SEM estimated coefficient = -0.002 ± 0.001, $z = -2.293$, $p = 0.02$) being not significant when considered directly ($r^2 = 0.0002$, $F_{1,94} = 0.017$, $p = 0.89$; *lm* estimated coefficient = -0.0009 ± 0.00073, $t = -0.133$, $df = 92$, $p = 0.89$) following James and Brett (1984), and significant when considered indirectly following Baron and Kenny (1986) as controlling for the effect of the condition as a causal variable (*lm* estimated coefficient = -0.002, ± 0.001, $t = -2.498$, $df = 91$, $p < 0.001$). The low reliability of such a mutual relationship only in part fulfills the criteria for the establishment of an asymmetry mediation of the total effect. However, the lack of mediation is fully demonstrated by the fact that the direct association between condition and inversion effect was not significantly affected by the addition of the asymmetry as a mediator (*c*' path) (SEM estimated coefficient = 0.030 ± 0.008, $z = 3.192$, $p = 0.001$; $F_{3,91} = 6.242$, $p = 0.01$). This was further corroborated by the fact that a significant loss in the fit was found when contrasting an *lm* model with asymmetry as the only predictor of inversion effect vs. an *lme* model including both asymmetry and condition ($F = 8.34$, $df = 3$, $p < 0.001$). The results of the mediation analysis thus provide no evidence that the asymmetry of images mediates the differential effect of inversion on matching performance observed among the different categories of images.

Experiment 2

The Experiment 2 was conducted to test the whether the results obtained in Experiment 1 using a between subject design generalize to a within subject design. To this aim, participants were exposed within the same experimental session to all types of images used in Experiment 1 (houses, mannequins, sexualized and personalized woman).

Methods

Participants

Eighty healthy students (*N* = 40 men and *N* = 40 women; age *M* = 23.06, *SD* = 3.23 years) took part in the present study in exchange of monetary reward. The study was conducted at the SISSA. All participants gave written informed consent before participating in the study, which was approved by the SISSA ethical committee and treated in accordance with the Declaration of Helsinki. Participants were naïve to the aim of the study and did not participate in similar experiments before.

Procedure

Participants were engaged in the same paradigm describe in the Experiment 1, but this time with a within subject design. Each participant therefore saw a total of 96 pictures: 72 target pictures (24 personalized women, 24 sexualized women and 24 mannequins) and 24 pictures of houses.

Results

Accuracy

Accuracy was analyzed by applying a generalized linear mixed effect model (*glmer*) with the same settings described in the Experiment 1.

The model contained 4 Condition (Sexualized, Personalized, Mannequins, Houses) x 2 Orientation (Upright, Inverted) x 2 Gender of the participant (Male, Female) fixed effects factors, while to control for the individual variability of matching performance as signaled by accuracy participants were treated as random effects. An outlier analyses was applied in order to exclude from the original sample all the subjects which had, among all conditions, a performance below the chance level (i.e., 75% correct) in more than 37.5% of tested experimental conditions resulting in 8 outliers' subjects and a final total number of 72 subjects. After the application of this exclusion criteria, trials in which any one of the considered individual binary response deviated more than 4 SD from the individual best fitting *glmer* model, including all interaction terms as fixed factors, were removed from the analyses (3 trials out of the remaining 6912).

Results revealed a significant main effect of Orientation F (1, 6908) = 14.26, p < .001, which was moderated by the Condition F (3, 6906) = 3.26, p = .02. In order to clarify the origin of such an interaction we looked at the effect of Orientation on the accuracy separately for each condition and run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for each condition subsets. Analyses indicated that the pictures were better recognized in the upright than the inverted position in the personalized (*glmer* estimated accuracy for upright vs. inverted = = .95 ± .02 vs. .92 ± .02, z = 2.28, p = .03; F (1, 1726) = 5.16, p = .02) and in the mennequin (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .89 ± .02, z = 4.15, p <. 001; F (1, 1726) = 17.26, p < .001) condition but not in the sexualized (*glmer* estimated accuracy for upright vs. inverted = .96 ± .02 vs. .96 ± .02, z = 0.31, p = .76; F (1, 1725) = .09, p = .76) and in the house condition (*glmer* estimated accuracy for upright vs. inverted = .92 ± .02 vs. .91 ± .02, z = 1.24, p = .21; F (1, 1726) = 1.55 p = .21).

All the other effects and interactions did not approach the significance level p > .12 (See Figure 4).

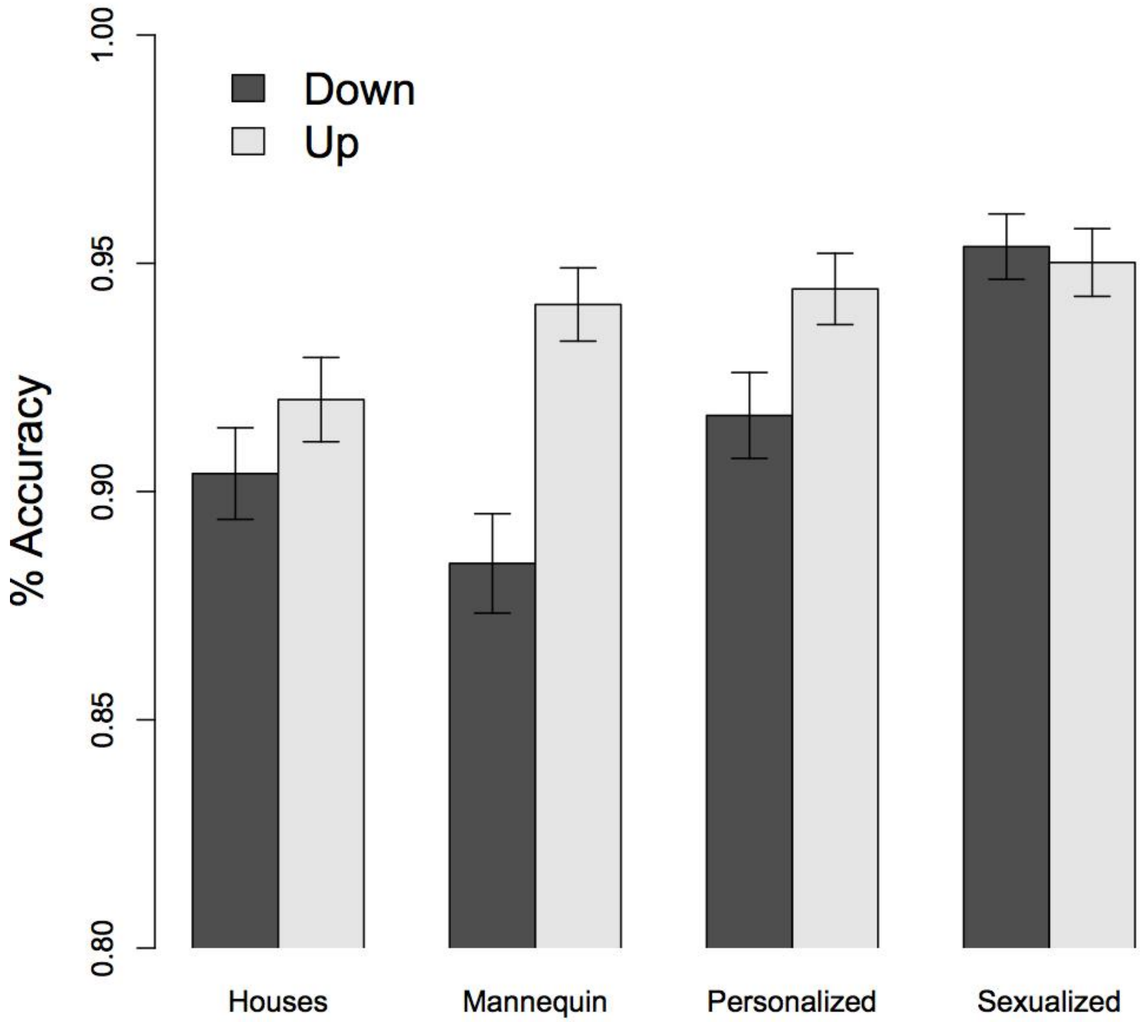

Figure 4. *Accuracy*. Mean values of the accuracy score split by condition (Sexualized, Personalized, Mannequins and Houses), and Orientation (Up and Down), are reported. The asterisk indicates the presence of the inversion effect. Error bars ± *SE*.

Mediation analyses

In order to ascertain whether the SBIE was mainly driven by the different asymmetry between the condition stimuli, a mediation analysis was conducted with the same parameters already described in Experiment 1.

The analysis revealed a good fit of the model (Hu & Bentler, 1999) with the Comparative Fit Index (CFI) always larger than 0.95 (CFI = 0.99, 1st to 3rd quartile 0.989 to 0.999) and the Standardized Root Mean-square Residual (SRMR) always smaller than 0.08 (SRMR = 0.0321, 1st to 3rd quartile 0.0115 to 0.0474). The model was characterized by a significant Total Effect (*c* path) (r^2= 0.10, $F_{3, 92}$= 3.42, p = 0.02) with a minimal though not different from zero inversion effect for the house condition (*lm* estimated inversion effect = 0.018 ± 0.0139, *t*= 1.313, *df*= 92, *p* = 0.19), which was smaller than the inversion effect found in the mannequin (*lm* estimated inversion effect difference from the house inversion effect = 0.0415 ± 0.019, *t*= 2.109, *df*= 92, *p* = 0.037) but not from the one found in the personalized women condition (*lm* estimated inversion effect difference from the house inversion effect = 0.009 ± 0.01967, *t*= 0.453, *df*= 92, *p* = 0.65) and in the sexualized women condition (*lm* estimated inversion effect difference from the house inversion effect = - 0.020 ± 0.01967, *t*= -1.032, *df*= 92, *p* = 0.30). Notably the magnitude of the Total Effect calculated on the inversion effect values was of about the same statistical entity of the Condition × Orientation interaction revealed by the *glm* analysis on the individual pattern of correct responses. This demonstrated that the 96 inversion effect values here used to infer the mediating role of asymmetry on the performance provided a reliable synthetic measure of individual performance.

Furthermore, as the condition significantly contributed to the variance of the inversion effect it also contributed to the variance of the asymmetry (SEM estimated coefficient = 5.822 ± 0.794; *z*

= 7.331, $p < 0.001$; $r^2 = 0.45$, $F_{3, 92}= 25.4$, $p < 0.001$), with the asymmetry of the mannequin (*lm* estimated asymmetry = 8.967 ± 2.079, $t= 4.313$, $df= 92$, $p < 0.001$) been lower, the one of the personalized woman been intermediate (*lm* estimated asymmetry = 14.91 ± 2.079, $t= 7.172$, $df= 92$, $p < 0.001$), and of the sexualized woman (*lm* estimated asymmetry = 22.45 ± 2.079, $t= 10.79$, $df= 92$, $p < 0.001$), been maximal relative to the asymmetry imposed in the present analysis to houses as a baseline (i.e., 0). This result corroborated the condition by asymmetry co-variation revealed by the preliminary analysis of the asymmetry of the stimuli used in our dataset.

Moreover, the relation between asymmetry and inversion effect (*b* path) resulted to be not statistically significant (SEM estimated coefficient = 0.001 ± 0.001, $z= -1.637$, $p = 0.102$) both when considered directly ($r^2 = 0.027$, $F_{1,94}= 2.65$, $p = 0.107$; *lm* estimated coefficient = -0.0001 ± 0.0006, $t= -1.629$, $df= 92$, $p = 0.106$) following James and Brett (1984), and indirectly (*lm* estimated coefficient = -0.001, ± 0.0009, $t= -1.04$, $df= 91$, $p = 0.29$) (Baron & Kenny, 1986) as controlling for the effect of the condition as a causal variable. However the direct association between condition and inversion effect was not significantly affected by the addition of the asymmetry as a mediator (c' path) ($F_{1,94}= 3.42$, $p= 0.02$). This was further corroborated by the fact that a significant loss in the fit was found when contrasting an *lm* model with asymmetry as the only predictor of inversion effect vs. an *lme* model including both asymmetry and condition ($F_{1,94}= 2.85$, $df= 3$, $p = 0.04$). The results of the mediation analysis thus provide no evidence that the asymmetry of images mediates the differential effect of inversion on matching performance observed among the different categories of images.

Experiment 3

In order to empirically rule out the possibility that the findings of Experiments 1 and 2 were due to the different level of asymmetry between conditions (given that a significant inversion effect was observed in both *Experiment 1* and *2* for the more symmetrical pictures: mannequins and personalized conditions), a third experiment was conducted with a new dataset of stimuli matched for asymmetry. The dataset was extended to include also sexualized and personalized male pictures. In addition, through an eye-tracker device, the movements of the eyes were recorded for each participant together with the usual behavioral data.

Eye-movements (i.e. mean fixation duration (MF) and total number of fixations (NF)), were analyzed to test whether differences in recognition for different categories can be explained by a different visual sampling of the body parts. Previous findings in literature already demonstrate a prevalent focus on the chest and pelvic region compared to the face when scanning pictures representing naked people compared to dressed ones (Nummenmaa et al., 2012). Therefore, we predicted higher MF and NF for the face region of personalized as compared with sexualized condition, and higher MF and NF on the chest and pelvic regions for sexualized vs. personalized condition. Finally, we expect that higher MF and NF when investigating the face region was associated with stronger inversion effect.

Methods

Participants

Sixty healthy students (*N* = 30 men and *N* = 30 women; age *M* = 27.52, *SD* = 7.46 years) took part in the present study in exchange of monetary reward. The study was conducted at the University of Vienna. Verbal instructions were translated in German based on the Italian version.

All participants gave written informed consent before participating in the study, which was approved by the University of Vienna ethical committee and treated in accordance with the Declaration of Helsinki. Participants were naïve to the aim of the study and did not participate in similar experiments before.

Stimuli

Participants were engaged in the same paradigm described in Experiment 2.

The stimuli dataset was extended to include 24 pictures of women and 24 pictures of man wearing a swimsuit or underwear (sexualized condition), 24 pictures of women and 24 pictures of man wearing casual/classical clothes (personalized condition).

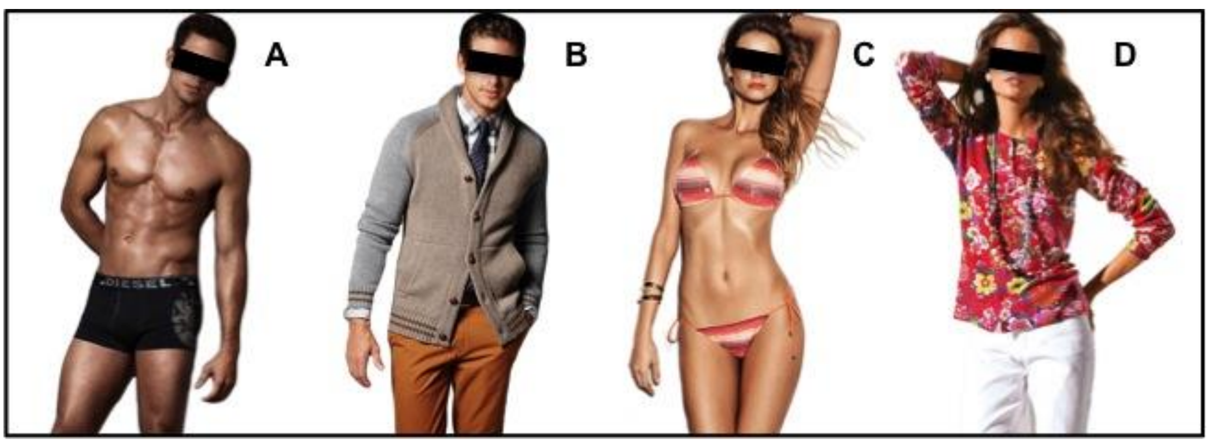

Figure 5. *Exemplar target stimuli.* Sexualized man picture (A), Personalized man picture (B). Sexualized woman picture (C), Personalized woman picture (D). All stimuli were presented without covering black bars.

Stimuli were collected from free sources from the web. In particular, the pictures of the same model portrayed in the sexualized as well as in the personalized condition were selected, in order to avoid possible confounds related to the identity of the model. Both man and women were shown from head to knee, in a standing Orientation, with eyes/face focused on the camera. All pictures were modified to have a white background, same luminance and the dimension of 397 x 576 Pixels (see Figure 5 for an exemplar of each stimulus´ condition).

Furthermore, in order test whether the selected pictures were perceived differently in terms of attractiveness, sexiness, intelligence and familiarity, a pretest was conducted on an independent pool of subjects. Precisely, 16 naïve participants issued from the same population of the experimental sample rated the personalized women, sexualized women, personalized men, and sexualized men on a Likert point scale, ranging from 1 (= not at all) to 6 (= completely) on the perceived level of attractiveness, sexiness, intelligence and familiarity.

A main effect of gender of the picture was observed, meaning that women were rated sexier, more attractive and familiar than men. Also a main effect of condition was observed, meaning that sexualized pictures were rated as sexier than the personalized ones (especially for the female pictures); while the personalized pictures were rated as more intelligent than the sexualized ones (see Supplementary Results for the full statistic).

Analysis of the symmetries of the stimuli

A 2 Condition (sexualized *vs.* personalized) x 2 Gender of the picture (male vs. female) ANOVA was carried out on the Average Axes values (mean of the eyes, shoulders, elbows, hands and hips axes). Both main effects and interactions did not approach the significance level $p > .19$, indicating that there were no differences in terms of asymmetry between the gender of the pictures and the two conditions (See Supplementary Material for the full statistic).

Procedure

During the experiment participants´ eye movements were tracked via an EyeLink 1000 Desktop Mount eye tracker (SR Research Ltd., Mississauga, Ontario, Canada), sampling at 1000 Hz. Viewing was binocular but only the orientation of one eye was recorded. Stimuli were shown on a monitor from a distance of 64 cm. We defined areas of interest (AOI) covering the head, breast and pubic region of the shown persons to be able to analyze if fixating one of this regions was necessary for the decision. For the breast and pubic region the AOIs were rectangular and of the same size while for the face region the AOIs were circles.

Eye movement data analysis

Raw eye movement output files were filtered using Matlab (version R2012b) to derive fixations. The analyses were focused on three areas of interest (AOIs) of the first presented picture in the task corresponding to the head, breast and pubic region. Fixations within the AOIs were analyzed along the main factors (i.e., Gender, Condition and Orientation) for the following dependent variables: mean fixation duration (MF) and total number of fixations (NF).

Results

Accuracy

Accuracy was analyzed by applying a generalized linear mixed effect model (*glmer*) with the same settings described in the Experiment 1. The model contained 2 Condition (Sexualized, Personalized) x 2 Orientations (Upright, Inverted) x 2 Gender of the picture (Male, Female) x 2 Gender of the participant (Male, Female) fixed effects factors, and to control for the individual variability on the accuracy, participants were treated as random effects. An outlier analyses was applied in order to exclude from the original sample all the subjects which had, among all conditions, a performance below the chance level (i.e., 75% correct) in more than 37.5% of tested experimental conditions resulting in 8 outliers' subjects and a final total number of 52 subjects. After the application of this exclusion criterion, trials in which any one of the considered individual binary response deviated more than 4 SD from the individual best fitting *glmer* model, including all interaction terms as fixed factors, no trials were removed from the analyses (4992 trials in total).

Results showed a significant main effect of Orientation F (1, 4991) = 3.69, p = .05, meaning that upright pictures (*glmer* estimated accuracy = .93 ± .01) (z = 2.00, p = .05) were better recognized than the inverted one (*glmer* estimated accuracy = .92 ± .02).

Given the complexity of the model we looked at the effect of Orientation on the accuracy separately for each Condition and Gender of the pictures. We run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for each condition of each gender of the picture subsets. Analyses (1 tailed) revealed that in the personalized condition female pictures were better recognized in the upright than the inverted position (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .92 ± .01, z = 1.67, p = .05; F (1, 1247) = 2.76, p = .05) while male pictures were equally recognized in the two orientations (*glmer* estimated accuracy for upright vs. inverted = .93 ± .02 vs. .91 ± .03, z = 1.39, p = .08; F (1, 1247) = 1.93, p = .08) even if the trend suggest a better recognition for the upright as compared to the inverted one. As for the sexualized condition, female pictures (*glmer* estimated accuracy for upright vs. inverted = .92 ± .02vs. .92 ± .02, z = .01, p = .49; F (1, 1247) = 0.01, p = 1) as well as male pictures (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .92 ± .03, z = .98, p = .17; F (1, 1247) = 0.95, p = .17) were equally recognized in the two orientations. All the other effects and interactions did not approach a significance level, all $p > .09$ (See Figure 6).

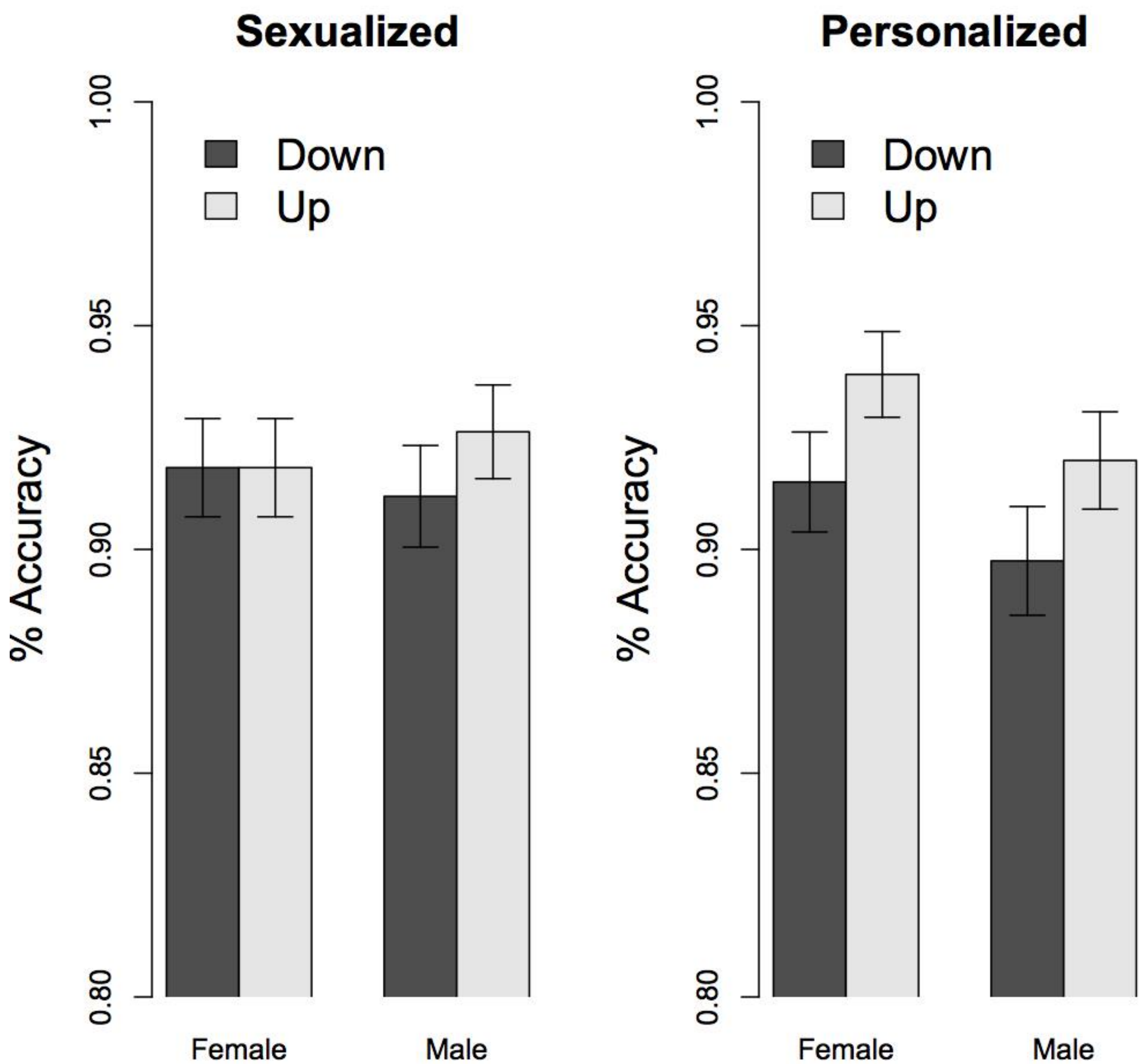

Figure 6. *Accuracy*. Mean values of the accuracy score split by Gender of the picture (male, female), Condition (sexualized, personalized) and Orientation (up and down), are reported. Error bars ± *SE*.

On the moderating role of asymmetry

Although the asymmetrical properties of the pictures were equal among conditions and gender of the pictures, their distribution is still continuous. Therefore we run a *glmer* model containing in addition to the factors already described for the accuracy analyses of the Experiment 3 (i.e. 2 Condition (Sexualized, Personalized) x 2 Orientations (Upright, Inverted) x 2 Gender of the picture (Male, Female), a 2 Asymmetry (Low, High) fixed factor. Pictures were categorized as low and high asymmetrical according to a two median split of their asymmetry index.

Analyses revealed a significant main effect of the Asymmetry indicating that the high asymmetrical pictures were better recognized than the low asymmetrical one (*glmer* estimated accuracy for high vs. low = .94 ± .01 vs. .91 ± .02, $z = 3.24$, $p < .001$; F (1, 4992) = 25.20, $p < .001$). A main effect of Orientation was also found indicating that pictures were better recognized in the upright than in the inverted position (*glmer* estimated accuracy for upright vs. inverted = .93 ± .01 vs. .91 ± .02, $z = 2.00$, $p = .05$; F (1, 4992) = 4.07, $p = .04$).

However given the complexity of the model we run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for each condition and asymmetry level subsets. Analyses (1 tailed) revealed that only in the personalized condition the low asymmetrical pictures were better recognized in the upright than in the inverted position (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .90 ± .03, $z = 1.77$, $p = .04$; F (1, 1404) = 3.14, $p = .04$), while in the sexualized condition they were equally recognized in the two orientations (*glmer* estimated accuracy for upright vs. inverted = .91 ± .03 vs. .88 ± .03, $z = 1.25$, $p = .11$; F (1, 1092) = 1.57, $p = .11$). On the contrary high asymmetrical pictures were equally recognized in the two orientations in both the personalized (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .93 ± .02, $z = 1.17$, $p = .12$; F (1, 1092) = 1.37, $p = .12$) and the sexualzied condition (*glmer* estimated accuracy for upright vs. inverted = .94 ± .02 vs. .95 ± .02, z = .42, p = .34; F (1, 1404) = .18, p = .34).

Eye movement data

A 2 (Condition: sexualized *vs.* personalized) x 2 (Orientation: upright *vs.* inverted) x 2 (Gender of the picture: male vs. female) x 2 (Gender of the participant: male vs. female) within-subjects ANOVA was carried out on gaze data separately for each AOI, on participants 'duration and sum of fixations. See Figure S3 and Table 1 and 2.

Mean fixation duration (MF)

Breast AOI

A main effect of Orientation was found F (1, 50) = 50398.99, $p < .001$, $\eta_p^2 = .42$, meaning that the Breast AOI of the inverted pictures was fixated longer than in the upright ones. A trend for the interaction of Condition x Gender of the picture x Orientation was also found F (1, 50) = 3.78, $p = .06$, $\eta_p^2 = .07$. All the other effects and interactions did not approach the significance level $p > .11$.

Face AOI

A main effect of Orientation was found F (1, 50) = 39.30, $p < .001$, $\eta_p^2 = .44$, meaning that that the face AOI of the upright pictures was fixated longer than in the inverted ones. A main effect of Condition was observed F (1, 50) = 7.04, $p = .01$, $\eta_p^2 = .12$, indicating that the face AOI of the personalized pictures was fixated longer than in the sexualized ones. A trend for the interaction of Condition x Orientation was also found F (1, 50) = 3.71, $p = .06$, $\eta_p^2 = .07$ indicating that only in the upright ($p = .03$) but not in the inverted Orientation ($p = .13$) the face AOI of the personalized pictures was fixated longer than the sexualized one. All the other effects and interactions did not approach the significance level $p > .11$.

Table 1.

Participant	Picture	Condition	Orientation	Pelvic	Face	Breast
Female	Female	Sex	Up	2.00 (10.20)	14.10 (25.02)	181.20 (34.72)
			Down	24.38 (57.73)	1.27 (6.47)	194.52 (34.66)
		Pers	Up	0.00 (0.00)	20.66 (22.78)	173.67 (34.60)
			Down	14.19 (46.18)	2.32 (8.23)	198.95 (31.73)
	Male	Sex	Up	1.62 (8.24)	24.93 (25.17)	172.27 (37.15)
			Down	31.79 (65.62)	0.00 (0.00)	204.59 (21.98)
		Pers	Up	0.00 (0.00)	26.61 (27.84)	177.07 (31.53)
			Down	26.42 (52.43)	4.75 (10.44)	196.29 (28.75)
Male	Female	Sex	Up	0.00 (0.00)	16.94 (32.58)	174.47 (41.67)
			Down	20.95 (51.29)	0.00 (0.00)	195.10 (32.90)
		Pers	Up	0.00 (0.00)	25.82 (45.15)	176.04 (34.73)
			Down	24.50 (69.28)	0.00 (0.00)	201.93 (32.21)
	Male	Sex	Up	0.00 (0.00)	12.08 (23.20)	169.36 (38.04)
			Down	13.56 (31.41)	1.58 (8.04)	191.46 (44.94)
		Pers	Up	0.00 (0.00)	29.78 (58.84)	177.67 (34.79)
			Down	17.69 (54.31)	0.00 (0.00)	195.03 (31.83)
Total	Female	Sex	Up	1.00 (7.21)	15.52 (28.79)	177.84 (38.13)
			Down	22.67 (54.10)	0.63 (4.58)	194.81 (33.46)
		Pers	Up	0.00 (0.00)	23.24 (35.50)	174.86 (34.35)
			Down	19.35 (58.53)	1.16 (5.88)	200.44 (31.69)
	Male	Sex	Up	0.81 (5.82)	18.50 (24.83)	170.81 (37.25)
			Down	22.67 (51.76)	0.79 (5.69)	198.02 (35.65)
		Pers	Up	0.00 (0.00)	28.19 (45.61)	177.37 (32.87)
			Down	22.06 (53.03)	2.38 (7.70)	195.66 (30.04)

Note. Mean values and standard deviation (in brackets) for the mean fixation duration, divided by Condition (Sexualized, Personalized), Orientation (Up, Down), Gender of the picture (Male, Female) and Gender of participants (Male, Female).

Pelvic AOI

A main effect of Orientation was found F (1, 50) = 16.38, $p < .001$, $\eta_p^2 = .25$, meaning that the pelvic AOI of the inverted pictures was fixated longer than the upright ones. All the other effects and interactions did not approach the significance level $p > .26$.

Total number of fixations (NF)

Breast AOI

A main effect of Gender of the picture was found F (1, 50) = 28.00, $p < .001$, $\eta_p^2 = .36$, meaning that the breast AOI of the female pictures was fixated more times than in the male ones. A main effect of Condition was found F (1, 50) = 60.84, $p < .001$, $\eta_p^2 = .55$, meaning that the breast AOI of the personalized pictures was fixated more times than in the sexualized ones. An interaction of Orientation x Gender of the participant was found F (1, 50) = 6.29, $p = .02$, $\eta_p^2 = .11$, meaning that only female participants fixated more times the breast AOI of the inverted pictures than in the upright ones ($p = .02$). A interaction of Condition x Gender of the picture was found F (1, 50) = 22.90, $p < .001$, $\eta_p^2 = .31$, meaning that only in the sexualized condition the breast AOI of the female pictures was fixated more times than in the male pictures ($p < .001$). A trend for the interaction of Condition x Gender of the picture x Gender of the participant was found F (1, 50) = 3.37, $p = .07$, $\eta_p^2 = .06$, meaning that only female participants equally fixated the breast AOI of the sexualized and personalized female pictures ($p = .22$), while male participants fixated more times in the breast AOI the personalized pictures than the sexualized pictures ($p = .004$). All the other effects and interactions did not approach the significance level ($p > .10$).

Face AOI

A main effect of Gender of the picture was found F (1, 50) = 6.23, p = .02, ηp2 = .11, meaning that the face AOI of the male pictures was fixated more times than in the female ones. A main effect of Condition was found F (1, 50) = 14.76, p < .001, ηp2 = .23, meaning that the face AOI of the personalized pictures was fixated more times than in the sexualized ones. A main effect of Orientation was found F (1, 50) = 19.33, p < .001, ηp2 = .28, meaning that the face AOI of the upright pictures was fixated more times than in the inverted ones. An interaction of Gender of the participants x Gender of the picture was found F (1, 50) = 4.17, p = .05, ηp2 = .08, meaning that only female participants fixated more times in the face AOI the male pictures than the female ones (*p* = .002). An interaction of Gender of the picture x Orientation was found *F* (1, 50) = 4.19, *p* = .05, η_p^2 = .08, meaning that when presented upright, the male pictures were fixated more times in the face AOI than the female pictures (*p* = .02). The face AOI of the pictures presented inverted was fixated similarly in the female pictures and the male one (*p* = .85). An interaction of Condition x Orientation was also found *F* (1, 50) = 9.37, *p* = .004, η_p^2 = .16, meaning that the personalized pictures were fixated more times in the face AOI than the sexualized pictures only when presented in the upright position (*p* = .001) as compared to the inverted one (*p* = .06).

Pelvic AOI

A main effect of Orientation was found *F* (1, 50) = 15.66, *p* < .001, η_p^2 = .24, meaning that the pelvic AOI of the inverted pictures was fixated more times than in the upright ones.

Table 2.

Participant	Picture	Condition	Orientation	Pelvic	Face	Breast
Female	Female	Sex	Up	0.08(0.39)	0.62(1.20)	7.35(2.70)
			Down	0.38(0.80)	0.04(0.20)	9(2.15)
		Pers	Up	0(0.00)	1.58(2.39)	8(3.03)
			Down	0.31(0.62)	0.19(0.80)	9.19(2.32)
	Male	Sex	Up	0.04(0.20)	1.5(2.16)	5.27(1.51)
			Down	0.42(0.90)	0(0.00)	6.73(1.78)
		Pers	Up	0(0.00)	1.85(2.62)	7.35(1.98)
			Down	0.42(0.64)	0.23(0.51)	9.04(1.82)
Male	Female	Sex	Up	0(0.00)	0.65(1.41)	8.04(3.00)
			Down	0.35(0.85)	0(0.00)	7.19(2.28)
		Pers	Up	0(0.00)	1(1.63)	9.08(3.11)
			Down	0.12(0.33)	0(0.00)	8.19(2.61)
	Male	Sex	Up	0(0.00)	0.65(1.74)	7.12(2.88)
			Down	0.23(0.51)	0.04(0.20)	6(2.02)
		Pers	Up	0(0.00)	1.08(2.24)	8.31(2.64)
			Down	0.19(0.57)	0(0.00)	8.42(1.55)
Total	Female	Sex	Up	0.04(0.28)	0.63(1.30)	7.69(2.85)
			Down	0.37(0.82)	0.02(0.14)	8.1(2.38)
		Pers	Up	0(0.00)	1.29(2.04)	8.54(3.09)
			Down	0.21(0.50)	0.1(0.57)	8.69(2.49)
	Male	Sex	Up	0.02(0.14)	1.08(1.99)	6.19(2.46)
			Down	0.33(0.73)	0.02(0.14)	6.37(1.92)
		Pers	Up	0(0.00)	1.46(2.45)	7.83(2.36)
			Down	0.31(0.61)	0.12(0.38)	8.73(1.71)

Note. Mean values and standard deviation (in brackets) for the number of fixation, divided by Condition (Sexualized, Personalized), Orientation (Up, Down), Gender of the picture (Male, Female) and Gender of participants (Male, Female).

Correlation Analyses

A Pearson correlation was computed to assess the relation between the accuracy scores and the NF and the MD variables separately.

A significant negative correlation was found between the accuracy score and the MD of the Breast AOI in the Sexualized condition and the inverted orientation of the female pictures (r = -.27, p = .05, N = 52). This association revealed that the more time participants spent to observe the Breast region of the sexualized female pictures in the inverted position, the worse they recognized them. A significant positive correlation was found between the accuracy score and the NF of the Breast AOI in the Sexualized condition and the upright orientation of the female pictures (r = .27, p = .05, N = 52), indicating that the more participants observed the Breast region of the sexualized female pictures in the upright position, the better they recognized them.

A significant negative correlation was found between the accuracy score and the NF of the Face AOI in the Sexualized condition and the inverted orientation of the female pictures (r = -.27, p = .05, N = 52), showing that the more participants observed the Face region of the sexualized female pictures in the inverted position, the worse they recognized them. A significant negative correlation was found between the accuracy score and the NF of the Breast AOI in the Sexualized condition and the inverted orientation of the male pictures (r = -.30, p = .03, N = 52), meaning that the more participants observed the Breast region of the sexualized male pictures in the inverted position, the worse they recognized them. (See supplementary results for the analyses separate for gender of the participants).

Experiment 4

In order to formally test the moderating role of asymmetry in shaping the SBIE a forth experiment was run. Participants were engaged in the same paradigm described in the Experiment 1 and 2, with the exception that mannequins and houses were removed from the stimulus set. Importantly, and differently from Experiment 1 and 2, the asymmetry of the stimuli was experimentally manipulated, having in both conditions (personalized and sexualized) half of the stimuli at low asymmetry and half at high asymmetry.

Methods

Participants

Seventy-seven healthy students (*N* = 38 men and *N* = 39 women; age *M* = 22, *SD* = 2.83 years) took part in the present study in exchange of monetary reward. All participants gave written informed consent before participating in the study, which was approved by the SISSA ethical committee and treated in accordance with the Declaration of Helsinki. Participants were naïve to the aim of the study and did not participate in similar experiments before.

Stimuli

Pictures used in Experiment 4 were collected from the same sample as in Study 1, 2 and 3, taking care of obtaining pictures of equally low asymmetry for the sexualized and personalized stimuli as well as of equally high asymmetry for the both types of stimuli. Concretely, each participant saw a total of 48 pictures: 24 sexualized women and 24 personalized women, each of them were divided into 12 pictures with low asymmetry and 12 pictures with high asymmetry (see supplementary material).

Analysis of symmetries

A 2 (Condition: sexualized *vs.* personalized) x 2 (Asymmetry: high *vs.* low) Univariate ANOVA was carried out on the Average Axes values (mean of the five different axes) as showed in Table S5. Results showed a main effect of the Asymmetry, F (1, 44) = 516,912, $p < .001$, $\eta_p^2 = .92$

indicating that high asymmetrical pictures had more prominent axes than the low asymmetrical ones. The other main effect and interaction did not approach the significance level $p > .33$.

Results

Accuracy

Accuracy was analyzed by applying a generalized linear mixed effect model (*glmer*) with the same settings described in the Experiment 1. The model contained 2 Condition (Sexualized, Personalized) x 2 Orientations (Upright, Inverted) x 2 Asymmetry (High, Low) x 2 Gender of the participant (Male, Female) fixed effects factors, while to control for the individual variability on the accuracy participants were treated as random effects. An outlier analyses was applied in order to exclude from the original sample all the subjects which had, among all conditions, a performance below the chance level (i.e., 75% correct) in more than 37.5% of tested experimental conditions resulting in 8 outliers' subjects and a final total number of 72 subjects. After the application of this exclusion criteria, trials in which any one of the considered individual binary response deviated more than 4 SD from the individual best fitting *glmer* model, including all interaction terms as fixed factors, were removed from the analyses (37 trials out of the remaining 3456).

The *glmer* was fitted to the data using Likelihood Ratio Tests estimation. Statistical results were in line with hypotheses. The *glmer* model revealed a significant main effect of Gender indicating that the male participants performed better than the female one (*glmer* estimated accuracy for male vs. female = .98 ± .01 vs. .95 ± .02, $z = 2.31$, $p = .02$; $F(1, 3418) = 5.10$, $p = .02$).

A significant main effect of Orientation was found indicating that upright pictures were better recognized than the inverted one (*glmer* estimated accuracy for upright vs. inverted = .98 ± .01 vs. .96 ± .02, z = 2.09, p = .04; F (1, 3418) = 4.30, p = .04).

A significant main effect of Asymmetry was found F (1, 3418) = 57.98, p < .001, which was moderated by the Condition F (1, 3418) = 3.54, p = .03 (1 tailed). In order to better understand this interaction we looked at the effect of Orientation on the accuracy separately for each Condition and Asymmetry of the pictures and run a *glmer* model containing only the Orientation as the main effect and the subjects as random effects, separately for each condition of each asymmetry subsets. Analyses revealed that only in the personalized condition, for the low asymmetrical pictures, personalized pictures were better recognized in the upright position than the inverted one (*glmer* estimated accuracy for upright vs. inverted = .94 ± .03 vs. .90 ± .04, z = 2.06, p = .04; F (1, 851) = 4.32, p = .04), whereas sexualized pictures were equally recognized in the upright and in the inverted position (*glmer* estimated accuracy for upright vs. inverted = .97 ± .02 vs. .97 ± .02, z = .10, p = .91; F (1, 846) = 0.01, p = .91). As for the high asymmetrical pictures, pictures were equally recognized in the upright and in the inverted position in the personalized condition (*glmer* estimated accuracy for upright vs. inverted = .99 ± .02 vs. .98 ± .02, z = .65, p = .51; F (1, 861) = 0.37, p = .54), as well as in the sexualized condition (*glmer* estimated accuracy for upright vs. inverted = .99 ± .0001 vs. .99 ± .0002, z = .996, p = .32; F (1, 857) = 0.82, p = .37). All the other effects and interactions did not approach a significance level, all p > .33 (See Figure 7).

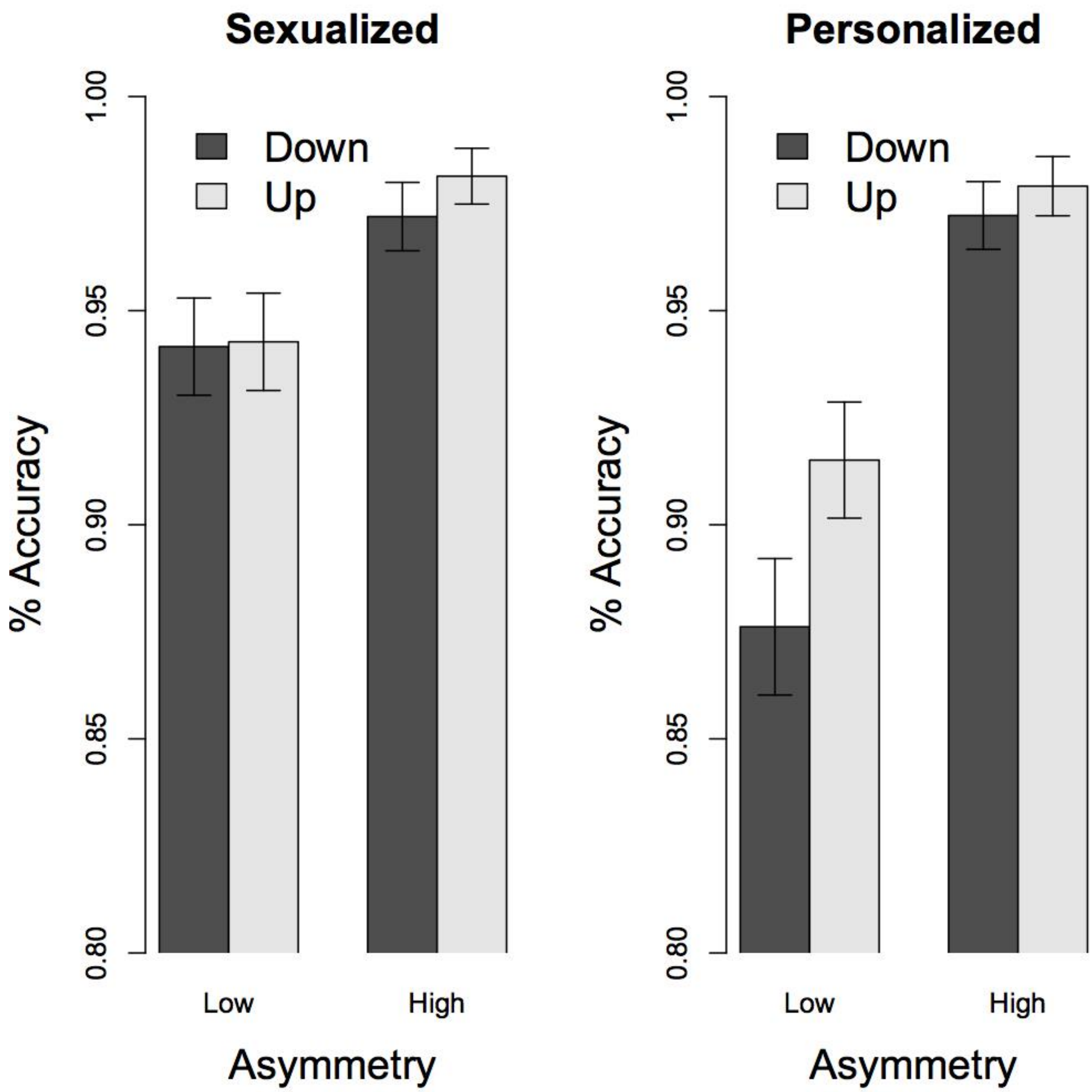

Figure 7. *Accuracy*. Mean values of the accuracy score split by Asymmetry (Low, High), Condition (sexualized, personalized) and Orientation (up and down), are reported. Error bars ± *SE*.

Discussion

In spite of the huge amount of literature issued on the sexual objectification theory (see (Moradi & Huang, 2008), and on the basic processes involved in the perception of sexualized women (Bernard et al., 2012; Gervais et al., 2012; Bernard et al., 2015; Schmidt & Kistemaker, 2015), no clear conclusion can be drawn about which factors modulates the cognitive processing style of the perceiver, namely if sexualized women are perceived and processed in an analytical way, similarly to the processing of objects (as indicated by an absence of the inversion effect). Overall, we were able to show in four different experiments that both the degree of sexualization of the target and the visual properties of the pictures are factor responsible for the presence/absence of the inversion effect. More importantly, we were able to show that the inversion effect is moderated (and not mediated) by the visual properties of the stimuli, namely the degree to which the stimuli differ in term of asymmetry. Only at low level of asymmetries the category of the stimuli (sexualized vs. personalized) influences the processing style of recognition resulting in an analytical style adopted for the sexualized targets and a configural style adopted for the personalized target as suggested by the presence of the inversion effect.

Conceptual replication of the sexualized-body inversion effect

The first step of our study was to establish the presence of the *sexualized-body inversion effect* SBIE (i.e sexualized women do not show an inversion effect, indicating an analytical processing style) by using a set of stimuli comparable to the one of Bernard and colleagues (2012, 2015). This first step allowed us to show that without controlling for visual properties of the stimuli such as asymmetry, results clearly support the SBHI (Bernard et al., 2012).

In line with the previous literature, in Experiment 1 and 2 we observed that the recognition of personalized women is worse in the downward compared to the upward orientation (indicating the presence of an inversion effect), whereas sexualized women were accurately recognized to a similar extent in the upward and downward orientation (to be note that in Experiment 1 there was a tendency toward the inversion effect).

In addition to Bernard et al. (2012, 2015), we showed that the way participants process pictures of sexualized women is similar to the way participants match pictures of objects such as houses with different orientations. By contrast, the similarity in processing upward and inverted pictures of houses was not found when handling with pictures of personalized women, which showed a relative advantage in the upward compared to the inverted orientation. This pattern of results prompts the reader to accomplish that only sexualized women are appraised with the same analytic process that also applied to objects such as houses, leading to the conclusion that is indeed the sexualized nature and not the gender of the stimulus that triggers the different processing style.

The inversion effect as an indicator of person vs. object processing style

As a second step, we tested the assumption that the absence of an inversion effect for the sexualized targets (and therefore the presence of an analytical processing style) means being processed as an object. To this aim, in Experiment 1 and 2 we also estimate to which extent the analytical processing style is applied to different types of objects.

We observed that participants were less accurate in processing human-like objects such as mannequins in the downward than in the upward orientation, suggesting that mannequins were more likely to be processed in a configural way. These results indicate that the classification of a stimulus as an object is not a sufficient condition for vanishing the inversion effect (See also Tarr 2013, Tarr & Pinker, 1989). In fact, human-like objects, such as mannequins, show the facilitation for upward compared to downward orientation, leading to the conclusion that other features, a part from the semantic category (human vs. object), are responsible for the observed effect. A possible explanation is that during the visual exploration of sexualized pictures, participants spend more time looking at the chest and pelvic regions (Nummenmaa et al., 2012; Gervais et al., 2013), triggering an analytic processing style for the recognition of the pictures. While, in the case of personalized women and mannequins (with less saliency on the sexual attributes), the focus of attention is probably directed toward the face and the orientation of the head in relation to the body, leading the participants relying more on a configural processing style. Top-down mechanisms may therefore be responsible to drive the focus of attention, according to the stimulus category presented (sexualized or non-sexualized rather than object vs. person). Note that this hypothesis is partially investigated in Experiment 3 (see later point in the discussion).

An alternative interpretation of the SBIE

Following Tarr´s criticisms (2013), several other factors that could have alternatively explained the data observed in Experiment 1 and 2 need to be considered. First, the pretest revealed that personalized women were perceived as more familiar than sexualized women and mannequins, thus putting forward the idea that our findings could have been driven by difference of stimulus-familiarity among targets. However, since houses represent a set of stimuli that can be by considered highly familiar, one would expect participants to show an inversion effect even with these stimuli (Scapinello & Yarmey, 1970; Tanaka & Taylor, 1991). In contrast, our findings revealed that participants were less accurate to recognize personalized women in the reverse than in the upright orientation, whereas they were equally accurate to recognize houses in both orientations, thus weakening the idea that stimulus-familiarity might have driven the observed pattern of results.

Second, in order to ascertain, that findings of Experiment 1 and 2 can be due to the different degree of asymmetry observed between the conditions, a mediational analysis was performed for both the experiments. Results suggested the exclusion of a mediating role of asymmetry in shaping the SBIE: the difference recognition of the targets in the two orientations was not driven by the stimulus asymmetry. However mediational analyses are not sufficient to establish a clear role of the asymmetry in shaping the inversion effect.

Experiments 3 was subsequently performed with a new set of stimuli matched for asymmetrical features in order to test the consistency of the SBIE in the case of equal visual properties of the used stimuli. Results showed the presence of the inversion effect only for the personalized conditions while pictures in the sexualized conditions were equally well recognized in the upright and inverted orientation. This result is an indication that the visual properties are not sufficient to explain the occurrence of the SBIE and it is in contrast with the findings of Schmidt (2015), showing that SBIE disappears when the presented stimuli are matched for asymmetry.

Notably, the use of an eye-tracker device in Experiment 3 allowed us to measure how pictures were inspected in all the conditions, and which factors were predictive of a better performance in the matching task. As expected, an orientation effect was found, indicating that the visual inspection of the stimuli was influenced by their orientation in the screen. Specifically, in relation to the portion of the picture located in the center of the screen (i.e. face and breast for the upright pictures and pelvic for the inverted pictures), the upright pictures were longer fixated in the face and breast region as compared to the inverted pictures that instead were longer fixated in the pelvic region. However, in line with the research of Nummenmaa (2012), we observed that people tend to focus more to the face region of the personalized pictures in comparison to the sexualized pictures, suggesting that the sexualized representation of a target shifts the focus of attention from the face toward the body parts (chest and pelvic regions, see also Gervais et al. 2013). Moreover, the male Face region was fixated more times than the female one indicating that the shifting of the attention from the face to other body parts is a phenomenon that is more present when exploring women targets.

The correlation analysis between the eye-tracker data and the accuracy score revealed that participants showed impairment in the recognition of the female sexualized pictures in the inverted orientation, the longer the time they spent focusing on the face region. While the same impairment is present both for the female and male sexualized pictures the more time participants spent focusing on the breast region. Taken together, the data shows that 1) sexualized targets are visually inspected in the region of the face to a less extent as compare to personalized targets, and that 2) when the focus of attention is higher to the face or the breast region, the performance during their recognition in the inverted orientation declines. This suggests that sexual objectification has an impact on the visual exploration of the stimuli, altering the processing of the stimuli. Namely, it induces a shift of attention from the face to other parts of the body, possibly disrupting the configural processing otherwise applied to the perception of the personalized targets.

However in the Experiment 3, the analyses performed including the asymmetry as an additional variable suggest that the level of asymmetry of the pictures likely shapes the inversion effect, thus highlighting its moderating role. Namely only at a low level of asymmetry the effect of the condition is evident, resulting in the presence of the inversion effect for the personalized images but not for the sexualized one. While at high level of asymmetry stimuli are equally well recognized in the two orientations regardless of the condition. In order to better ascertain the moderating role of the asymmetry, avoiding also possible influences of the complexity of the eye tracker setup on the performance we run Experiment 4. Results on the analyses, confirmed the results of the moderation analysis in Experiment 3 and revealed that the asymmetry does play a moderating function on the inversion effect, in that it reduces its presence in the case of high asymmetrical stimuli. Therefore, it is true that the SBIE occurs even when stimuli are matched for asymmetry as Bernard claimed (2015), but it is also true that it plays a fundamental role in influencing the recognition by facilitating visual matching for high asymmetrical stimuli, as Schmidt claimed (2015). Therefore, the results of Experiment 4 are in favor of the SBIH, adding new elements to define the boundaries conditions under which the SBIE occur or not. Namely when the task is easy (high asymmetrical stimuli) the degree of sexualization of the target does not affect the recognition of these pictures, as opposed to the more difficult task (low asymmetrical stimuli) in which a configural processing style is adopted only for the less sexualized stimuli.

Conclusion

In a series of experiments, we were able to show that the presence or absence of the inversion effect (index of an analytical processing style), previously associated to the processing of sexually objectified women, is strongly influenced by the level of asymmetry of the target pictures, in that when the pictures are less asymmetric their recognition is more impaired in the inverted than in the upright orientation. Importantly, the occurrence of the inversion effect is restricted to personalized pictures while sexualized pictures are equally recognized in the upright and inverted orientation, regardless of the asymmetrical level. Sexualized pictures are in fact perceived as more attractive and sexy and less intelligent, and with a different pattern of visual exploration as indicated by lower number of fixations in the face region compared to the personalized pictures. Our study suggests that these differences in the visual exploration of the stimulus trigger a differential processing style translated in the SBIE. In general, we can conclude that sexual objectification is translated on a low perceptual level in an analytical *vs.* configural processing style.

Chapter 2

Empathy for affective touch towards sexually objectified targets[2]

[2] This research is submitted for publication in peer-reviewed journal: Cogoni, C., A. Carnaghi and G. Silani (2016). Can we empathize with sexually objectified women? Shared representations are reduced for objects and objectified women compared to personalized women.

Abstract

Extensive research has been conducted to investigate how individuals empathize with others and how this social emotion changes depending on contextual and motivational factors. However, little is known about the effect of sexual objectification on empathy. Indeed, when women are sexually objectified (i.e., represented by their physical appearance over mental states), they are perceived as less human, be less agentic and deprived of their mental capacities. The aim of the present study is to shed lights on empathic responses toward human and objects and whether those responses are modulated by the perceived objectification of the target. Hence, male and female participants took part into an empathy for affective touch paradigm. Specifically, the task is based on visuo-tactile stimulation of the participant and the confederate and it allows for the assessment of shared representations between the self and the other person. Depending on the experimental condition, the confederate was a mannequin (object condition) or a real female individual. The female confederate was either dressed in a sexually objectified fashion (objectified condition) or in a non-sexually objectified manner (personalized condition). Results showed that shared representations (measured in terms of similarity between self and other affective ratings) are significantly lower for the mannequin, intermediate for the objectified women and reaches the highest values for the personalized women. The findings suggest that women sexual objectification does not lead to a shift from human to object-like processing, assimilating women to inanimate entities, but it reduces empathic responses that are typically recruited when processing human beings.

Introduction

Humans are social animals that interact with each other in everyday situations. The human capacity to understand the mental and affective states of conspecifics has revealed to be fundamental in order to predict others' actions and to adjust one's own behavior in a given interaction (Singer & Lamm, 2009). Notably, the perception of the affect of someone else tends to induce, usually with a less degree, the same affect in the perceiver. This process has been referred to as empathy (Singer & Lamm, 2009). Over the past decades, extensive research has been conducted to investigate the cognitive and neurophysiological processes behind empathy for others' emotions and sensations (Davis, 1983; Singer & Lamm, 2009). To this end, simulation theory proposes that individuals use their own cognitive and affective representations as a model to understand the cognitive and affective states of others (Gordon, 1986). The similarity between one's own affective reactions in terms of both neurophysiological responses and affective judgments and the attribution of similar reactions to the other person (i.e., *shared representations*) has been therefore used as a proxy to investigate empathic responses (Davies & Stone, 1995a; Davies & Stone, 1995b; Gallese & Goldman, 1998; Shanton & Goldman, 2010; Silani et al., 2013).

Notably, the ability to empathize (and therefore to share other affective states) is strongly influenced by contextual and motivational factors. For example, it has been shown that the perceived unfairness of a target significantly reduces behavioral and neurophysiological empathic reactions (Singer et al., 2006). Similarly social factors such as group membership can modulate empathy, leading for example to a reduction of shared neural representations during the perception of the suffering of an outgroup member (Hein et al., 2010). A possible explanation behind such findings could be advocated as the different perceived similarity between the self and the other. Indeed, it has been recently shown that the more the target is perceived as similar to ourselves the greater is the subsequent empathic feeling (Majdandzic et al., 2016). Another fundamental factor that needs to be considered for empathy and simulation to take place is the attribution of mental states to the target of the empathic reaction (Gray et al., 2007; Waytz et al., 2010). It is in fact difficult to share representations if a mind has not been detected (Zaki, 2014). Initial evidence on this regard comes from studies investigating the impact of dehumanization and objectification on the perceiver cognitive and affective responses towards the target (Heflick & Goldenberg, 2009; Loughnan et al., 2010; Gray et al., 2011; Heflick et al., 2011; Vaes et al., 2011; Loughnan et al., 2013). Objectification in particular refers to the act of treating a human being as an instrument that serve specific goals or functions for the observer (Nussbaum, 1995), and it has been associated to the denial of mind and moral status of the objectified target (Loughnan et al., 2010). A particular case of objectification is what has been termed as sexual objectification.

Sexual objectification, a deeply eradicate phenomenon clearly manifested in the western society (Frith et al., 2005), consists of appraising and treating people, especially women, as sexual objects (Fredrickson & Roberts, 1997). The sexual objectification process can be framed as a form of 'body reduction' (Holroyd, 2011) occurring when perceives are exposed to women portrayed in a sexualized manner (e.g., revealing clothes, seducing poses). Indeed, sexualized compared to non-sexualized female targets, are judged to be less human (Loughnan et al., 2010), less agentic (Gray et al., 2011), and less moral (Loughnan et al., 2013). Moreover, sexual objectification also occurs when perceivers come across an individual portrayed in a non-sexualized fashion but the perceivers' attention is shifted from the thoughts and feeling of that individual, to his/her physical attributes, body parts or sexual functions (Bartky, 1990).

Indeed, in a study in which two famous women were used as stimuli (i.e., Sarah Palin and Angelina Jolie), it has been showed that simply instructing participants to focus on the appearance of the women rather than on who they are as a person, led participants to perceive them as less competent and less fully human (Heflick & Goldenberg, 2009).

In addition, sexual objectification does not only deprive individuals from their mental states (Loughnan et al., 2010) but further influences pain perception. Indeed, participants are more willing to inflict pain (i.e. intent to administer hypothetical painful tablets) to sexually objectified target (i.e. images of women in bikinis and shirtless men) than to non-objectified targets (i.e. images of women and men fully clothed). The result can be interpret either as an index of less empathic reaction for the suffering of the objectified target or as a misattribution of lower sensitivity to pain (Loughnan et al., 2010). Notably, a recent study has shown that perceivers are more prone to attribute greater ability to experience emotions and bodily sensations to objectified women (i.e. women with appealing bodily parts such as hip and breast prominently displayed) than to personalized women (i.e. women with appealing body parts more covered) (Gray et al., 2011). This suggest that the higher tendency to inflict pain to objectified than personalized women may be accounted not by a misattribution of pain sensitivity but by rather to a reduced empathic reaction to their negative emotional states.

Notwithstanding the importance of this research to understand the psychological consequences of sexual objectification from the perceivers' perspective, only one study has been performed on the empathy domain (Loughnan et al., 2010) and notably only using hypothetical scenarios. Built on this insight, the current study aims at investigating whether empathic responses, defined as shared representation of emotional states between the perceiver and the target, differ when the target is either an objectified or a personalized woman.

Differently from previous studies, which mainly rely on questionnaires or ratings of pictures, in the present research we gained a direct estimation of empathic responses by looking at the similarity between emotion attributed to ourselves and the other person after positive and negative online visuo-tactile stimulation (Silani et al., 2013). More importantly, and for the first time within the sexual objectification research, the other person was a real woman, instead of a picture, presented in a sexually objectified or non-objectified condition. Furthermore, a human-like object was used as a control comparison condition. These three novelties thus allowed us to measure shared representations, defined as the overlap between affective ratings attributed to the self and the target of the empathic judgment.

We hypothesized that the lowest level of empathy (and therefore shared representations), corresponding to a reduced similarity between self and other emotional appraisal, would be displayed by participants interacting with human-like objects (mannequins), while the highest level of empathy would be shown by participants interacting with personalized women. Moreover, we expected the levels of empathy in the objectified woman group to be higher than the mannequin group, but to be lower than the personalized woman group.

Methods

Participants

One hundred eighty participants took part in the study in exchange of monetary reward. All participants gave written informed consent before participating in the study, which was approved by the local ethical committee and treated in accordance with the declaration of Helsinki. Data from 8 participants were removed from analyses due to technical problems during the execution of the experiment. Hence the final sample included (N = 85 female and N = 85 male participants), age ranged from 18 to 38 (M = 23.45, SD = 3.40). All measures, manipulations, and exclusions in the study are disclosed. Sample size was determined a priori with G*power3 using a medium effect size (f = .25), an alpha level of .05 and power at .80.

Paradigm

An experimental paradigm tailored to investigate empathic responses via visuo-tactile stimulation of the participant and a confederate, with the aim of inducing pleasant or unpleasant emotions (Lamm et al., 2015), was employed in this study. Depending on the experimental condition, the confederate was either a mannequin (mannequin condition) or a female individual. Two young adult women, one blonde and one brunette, of similar age, height and weight participated as confederate in the experiment. The confederate could be either dressed in a sexually objectified fashion (objectified condition) or in a non-sexually objectified manner (personalized condition) with the former generally characterized by having more skin revealed and a heavier makeup than the latter one (See Janssens et al., 2011 for a similar manipulation).

The objectified outfit consisted of a short skirt, stocking, a tight t-shirt, and heels. The personalized outfit consisted of pants, sweaters and sports shoes (See Figure 1). Both outfits were pretested on Sexiness, Attractiveness, Intelligence and Familiarity scores and also on Agency and Experience capacity following the mental state attribution scale (Gray et al., 2011).

Figure 1. Representation of the "Other" targets of the empathic judgment: Objectified confederates (A), Personalized Confederates (B), Mannequin (C). Note that the real person/object was present in the room during the entire execution of the task.

Following the same procedure of Lamm et al. 2015, the participant and the confederate (or mannequin) were unknown to each other and briefly introduced (except for the mannequin condition) before the starting of the task. Immediately after, they were sitting in front of a touch screen, with their left hand under a black curtain and back to back with each other. They were presented on the screen for 1 second with the picture of different objects (see Lamm et al. 2015 for more details). At the same time and for the same duration, they were touched on their left hand with a material correspondent to the image on the screen. The stimulation could be pleasant (e.g. feather), unpleasant (e.g. spider) or neutral (e.g. branch). A total number of 30 trials were used, with 10 trials for every possible valence. For each stimulation participants were asked to judge, on a continuous scale ranging from + 10 (very pleasant) to – 10 (very unpleasant), the emotions associated to the stimulation (See Figure 2). The target of the emotional judgment could be either the self (self run), or the other person (other run). During the other run, participants were presented on the screen with the objects that the confederate was going to be touched, while they did not undergo under any tactile stimulation. Immediately afterwards, they were asked to judge on the same continuous scale, how the confederate evaluated the stimulation (empathy condition).

In the case of the mannequin, participants were told that, due to an error in the booking system, the participant supposed to perform the experiment with them did not show up and for this reason a mannequin available in the laboratory was placed as a substitute in the chair of the other participant. They were afterward instructed to imagine its reactions as the ones of a real person.

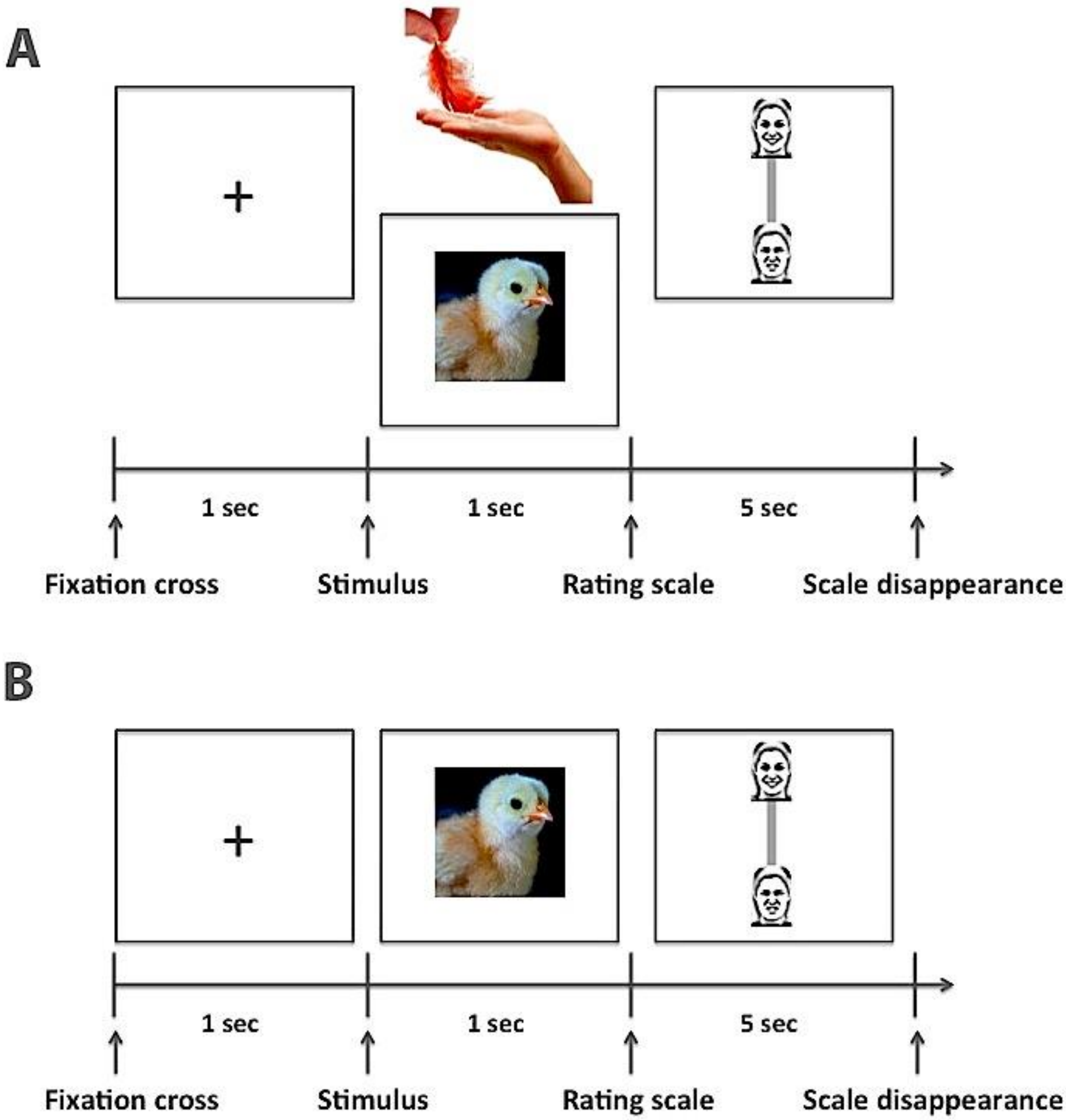

Figure 2. Timeline of one trial for the “self” (A) and the “other” runs (B). Every stimulus is preceded by a fixation cross presented in the middle of the screen for 1 sec, then the stimulation (visual and tactile, or visual only) occurred for a period of 1 second, and after the rating scale was displayed for 5 seconds.

The overall paradigm is based on a full factorial design with the within subject factor Target (Self, Other) and the between subject factor Group (Objectified, Personalized, Mannequin).

The similarity between self and other's emotional rating were used as an index of shared representations.

Results

Pretest

A pretest was conducted to assess the efficacy of our experimental manipulation. Twenty participants[3] (*N* = 10 female and *N* = 10 male, selected from an independent pool issued from the same population of the experimental sample), age ranged from 20 to 32 (*M* = 26.7, SD = 2.61), were tested. Participants rated the pictures of the personalized women, sexualized women and mannequin on Intelligence, Attractiveness and Sexiness on a 6 point scale, ranging from 1 (= not at all) to 6 (= completely). We decided to rely on the intelligence and attractiveness/sexiness dimensions as they operationalized a non-physical, inner state (see Loughnan et al., 2010 for a similar operationalization) and the appearance aspect of the target, respectively. Moreover the Familiarity with the other-target was also measured by means of the same 6-point scale as above. Finally, the other-targets were also rated with respect to their capacity in terms of Agency and Experience, through 12 items of the mental state attribution scale (Gray et al., 2011).

The two dimensions of the physical appearance (i.e. Sexiness and Attractiveness) were highly correlated r (19) = .81, $p < .001$ hence averaged as single indicator of the physical appearance.

The Physical Appearance and Intelligence rating scores were analyzed by means of 2 (Dimension: Physical appearance, Intelligence) by 3 (Group: Objectified, Personalized,

[3] Note that one participant completes only the front page of the questionnaires resulting in a total number of participants tested with the mental attribution scale and 19 participants tested with the other questionnaires.

Mannequin) repeated measures ANOVA with the former and the latter variable as within-participants factors. Results revealed a significant main effect of the Group $F(2,17) = 7.49$, $p = .01$, $\eta_p^2 = .47$, that was qualified by the interaction with the Dimension $F(2,17) = 10.57$, $p = .001$, $\eta_p^2 = .55$. This interaction revealed that greater physical appearance characteristics than intelligence were attributed to the objectified women $p = .03$ while more intelligence than physical appearance were attributed to the personalized women $p = .001$. No differences were found between the attribution of intelligence and physical appearance to the mannequin $p = .94$.
The Agency and Experience rating scores were analyzed by means of 2 (Dimension: Agency, Experience) by 3 (Group: Objectified, Personalized, Mannequin) repeated measures ANOVA with the former and the latter variable as within-participants factors. Results revealed a significant main effect of the Group $F(2,18) = 12.44$, $p < .001$, $\eta_p^2 = .58$, indicating that the agency and experience attributed to the mannequins were reduced as compared to both objectified women $p < .001$ and personalized women $p = .002$, while no differences were found between the objectified and personalized women $p = .49$. (See Table 1 for the mean values).

Participants' ratings on the Familiarity dimension were affected by the factor Group $F\ (2,17) = 13.52$, $p < .001$, $\eta_p^2 = .61$. In particular the mannequins (M= 1.74, SD = 1.05) were rated as less familiar than the objectified women (M= 2.84, SD = 1.17) $p = .001$ and the personalized women (M= 3.47, SD = 1.58) $p < .001$. The personalized women were rated as more familiar than the objectified women, even if it fell short of significance $p = .055$.

Table 1.

Mean values and standard deviations (in brackets) for the ratings dimensions as a function of group.

	Physical Appearance		Intelligence		Agency		Experience	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Personalized	2.97 (1.05)[a]	[2.47, 3.48]	3.63 (1.21)[b]	[3.05, 4.22]	3.08 (0.61)[a]	[2.79, 3.36]	2.78 (0.55)[a]	[2.55, 3.04]
Objectified	4.00 (1.00)[a]	[3.52, 4.48]	3.42 (1.22)[b]	[2.84, 4.01]	3.02 (0.52)[a]	[2.78, 3.26]	2.95 (0.60)[a]	[2.67, 3.23]
Mannequin	2.50 (1.55)[a]	[1.75, 3.25]	2.47 (1.39)[a]	[1.80, 3.14]	2.01 (0.93)[b]	[1.58, 2.45]	1.93 (0.97)[b]	[1.47, 2.38]

Note. Means with a different superscript indicate significant differences ($p < .05$), within groups and between dimensions pairs separately (a: Physical Appearance *vs*. Intelligence, b: Agency *vs*. Experience).

These results indicated that the sexual objectification was operationalized in this experiment according to the emphasis on the physical appearance over intelligence attribution (Bartky, 1990; Vaes et al., 2011). Namely greater physical appearance characteristics were attributed to the objectified women as compared to their intelligence, while greater intelligence was attributed to the personalized women as compared to their physical appearance. This differential attribution is absent for the mannequin. Moreover objectified and personalized women did not differ in terms of experience and agency. Importantly, mannequins were perceived to lack both experience and agency with respect to the objectified and personalized women. Finally, participants reported to be less familiar with the mannequins than with both type of women, and slightly less familiar with objectified than personalized women.

In sum, objectified women were perceived as sexier than personalized women, and as less intelligent than personalized women. Both types of women differed from mannequin in their experience and agency, being the former more agentic and able to experience than the mannequin. In other words, the two women differ in terms of sexualization but not humanness while the mannequin differs from the two women categories in terms of humanness (Haslam, 2006; Haslam et al., 2007).

Shared representations

Participants' similarities between the ratings in the self and in the other runs were computed as within-subject correlations (for similar procedure, see Latrofa et al., 2010 and Cadinu et al., 2013). Correlation coefficients were Fisher Z-transformed (McNemar, 1962; from now on self-other overlap scores) to reach a normal distribution. The order of presentation of the stimuli in the other run was used as standard order to sort the ratings in the self run. The stimuli were then grouped in three subsets composed by ten consecutive trials, according to an initial (trial 1 to 10), middle (trial 11 to 20) and final (trial 21 to 30) moment of the task (See Table 2 and 3 for values). In so doing, we gather information about the overall similarity between the self- and the other-emotional ratings, controlling also for the effect of the order of presentation. Replicating previous research in the objectification domain (Heflick & Goldenberg, 2009; Loughnan et al., 2010; Gray et al., 2011; Heflick et al., 2011; Vaes et al., 2011; Loughnan et al., 2013) participants' gender did not interact with any of the independent variable and was dropped from the analyses.

Table 2.

Mean values and standard deviations (in brackets) for the affective ratings for each group in the two different runs.

	Self						Other					
	1-10		11-20		21-30		1-10		11-20		21-30	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Personalized	4.56 (1.46)	[4.18, 4.95]	4.93 (1.55)	[4.52, 5.33]	4.77 (1.60)	[4.36, 5.20]	4.83 (1.30)	[4.44, 5.22]	5.46 (1.30)	[5.10, 5.82]	5.41 (1.51)	[4.99, 5.83]
Objectified	4.94 (1.61)	[4.5, 5.35]	5.04 (1.72)	[4.6, 5.48]	4.96 (1.80)	[4.52, 5.40]	4.99 (1.72)	[4.57, 5.41]	5.31 (1.51)	[4.92, 5.7]	5.41 (1.86)	[4.95, 5.86]
Mannequins	4.43 (1.49)	[4.04, 4.82]	4.55 (1.57)	[4.14, 4.97]	4.17 (1.39)	[3.76, 4.58]	4.57 (1.60)	[4.18, 4.97]	4.96 (1.47)	[4.60, 5.33]	5.25 (1.66)	[4.82, 5.68]

Table 3.

Mean values and standard deviations (in brackets) for the Fisher-Z transformed correlation coefficient (i.e. self-other overlap scores) for each group in the three moment of the task.

	Correlation coefficients					
	1-10		11-20		21-30	
	M (*SD*)	95% CI	*M* (*SD*)	95% CI	*M* (*SD*)	95% CI
Personalized	.81 (.57)	[.69, .94]	.81 (.46)	[.69, .93]	.63 (.47)	[.51, .76]
Objectified	.74 (.41)	[.60, .87]	.65 (.36)	[.52, .78]	.54 (.50)	[.40, .68]
Mannequins	.50 (.48)	[.37, .63]	.48 (.54)	[.36, .60]	.41 (.53)	[.29, .54]

The Self-other overlap scores were analyzed by means of a 3(Group: Objectified, Personalized, Mannequin) X 3(Order: 1-10, 11-20, 21-30) ANOVA, with the former variable as a between-participant factor, and the latter as within-participants factor.

Results revealed a significant main effect of the order $F(2,167) = 6.27$, $p = .002$, $\eta_p^2 = .08$, indicating that the self-other overlap scores were similar in the 1-10 (M= .68, SE = .04) and in the 11-20 order (M = .64, SE = .04, p = .37), and higher than the 21-30 order (M = .53, SE = .04, p < .01). This result indicated that the self-other overlap decreased only at the late moment. Moreover, and in line with our expectation, the effect of the group was significant $F(2,167)$ = 9.6, p < .001, $\eta_p^2 = .10$ (See Figure 3).

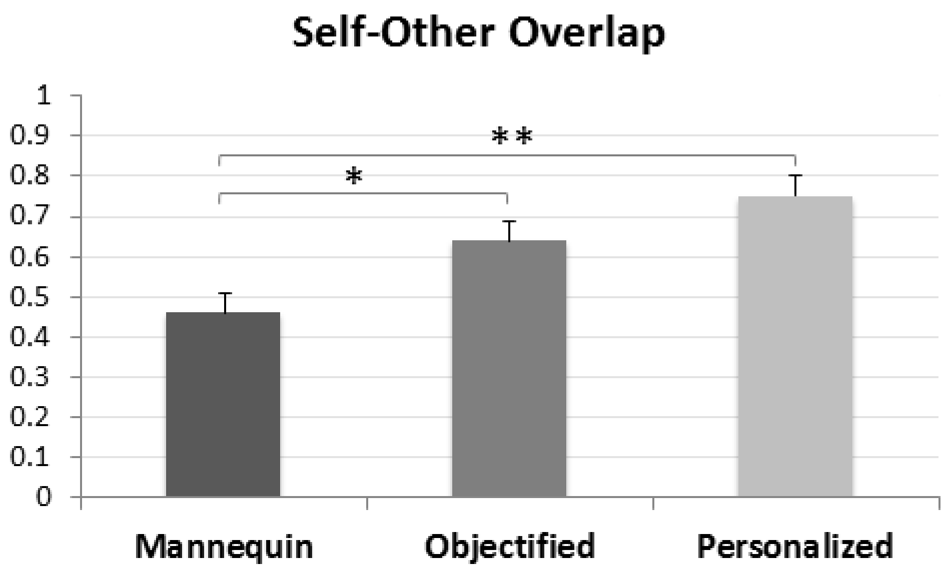

Figure 3. Mean and standard error of the correlation coefficients, representing the total overlap between self and other, divided by the three groups. The asterisks indicate a significant difference of the self-other overlap between groups (* p < .05; ** p < .001).

A significant linear trend was found (p < .001) indicating that the self-other overlap scores are lower in the mannequin group, increase at intermediate levels in the objectified group, and reach the highest levels in the personalized group. Pairwise-comparisons (one-tailed) confirmed this interpretation as they indicated that the self-other overlap scores are lower in the mannequin (*M* = .46, *SE* = .05) than in both the objectified (*M* = .64, *SE* = .05; *p* = .01) and the personalized (*M* = .75, *SE* = .05; *p* = .001) group. Importantly, the self-other overlap scores in the objectified group are lower than in the personalized group, albeit this difference fell short of significance (*p* = .06). This pattern of results confirmed that self-other overlap is higher when interacting with a personalized woman, decreased when dealing with an objectified woman, and it was lower when dealing with an object. Moreover the mean self-other overlap was statistically different from the zero level for the mannequin group t (58) = 9.23, p < .001, *d* = 2.42, as well as for the personalized group t (60) = 15.12, p < .001, *d* = 3.9, and the objectified group t (49) = 14.14, p < .001, *d* = 4.04.

The interaction between group and order was not significant $F(4, 334) = .52$, $p = .72$, $\eta_p^2 = .01$, indicating that the effect of the order on the self-other overlap scores is similar among the groups.

Discussion

Empathic responses, in terms of similarity between one's own affective reactions and the attribution of similar reactions to the other person, are subject to variations depending on contextual and motivational factors (Xu et al., 2009; Mathur et al., 2010). In this study we were able to bring fresh evidence on the impact of social factors such as the perceived objectification of the target on empathy for positive and negative emotions. In so doing, for the first time within the research on objectification, the comparison between a sexually objectified woman and an object has been addressed, thus shedding light on the differences between reactions towards these two categories. Moreover differently from previous research, in which empathy towards sexually objectified or not objectified women has been tested only through indirect measures (Loughnan et al., 2010), this study assessed the effect of the perceived objectification on shared representations by means of the direct comparison of online self-related and other-related affective ratings.

Results showed a modulation of the self-other overlap (i.e. an index of shared representations) by the factor group. In line with our hypothesis, the self-other overlap reaches its highest value when the target is a personalized woman, implying a facilitation of the empathic feeling toward personalized women as opposed to objectified women. It has already been shown that people attribute less humanness to objectified targets as compared to non-objectified targets (Loughnan et al., 2010), and that mind attribution is an essential characteristic for the shared representation to occur (Zaki, 2014). At the same time, objectified women are perceived (blatant measure) as less similar to the self (female perspective) (Vaes et al., 2011), and a reduced similarity of the target decreases the empathic feeling (Majdandzic et al., 2016).

In this study we were able to extend previous empirical evidences on the spectrum of consequences of sexual objectification by showing that being confronted with a real human wearing an objectified outfit leads to a reduction of self-other overlap in terms of affective ratings, as compared to a personalized version, providing therefore an ecological validation of the theory.

Moreover, as expected, participants display a lower similarity between the scores attributed to self and the other when the mannequin was the other target in comparison to both objectified and personalized women. Importantly, the use of the mannequin as a control condition allowed to deeper our understanding of fundamental research questions: on one hand the characterization of the mechanism behind sexual-objectification, and on the other the appraisal of human vs. non-human entities.

First, the comparison between the mannequin and the objectified women is important in order to address the core statement of the objectification theory, namely whether the appraisal of objectified women is equivalent to the appraisal of objects. Our results indicate that the two categories indeed display a different degree of share representation: self-other overlap toward objectified women is greater than the one toward an object. Consequently the processes behind sexual-objectification of human beings cannot be equalized to the ones behind the perception of real objects, as the terminology seems to suggest. Hence different mechanisms must be involved in the perception of these two categories.

Second, the comparison between the mannequins and the personalized women was relevant for the study on humanization of non-human entity. Despite the tendency of a perceiver to humanized an entity according to the degree of human-like features displayed (Krach et al., 2008), the physical appearance of the mannequin still differ from a real woman. Hence, as described by the uncanny valley theory (Mori, 1970; Mori et al., 2012), the emotional responses elicited by the mannequins are similar but not overlapping to the responses elicited by real humans. Therefore the higher displayed empathy toward women as compared to objects confirms previous assumption about the different empathic feelings toward humans and non-humans (Suzuki et al., 2015). Note nevertheless that the overlapping between the self and the other in the mannequin condition is significantly different from zero (as one may assume when evaluating an inanimate object). This result likely arises from the instructions given to the participants, in that it was explicitly asked to imagine the mannequin as being a hypothetical real woman. On the other hand, the similarity between the mannequin and the human body could trigger some sort of empathic simulation in the perceiver. Further studies should address this important issue by systematically varying the degree of humanness in inanimate objects and measure its impact on empathic responses.

By looking at the effect of time, our results showed that self and other ratings overlap was affected by the order of presentation. In particular at the beginning of the task, self and other scores were highly similar, suggesting that the self is used in a first place as a proxy to understand the other. Conversely, with the progress of the task, participants weakened the self-other overlap. In fact the higher discrepancy between the scores attributed to the self and the other is found in the last ten trials of the experiment. Hence while at the beginning, the self is used as a reference to evaluate the emotional state of the other target, during the task participants tend to evaluate the other`s feelings without using themselves as a reference. Notably, the time needed for the self-other overlap to change is constant across groups, indicating that no matter the kind of target that participants have to evaluate, the shared representation is reduced in the later trials. A possible explanation could be attributed to fatigue increase with the performance of the task. This in turn could have prevented participants from applying their initial strategy to empathize with the emotion of the other, and made it weaker toward the end of the task.

An additional result of this study is the absence of gender differences in empathic responses to objectified and personalized targets. Similar results have been previously reported in studies on mind attribution and dehumanization of objectified target (Heflick & Goldenberg, 2009;

Loughnan et al., 2010; Gray et al., 2011; Heflick et al., 2011; Vaes et al., 2011; Loughnan et al., 2013). Nevertheless it may be possible that participants of different gender show similar empathic feelings toward an objectified woman, although guided by different motivations. Considering the case of an equal level of dehumanization of objectified women (measured through the IAT), Vaes and colleagues (2011, but see also Morris & Goldenberg, 2015) hypothesized and showed that this phenomenon was driven by a combination of dehumanization/instrumental process applied by men, and by a dehumanization/avoidance process applied by women. Namely, the male sexual attraction for the objectified target leads to a shift of the interest from the personality to the physical appearance of the woman, resulting in a dehumanization reaction. On the contrary, female participants dehumanize objectified women because they perceive them as out-group members from which they feel disconnected. In fact, although in this study both male and female participants display a similar empathic response toward the same target, we can speculate that the male decreased empathic reaction toward objectified women could be driven by an increased sexual attraction and enhanced focus of attention on the woman physical appearance, thus hampering the share representation process. On the other hand, the female decreased empathic reaction toward objectified women could be guided by an avoidance reaction from a typology of women to which they want to be differentiated. Further studies should systematically investigate the processes behind such empathic responses in both genders.

In conclusion, in an era where violence against women represents an everyday topic, the understanding of how women's emotions are perceived and represented from an observer perspective is of fundamental interest. The current study provides an empirical basis of a behavior extensively described outside the laboratory: in a hypothetical assault, the diminished empathic feelings toward an objectified woman as compared to a personalized one can explain the tendency of a male perpetrator to perceive only his need and feelings ignoring the emotions of the person in front of him. Our results seem to suggest that this behavior could be due to the general perception of objectified women as having different feelings from ourselves. Future work should investigate the possible practical consequences of the diminished empathy toward objectified women in sexual harassment context.

Chapter 3

The neurophysiological basis of empathy for sexually objectified target [4]

[4] This research is in preparation for the publication in a peer-reviewed journal: Cogoni, C., A. Carnaghi and G. Silani. Neural correlates of empathy for social pain with objectified targets.

Abstract

When women are target of sexual objectification, perceivers focus more on women's bodies and appearance over women's mental state. This shift in terms of attention has negative consequences such as making the observers perceived women as less human, less competent and less moral. Moreover, perceivers' behavioral responses toward a target dramatically change as a function of the degree of target objectification. Empathic reactions can be dramatically different when directed to objectified and personalized women. In the present study, we investigated how neural regions involved in the perception of other social pain are modulated by the degree of sexualization of the targets. Using a within-subject fMRI design, we showed reduced empathic reactions toward objectified women as compared to personalized women. Moreover, empathy for social exclusion of personalized women recruited areas coding the affective component of pain (anterior insula and cingulate cortex), the somatosensory components of pain (posterior insula and secondary somatosensory cortex) together with the mentalizing network (middle frontal cortex) to a greater extent than for the objectified women. This diminished empathy is discussed in light of the gender-based violence, a plague that the modern society is increasingly paying attention to.

Introduction

Gender-based violence disproportionately affects women, and it constitutes an extensive human rights abuse that the modern society cannot afford to overlook. Whereas violence against women has always existed, it is only in the last two decades or so that the international community has begun to highlight and systematically sharpen the problem (European Union Agency for Fundamental Rights, 2014; Walby et al., 2016). In the attempt to examine and understand this modern plague, it has been theorized that behind the tendency to act violently likely stands, among other factors, a dramatic dampen of the empathic feelings of the perpetrator toward the victim of the violence (Baron-Cohen, 2011). Specifically, empathy has been defined as a social emotion triggered by the perception or imagination of someone else's emotional state and it is characterized by a partial sharing of this emotional state by the observer and the target of empathy (de Vignemont & Singer, 2006; Singer & Lamm, 2009). Empathy is a crucial skill for human and animal social interaction; it plays a fundamental role in the understanding of others' intentions and actions, and in the regulation of our behavior toward the target of empathy. Scientific research has begun investigating the conditions under which people behave empathically and which specific features of the target are able to modulate empathic responses in the observer. In particular, it has been shown that empathy diminishes if the target of the empathic judgment is perceived as unfair (Singer et al., 2006) or dissimilar from the self (Majdandzic et al., 2016). Similarly, the perception of the suffering of an outgroup member (i.e. soccer fan of a rival team), compared to the perception of the same emotional state experienced by an ingroup member (i.e. soccer fan of the same team), leads to a reduction of the affective shared representations between the perceiver and the target, with a concomitant reduction of helping behavior (Hein et al., 2010). To the same extent, a race bias can induce a negative modulation of the empathic feeling toward outgroup members (opposite race of the onlooker) as compared to ingroup members (same race of the onlooker) (Johnson et al., 2002; Cosmides et al., 2003; Xu et al., 2009; Avenanti et al., 2010; Forgiarini et al., 2011). Importantly, it has been recently disclosed a negative relationship between self-report level of empathy and violence of sexual nature, thus suggesting that behind this class of violent behaviors possibly lies a reduction/lack of the ability to represent and share the suffering of the recipient of the violent act (Baron-Cohen, 2011). In order to better understand this phenomenon, it is fundamental to highlights which specific features of the target are responsible for the different degree of empathic feeling in the observer. Objectification, in particular, stands as one of the possible mechanisms behind this reduction of empathic feelings.

Women Sexual Objectification

Objectification of an individual is a phenomenon that has been theorized and described by social philosophers since Immanuel Kant's "*The Metaphysical Elements Of Ethics*" (1780). Broadly, it refers to the perception of people as instruments useful only to achieve specific goals (Nussbaum, 1995). A specific form of objectification is sexualization or sexual objectification. When an individual target is sexually objectified, the appraisal of the target is mainly driven by the target's physical appearance with a concomitant denying of the target's capacity for actions and decision making (American Psychological Association, 2007). Sexual objectification can occur not only when perceivers are exposed to women (or men) that are portrayed in a sexualized manner (e.g., revealing clothes, seducing poses), but also when perceivers shift the focus of their attention from the target's mind toward the target's physical attributes (Bartky, 1990). As a result, sexualized targets are judged to be less competent (Heflick & Goldenberg, 2009), less moral (Loughnan et al., 2013), less human (Loughnan et al., 2010) and less agentic (Gray et al., 2011) as compared to non-sexualized targets. Interestingly, objectified women (i.e. women with appealing bodily parts such as hip and breast prominently displayed) are perceived as having greater ability to experience emotion and bodily sensations in comparison to personalized women (i.e. women with appealing body parts more covered), suggesting a misattribution solely due to the visual appearance of the target (Gray et al., 2011). In spite of this misattribution, preliminary studies on the relationship between empathy and sexual objectification have shown higher willingness to administer hypothetical painful tablets to objectified targets (i.e. pictures of shirtless men and women in bikinis) as compared to non-objectified targets (i.e. pictures of men and women fully clothed), suggesting altered empathic responses toward the former (Loughnan et al., 2010). We also recently showed that empathy for pleasant and unpleasant emotions is reduced toward objectified women as compared to personalized women, as indicated by a diminished shared representation between the self and the target (Cogoni et al., 2016). Given the increasing sexual objectification of (especially) women in modern media (American Psychological Association, 2007) and the paucity of studies exploring how the objectification of a target modulates empathy in the observer, the aim of the present study is therefore to unravel the behavioral and neurobiological mechanisms underlying this phenomenon, as a first attempt to understand the link between empathy and gender-based violence. Specifically, we intend to investigate how the vicarious experience of social pain may be affected by perceived sexual objectification of a target. Said otherwise, we intend to assess the behavioral and neurobiological mechanisms that are differently recruited when the target of the social exclusion is a sexually objectified woman and a non-sexually objectified woman.

To this aim, feelings of empathy for social pain will be elicited in participants by witnessing exclusion from a ball tossing game, under functional magnetic resonance imaging (fMRI) investigation. In the next section, the neurophysiological underpinning of first person and vicarious experience of social exclusion will be briefly introduced.

Empathy for social exclusion

The feeling of social pain has being defined as the *'unpleasant experience that is associated with actual or potential damage to one's sense of social connection or social value'* (Eisenberger, 2012). Among others, it may arise from the loss of a close person (Kersting et al., 2009), a romantic rejection (Fisher et al., 2010) or the experience of being excluded or ostracized (Masten et al., 2012). In experimental settings, social pain has been mainly investigated through the use of the cyberball paradigm, an interactive virtual ball tossing game which has been proved to be able to mimic a real life experience and elicit negative affect (Williams et al., 2000; Williams, 2003). The cyberball paradigm has been used both in behavioral (Zadro et al., 2004; van Beest & Williams, 2006) and in neuroimaging studies (Eisenberger et al., 2003; Eisenberger et al., 2007a; Eisenberger et al., 2007b; Dewall et al., 2010; Masten et al., 2010) and it has revealed to be particularly useful to study not only the first person but also the vicarious experience (empathy) of social pain (Masten et al., 2011; Novembre et al., 2015). While the first-hand experience of social pain has been associated with activity of brain regions usually related to the affective processing of aversive experience (especially of physical nature) such as anterior insula (aINS), anterior middle cingulate cortex (aMCC), posterior anterior cingulate cortex (pACC), and ventral cingulate cortex (vCC) (Eisenberger et al., 2003; Dewall et al., 2010; Bolling et al., 2011; Eisenberger, 2012), empathy for social pain has been associate with brain regions underlying the processing of the affective experience (aINS and aMCC) as well as the representation of other mental states, such as dorsomedial prefrontal cortex (DMPFC), medial prefrontal cortex (MPFC) and precuneus (PC) (Masten et al., 2010). Recently, Novembre and colleagues (2015) observed that empathy for another person undergoing social ostracism, when the ostracism is vividly elicited, recruits regions that are involved in the processing of the somatosensory-discriminative component of pain, such as the secondary somatosensory cortex (SII) and posterior insula (pINS) (Avenanti et al., 2005; Hein & Singer, 2008; Keysers et al., 2010).

Following the literature on sexual objectification, in the present study we hypothesized that the vicarious experience of social exclusion would be modulated by the level of objectification of the target. Specifically, we put forward that sexually objectified women would trigger lower empathic reactions both on a behavioral and neurophysiological level, by dampening the level of shared representation in the affective (aINS and aMCC) as well as in the somatosensory-discriminative processing brain regions (SII and pINS).

Methods

Subjects

A total of 41 participants (*N*=21 male, *N*=20 female) with a mean age of 23.2 years (*S.D.* = 3.51, range = 18-34) were recruited via an online recruitment platform and they took part in the fMRI experiment in exchange of monetary reimbursement. All participants gave informed consent and the study was approved by the Ethics Committee of 'Santa Maria della Misericordia' hospital, Udine, Italy. Three participants were excluded from the analysis due to anatomical anomalies, while two participants were excluded due to acquisition problems during the fMRI scanning, thus reducing the number of participants included in the final analysis to thirty-six.

Instructions about the experiment were provided to the participant outside the scanner. Immediately after the scan, self-report questionnaires were administered to measure general empathic traits (Interpersonal Reactivity Index - IRI (Davis, 1980)), social and political attitudes (Social Dominance Orientation - SDO (Pratto et al., 1994)), ambivalent attitudes toward women (Ambivalent Sexism Inventory - ASI (Glick & Fiske, 1996)), and level of self-objectification (Self-Objectification questionnaire (Noll & Fredrickson, 1998)).

Social pain task

The paradigm consisted of one session entailing four runs, performed on the same day. Each run was organized in a 3 (Target: Self, Other Objectified, Other Personalized) × 2 (Condition: Inclusion, Exclusion) within-subjects factorial design.

The social pain task was based on the original Cyberball task (Williams et al., 2000), with the peculiarity of replacing the animated cartoons playing the game with videos of real people tossing the ball to each other (see also Novembre et al. (2015), for a similar version of the cyberball game). Videos were recorded using a Digital Video Camcorder (Canon Legria FS406, Tokyo, Japan) and then edited with iMovie'11 (version 9.0.9 (1795)).

Each video lasted an average duration of 18.18 s (range 15–21 s), in which the ball was tossed every two seconds for 10 or 11 passes. The trials where participants were involved in the game (Self trials) were characterized by the presence of the hands in front of the camera (see Figure S1 in the supplementary material). The trials where participants watched the game played by the three other participants (Other Objectified trials, Other Personalized trials) were characterized by the presence of only one body at the center of the screen and two pairs of hands on the right and left side of the screen. The person whose body was fully displayed was a confederate either dressed in a sexually objectified manner (Other Objectified) or in a non sexually-objectified fashion (Other Personalized) (See Cogoni et al., 2016 for a similar manipulation). The objectified outfit consisted of a short dress, heels and heavy makeup. The personalized outfit consisted of comfortable trousers, a jersey, ballet flat shoes and a light makeup (see Figure S2 in the supplementary material). Both outfits were pretested on Sexiness, Attractiveness, Intelligence and Familiarity scores and also on Agency and Experience capacity following the mental state attribution scale (Gray et al., 2011). The confederates were two young adult women unknown to the participants, one blonde and one brunette, of similar age, height and weight. Each participant saw through the entire game the same combination of confederate (i.e. if the blond confederate was wearing an objectified outfit the brunette was wearing the personalized ones or vice versa). This combination was randomized across participants.

Procedure

Participants were told that they would have been alternatively connected via computer network to other three participants controlling the decisions of the players visible in the videos, which were located in another university building outside the Hospital. Therefore, the participants didn’t meet the other players.

The videos could belong to one of the three possible targets (Self, Other Objectified, Other Personalized) but no cues were given to the participants before the presentation of each of them. During the Self trials, participants were directly involved in the game and they had to decide to whom to throw the ball every time they were in possession of it by pressing either the left or the right keys on the pad that they held in the right hand.

In the Other Objectified and the Other Personalized trials, they watched the game played by the three other participants located in the university building (while in reality all the decisions were already preregistered). They were told that due to the small size of the university room, the camera would be able to record only one participant in the full body dimension while only the hands of the other two participants would be visible in the video. In each run, two videos for each of the three targets in the two conditions: ‘social inclusion’ and ‘social exclusion’ were displayed in a pseudo randomized order, resulting in 12 trials per run and a total number of 48 trials in the entire session The ‘social inclusion’ trials were the trials in which the player, either the participant or the confederate, received the ball among all the passes. The ‘social exclusion’ trials were characterized by no passes received by the player. At the end of each trial, the participant was asked to rate the valence of the emotion felt during the game on a Likert-type rating scale going from −10 = ‘very negative’ over 0 to +10 = ‘very positive’. The response was given using the same keys used for throwing the ball, within a time frame of 4 seconds (see Figure 1).

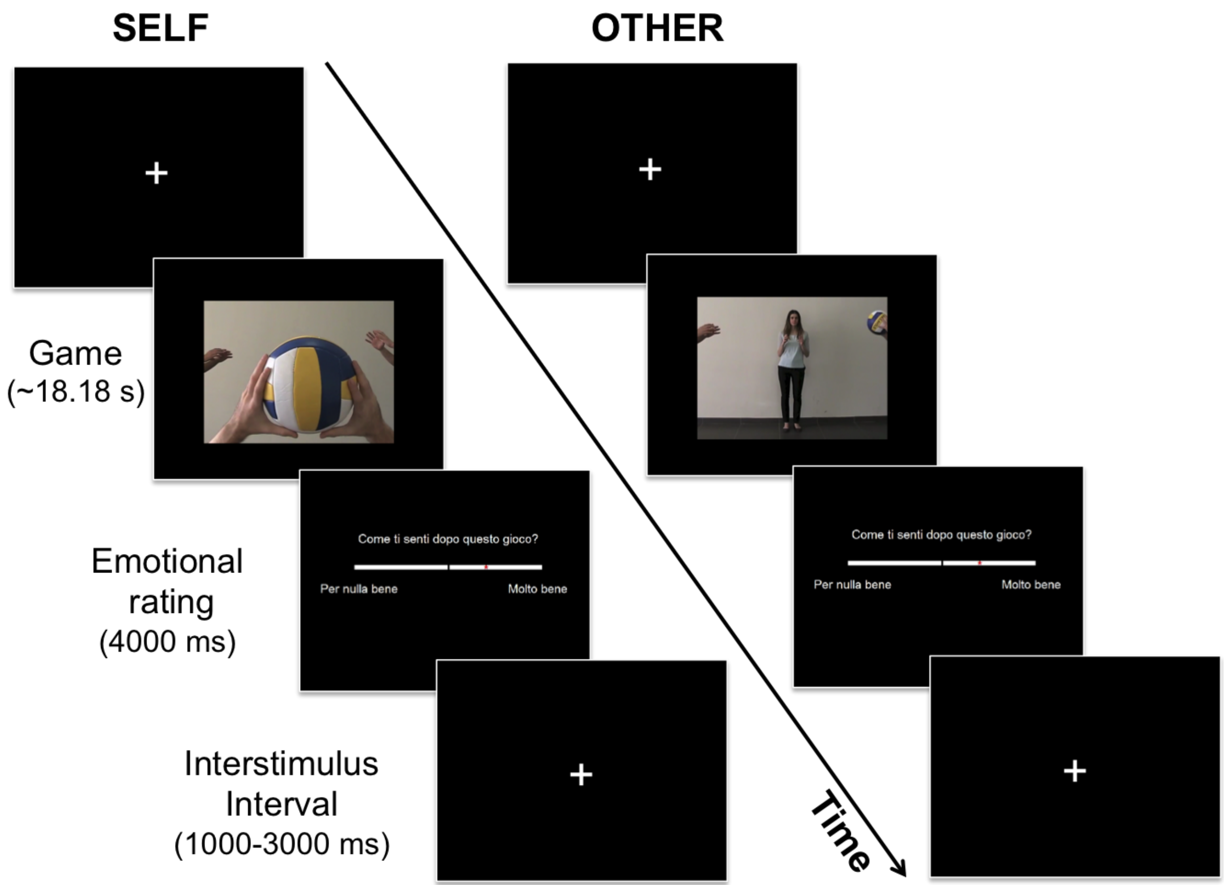

Figure 1. Exemplar trials of the social pain task. In each trial, participants could be involved in the game (Self), observe objectified targets involved in the game (other Objectified) or observe personalized targets involved in the game (Other Personalized). For illustrative purpose only the Self (left side of the figure) and Other Personalized (right side of the figure) trials are presented. At the end of the game they were ask to judge their own emotion on a Likert-type rating scale.

Behavioral data processing

For each subject, and for each condition, the average emotional rating was calculated from the four runs. The emotional ratings were then used in a 3 (Target: Self, Other Objectified, Other Personalized) × 2 (Condition: Inclusion, Exclusion) repeated-measures ANOVA. Statistical analyses were performed with SPSS 21.0 software.

fMRI data acquisition

A 3 Tesla Philips Achieva whole-body MR Scanner at the Hospital 'Santa Maria della Misericordia' (Udine, Italy), equipped with an 8-channel head coil, was used to acquire both T1-weighted anatomical images and gradient-echo planar T2-weighted MRI images with blood oxygenation level-dependent (BOLD) contrast. Functional images were acquired using a T2*-weighted echo-planar imaging (EPI) sequence with 33 transverse slices covering the whole brain (slice thickness 3.2 mm; interslice gap 0.3 mm; TR/TE = 2000/35 ms; flip angle = 90°, field of view = 230 × 230 mm^2; matrix size = 128 × 128, SENSE factor 2). Structural images were acquired as 180 T1-weighted transverse images (0.75 mm slice thickness).

fMRI data processing

Data were analyzed with SPM12 (Wellcome Department of Imaging Neuroscience, London, UK), running on Matlab R2012b. The scans were not slice timing corrected because with a relatively short TR (2 seconds) it could lead to artifacts (Poldrack et al., 2011). All functional volumes were realigned to a first functional image, co-registered to each individual's structural MRI scan, segmented in gray matter, white matter and cerebrospinal fluid tissues, normalized to a template based on 152 brains from the Montreal Neurological Institute (MNI), and then smoothed by convolution with an 8 mm full-width at half-maximum (FWHM) Gaussian kernel.

Motion and artifact analysis the movement-related variance was detected using the Art toolbox (www.nitrc.org/projects/artifact_detect). In each run, outlier scans were identified based on two measures: (a) if the TR-to-TR composite motion was more than 2mm and/or (b) if the scan-to-scan global BOLD signal normalized to z-scores deviated from mean more than z = 3. Each time-point identified as an outlier was regressed out as a separate nuisance covariate in the first-level design matrix. All participants display a percentage of outlier scan inferior to the cutoff (25%), therefore no one was excluded from the analyses.

Following pre-processing, data were analyzed using the general linear model framework (Kiebel & Holmes, 2003). Low-frequency signal drifts were filtered using a cutoff period of 128 s. Regressors of interest were convoluted with a canonical hemodynamic response function. The MRIcron software package (Rorden et al., 2007) was used for anatomical and cytoarchitectonic interpretation.

In the first-level analysis, data were analyzed separately for each subject. Two separate first-level regressors (interaction period and rating) were defined for each target (Self, Other Objectified, Other Personalized) and for each condition (Inclusion and Exclusion) for a total of twelve regressors for each of the four runs.

Images were then fed into a flexible factorial design with a within-subject factor of six levels using a random effects analysis (Penny et al., 2003).

Linear contrasts of the repeated measure ANOVA with two within-subject factors: Target (Self, Other Objectified, Other Personalized) and condition (Inclusion, Exclusion) were used to assess main effects and interactions.

Difference in the vicarious experience of social pain between Other Objectified and Other Personalized targets were calculate as the interaction effect (Exclusion, Inclusion) in (Other Personalized, Other Objectified).

Due to the unbalanced motor actions between self and other inclusion blocks, a conjunction analyses (Nichols et al., 2005) of the contrasts exclusion *vs* inclusion for the 'self' and 'other'-related conditions couldn't be used to identify brain regions commonly activated during the direct and the vicarious experience of social pain.

Results

Behavioral results

Pilot test on pictures

A pilot test was conducted to assess the efficacy of our experimental manipulation. Twenty participants (*N* = 10 female and *N* = 10 male, selected from an independent pool issued from the same population of the experimental sample), age ranged from 21 to 31 (*M* = 25.2, SD = 2.73), rated the pictures of the two confederates in the objectified and personalized outfit on mental (i.e. Intelligence) and physical appearance (i.e. Attractiveness and Sexiness) dimensions, by means of a 6-point scale, ranging from 1 (= not at all) to 6 (= completely). The Familiarity with the confederates was also measured by means of the same 6-point scale as above. Finally, the confederates were also rated with respect to their capacity in terms of Agency and Experience, through 12 items of the mental state attribution scale (Gray et al., 2011).

The physical appearance and intelligence rating scores were analyzed by means of 2 (Dimension: Physical Appearance, Intelligence) by 2 (Condition: Objectified, Personalized) repeated measures ANOVA with the former and the latter variable as within-subject factors. Results revealed a significant interaction of the Condition with the Dimension $F(1,19) = 34.47$, $p < .001$, $\eta_p^2 = .65$. This interaction revealed that more intelligence was attributed to the personalized condition (*M* = 4.10, *SE* = .27) than to the objectified condition (*M* = 3.10, *SE* = .25) *p* = .001, and also less physical appearance characteristics were attributed to the personalized condition (*M* = 3.12, *SE* = .31) than to the objectified condition (*M* = 4.03, *SE* = .28) *p* = .01.

The agency and experience rating scores were analyzed by means of 2 (Dimension: Agency, Experience) by 2 (Condition: Objectified, Personalized) repeated measures ANOVA with the former and the latter variable as within-subject factors. Results revealed a marginally significant effect of the Condition $F(1,19) = 3.89$, $p = .06$, $\eta_p^2 = .17$, indicating that the agency and experience attributed to the objectified condition ($M = 3.03$, $SE = .06$) were reduced as compared to the personalized condition ($M = 3.20$, $SE = .10$),

A significant interaction of the Condition with the Dimension was also found $F(1,19) = 23.34$, $p < .001$, $\eta_p^2 = .55$. This interaction revealed that greater experience was attributed to the objectified condition ($M = 3.21$, $SE = .09$) than to the personalized condition ($M = 2.93$, $SE = .12$) $p = .02$, and also more agency was attributed to the personalized condition ($M = 3.46$, $SE = .13$) than to the objectified condition ($M = 2.84$, $SE = .09$) $p < .001$.

The objectified and personalized conditions did not differ in terms of familiarity $F(1,19) = .41$, $p = .53$, $\eta_p^2 = .02$.

The pilot test results indicated that, in line with the operationalization of objectification already used in literature (Bartky, 1990; Vaes et al., 2011; Cogoni et al., 2016), confederate in the objectified condition were perceived with greater physical appearance characteristics but less intelligence than in the personalized condition. Moreover, in line with Gray and colleagues' results (2011), the confederates in the objectified condition were perceived as having less agency and more experience than in the personalized conditions. In other words, because experience and agency are two basic features that differentiate human from non-human entities (Fiske et al., 2002; Gray et al., 2007), we can affirm that in our experiment objectified and personalized women differ also in terms of perceived humanness (Haslam, 2006; Haslam et al., 2007).

Measures of objectification after scan

To confirm the pattern of result previously found in the pilot test, the same scales described in the pilot were administered to participant immediately after the scan.

The analyses of the physical appearance and intelligence rating scores[5] revealed a significant main effect of the Dimensions $F(1,32) = 6.74$, $p = .01$, $\eta_p^2 = .17$ indicating that intelligence characteristics ($M = 3.76$, $SE = .16$) were attributed to a greater extend in comparison with the physical appearance ($M = 3.33$, $SE = .15$) regardless of the condition. A significant interaction of the Condition with the Dimension $F(1,32) = 8.71$, $p = .01$, $\eta_p^2 = .21$ was also found. This interaction revealed that more intelligence was attributed to the personalized condition ($M = 4.12$, $SE = .20$) than to the objectified condition ($M = 3.40$, $SE = .21$) $p = .01$, while equal physical appearance characteristics were attributed to the personalized condition ($M = 3.11$, $SE = .23$) and to the objectified condition ($M = 3.56$, $SE = .23$) $p = .22$.

The analyses of the agency and experience rating scores revealed a significant effect of the Dimension $F(1,35) = 9.53$, $p = .004$, $\eta_p^2 = .21$, indicating that the agency characteristics ($M = 3.28$, $SE = .07$) were attributed to a greater extent than the experience characteristic ($M = 3.00$, $SE = .10$) regardless of the condition. A significant interaction of the Condition with the Dimension was also found $F(1,35) = 6.81$, $p = .01$, $\eta_p^2 = .16$. This interaction revealed that more agency was attributed to the personalized women ($M = 3.47$, $SE = .09$) than to the objectified women ($M = 3.08$, $SE = .10$) $p < .001$, while experience was equally attributed to objectified women ($M = 3.09$, $SE = .14$) and personalized women ($M = 2.92$, $SE = .13$) $p = .34$.

The personalized conditions ($M = 3.64$, $SE = 1.39$) was also rate as more familiar than the objectified condition ($M = 2.76$, $SE = 1.06$) $F(1,32) = 7.06$, $p = .01$, $\eta_p^2 = .18$.

These analyses indicated that, the pattern of result found in the pilot test was partially replicated: the personalized condition was perceived with a greater focus on the mind and with more agentic characteristics as compared to the objectified condition. On the contrary, differently from the

[5] Note that three participants complete only the front page of the questionnaires resulting in a total number 36 of participants tested with the mental attribution scale and 33 participants tested with the other questionnaires.

pilot test, personalized and objectified women were perceived as having similar physical appearance and experience characteristics.

Social exclusion task

The emotional ratings recorded during the social exclusion task were analyzed by a repeated measure ANOVA with 3 (Target: Self, Other Objectified, Other Personalized) × 2 (Condition: Inclusion, Exclusion) within-participants factors (Figure 2).

Result showed a main effect of the condition $F(1,35) = 160.44$, $p < .001$, $\eta_p^2 = .82$, indicating the inclusion (*M*= 3.68, *SE*= .45) and the exclusion from the game (*M*= -6.09, *SE*= .47) were able to elicit different affect.

A main effect of the target was also found $F(2,33) = 23.64$, $p < .001$, $\eta_p^2 = .40$, indicating that the emotional intensity are higher in the self (*M*= -.11, *SE*= .31), intermediate in the personalized other (*M*= -1.00, *SE*= .32) and lower in the objectified other (*M*= -2.51, *SE*= .34). Moreover a significant interaction of the target by condition $F(2,33) = 19.09$, $p < .001$, $\eta_p^2 = .35$ was found. Pairwise comparison indicate that in the exclusion condition the emotions related to the self (*M*= -5.74, *SE*= .61) were less intense than the other objectified (*M*= -6.52, *SE*= .40) $p = .04$ but equally intense then the other personalized (*M*= -6.01, *SE*= .47) $p = .41$, while emotions related to the objectified other were more intense than the personalized other $p = .06$.

In addition, in the inclusion condition the emotions related to the self (*M*= 5.53, *SE*= .35) were more intense than both the objectified target (*M*= 1.51, *SE*= .73) $p < .001$ and the personalized target (*M*= 4.01, *SE*= .50) $p < .001$, but also the emotions related to the personalized other were more intense then the objectified other $p < .001$.

Note that participant gender did not influenced the emotional ratings nor interacted with any of the aforementioned factors $p > .16$ therefore it was excluded from further analyses.

Correlation with self-report questionnaires

Associations between behavioral scores of the empathy for social exclusion task and both measures of objectification of the targets (Physical Appearance, Intelligence, Agency Experience) and self-reported questionnaire (IRI, SDO, ASI, Self-Objectification) were investigated. Result revealed that the empathy score (calculated as the difference between the Personalized and Objectified trials when subtracting the inclusion from the exclusion ratings) showed no association with any of the aforementioned subscale.

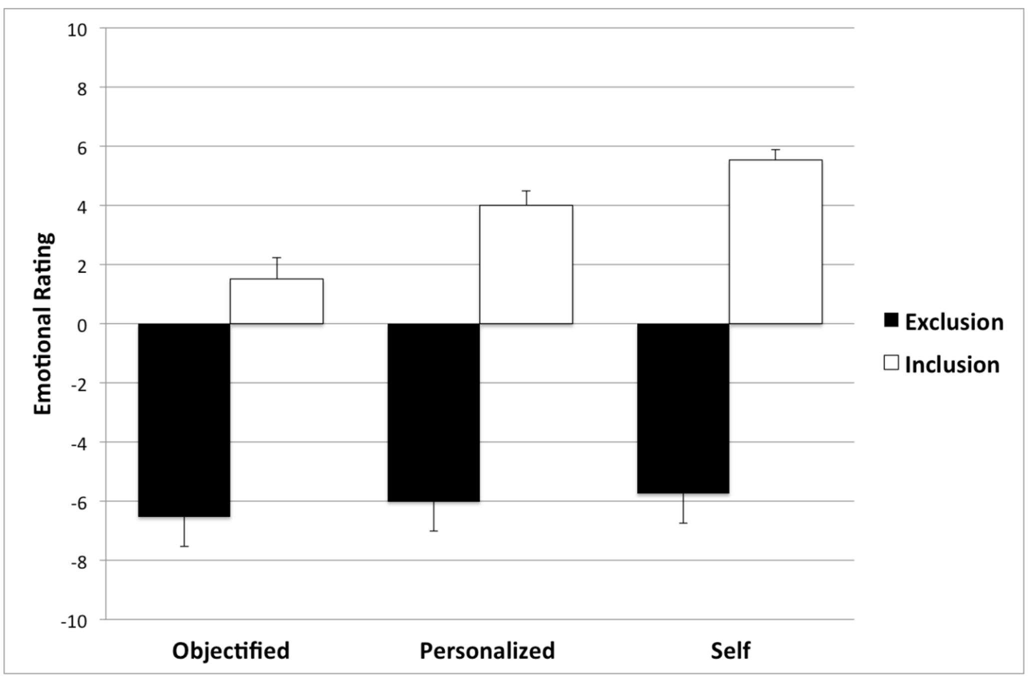

Figure 2. Mean and standard deviation of the emotional ratings, divided by the two conditions (Inclusion, Exclusion) and the three targets (Self, Objectified, Personalized).

fMRI results

Main effect of social pain: Self (Exclusion > Inclusion).

We focus on the main effect of social pain given by the comparison of the hemodynamic responses between exclusion vs. inclusion trials in the 'self' condition. This contrast revealed enhanced activity in the following regions: a) areas belonging to the mentalizing network: Left Precuneus, Left Medial Superior Frontal Cortex, Left Superior Frontal Lobule, Left Superior Frontal Medial Lobule; b) areas belonging to the somatosensory component of pain: Bilateral Rolandic Operculum extending also to Posterior Insula; c) other areas: Right precentral Gyrus, Right Heschl, Left Inferior Temporal Gyrus, Right Superior Temporal Gyrus, and Right Supplementary Motor Area ($P < 0.05$, FWE corrected, see Table 1). See also Table S1 for the reverse contrast.

Table 1.

Self (Exclusion > Inclusion).

	Anatomical Region	cluster K	p(FWE-corr)	T	Z score	x,y,z [mm]
L	Precuneus	234	0.001	8.58	7.82	-21 -49 11
R	Superior Temporal Gyrus	14	0.001	5.7	5.45	57 -13 -7
L	Medial Superior Frontal Cortex		0.003	5.39	5.18	-9 47 35
L	Medial Superior Frontal Cortex		0.013	5.06	4.88	-9 56 23
L	Rolandic Operculum	4	0.005	5.3	5.1	-54 -4 8
L	Superior Frontal Cortex		0.021	4.94	4.77	-15 35 41

L	Medial Superior Frontal Cortex	7	0.026	4.89	4.72	-6 59 11
R	Precentral Gyrus	265	0.001	8.29	7.6	39 -16 44
R	Precentral Gyrus		0.001	7.31	6.82	42 -22 59
R	Postcentral Cortex		0.001	6.37	6.03	27 -25 59
R	Rolandic Operculum	161	0.001	7.7	7.14	39 -16 17
R	Heschl Gyrus		0.001	7.23	6.75	51 -7 8
L	Inferior Temporal Gyrus	42	0.001	6.57	6.2	-45 2 -34
L	Posterior Insula		0.001	6.46	6.11	-36 -16 20

Main effect of empathy for social pain: Other (Exclusion > Inclusion).

A whole-brain contrast between the neural activity during observed exclusion vs. observed inclusion revealed that participants displayed greater activity in the following regions: a) areas belonging to the mentalizing network: Right Middle Frontal Gyrus; b) areas belonging to the somatosensory component of pain: Right Rolandic Operculum; c) areas belonging to the affective component of pain: Left Anterior Insula, Left Middle and Anterior Cingulate Cortex; d) other areas: Left Calcarine cortex, Left Postcentral Gyrus, Bilateral Putamen, Left Superior Temporal Gyrus, Bilateral Precentral Gyrus, Right Postcentral Gyrus, Right Superior Temporal Pole, (P < 0.05, FWE corrected, see Table 2). See also Table S2 for the reverse contrast.

Table 2.

Other (Exclusion > Inclusion).

	Anatomical Region	cluster K	p(FWE-corr)	T	Z score	x,y,z [mm]
R	Middle Frontal Cortex	4	0.023	4.92	4.75	27 35 32
R	Superior Temporal Pole	13	0.022	4.93	4.77	60 -4 -1
R	Rolandic Operculum		0.03	4.85	4.69	57 2 11
L	Anterior Insula	19	0.002	5.5	5.28	-33 8 8
L	Middle Cingulate Cortex	1012	0.001	6.91	6.49	-3 -1 44
L	Anterior Cingulate Cortex		0.001	6.83	6.42	-6 23 26
L	Anterior Cingulate Cortex		0.001	6.7	6.31	-3 35 14
R	Precentral Gyrus	13	0.01	5.13	4.94	39 -10 53
L	Precentral Gyrus	6	0.013	5.06	4.88	-51 2 29
R	Postcentral Gyrus	7	0.017	4.99	4.82	45 -19 41
L	Superior Temporal Gyrus	32	0.001	5.63	5.39	-48 -19 11
R	Putamen	2	0.02	4.95	4.78	15 14 -10
L	Calcarine Cortex	1665	0.001	9.35	Inf	-12 -82 2
R	Calcarine Cortex		0.001	8.21	7.54	15 -82 5
R	Calcarine Cortex		0.001	8.16	7.5	18 -61 11

Effect of objectification on empathy for social pain

Personalized Other (Exclusion > Inclusion) > Objectified Other (Exclusion > Inclusion)

Following the a priori hypothesis that the empathy for social pain network should be more active for the personalized as compared to the objectified women, we looked at the difference between personalized and objectified targets for the contrast Exclusion vs. Inclusion.

The Whole brain analysis revealed a network that comprised: a) areas belonging to the mentalizing network: Bilateral Middle Frontal Cortex; b) areas belonging to the somatosensory component of pain: Left Posterior Insula and Left Rolandic Operculum; c) areas belonging to the affective component of pain: Bilateral Supplementary Motor Area extending to the Anterior and Middle Cingulate Cortex but also Bilateral Anterior Insula; d) other areas: Bilateral Putamen, Left Lingual Gyrus, Right Fusiform, Right Calcarine, Left Postcentral Gyrus, Bilateral Precentral Gyrus, Bilateral Thalamus, Right Superior Temporal Gyrus, Bilateral Middle Occipital Cortex, Left Caudate ($P < 0.05$, FWE corrected, see Table 3 and Figure 3).

Table 3.

Personalized Other (Exclusion > Inclusion) > Objectified Other (Exclusion > Inclusion).

Anatomical Region		cluster K	p(FWE-corr)	T	Z score	x,y,z [mm]
R	Middle Frontal Cortex	4	0.026	4.89	4.73	30 41 23
L	Middle Frontal Cortex	25	0.001	5.72	5.47	-27 41 23
L	Anterior Insula	9	0.013	5.07	4.89	-33 14 8
R	Anterior Insula		0.011	5.1	4.92	30 26 5

R	Anterior Insula		0.023	4.92	4.75	36 14 8
L	Anterior Insula	13	0.001	5.69	5.44	-27 26 2
L	Posterior Insula	14	0.011	5.11	4.93	-36 -22 14
L	Rolandic Operculum		0.012	5.08	4.9	-45 -22 14
L	Caudate	7	0.008	5.2	5.01	-15 26 23
L	Putamen	204	0.001	7.6	7.06	-21 8 -1
R	Putamen	163	0.001	6.85	6.44	24 14 2
L	Supplementary Motor Area	420	0.001	7.46	6.94	-6 8 47
R	Supplementary Motor Area		0.001	6.4	6.06	9 8 47
R	Superior Temporal Cortex	13	0.002	5.47	5.25	54 -19 2
R	Precentral Gyrus	53	0.001	6.46	6.11	57 5 29
L	Precentral Gyrus	35	0.001	5.86	5.59	-48 -1 32
L	Postcentral Gyrus	168	0.001	6.72	6.33	-39 -19 50
L	Thalamus	36	0.001	6.25	5.93	-6 -19 2
R	Thalamus	18	0.002	5.55	5.32	9 -16 2
L	Lingual Gyrus	905	0.001	7.47	6.95	-12 -85 -1
R	Fusiform Gyrus		0.001	7.33	6.84	30 -52 -10
R	Calcarine Cortex		0.001	7.11	6.66	15 -85 5
R	Middle Occipital Cortex	18	0.006	5.25	5.05	36 -79 14
L	Middle Occipital Cortex	22	0.009	5.15	4.97	-33 -82 20
L	Middle Occipital Cortex		0.011	5.11	4.92	-30 -76 26

Note. Flexible factorial: Whole brain analysis Peak level (FWE-corrected , $p < 0.05$)

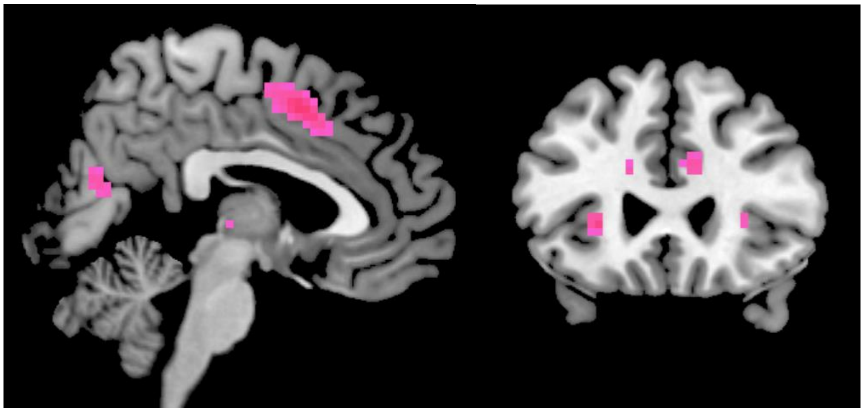

Figure 3. Difference in neural activation between empathy for social exclusion toward personalized and objectified targets (contrast: Personalized Other (Exclusion > Inclusion) > Objectified Other (Exclusion > Inclusion)). Statistical maps are derived with a threshold of p < 0.05 FWE corrected and superimposed on a standard T1 template (Coronal and sagittal views are displayed).

Objectified Other (Exclusion > Inclusion) > Personalized Other (Exclusion > Inclusion)

Also the difference between objectified and personalized targets for the contrast Exclusion vs. Inclusion was investigated. A whole-brain analysis revealed that participants displayed greater activity in the Middle Occipital Cortex See table 4.

Table 4.

Objectified Other (Exclusion > Inclusion) > Personalized Other (Exclusion > Inclusion).

	Anatomical Region	cluster K	p(FWE-corr)	T	Z score	x,y,z [mm]
L	Middle Occipital Cortex	51	0	6.29	5.96	-45 -73 5

Regressions with questionnaires

As a final step, a whole-brain regression analysis was performed in order to examine association between neural activity during observed exclusion vs. inclusion in personalized other vs. objectified other and self-reported trait empathy, SDO, ASI, Self-Objectification scale and behavioral scores of the empathy for social exclusion task. Results reveal no significant associations between the neural activity and all the aforementioned variables.

Discussion

The goal of the present study was to investigate the effect of perceived objectification on the behavioral and the neurophysiological underpinning of empathy for social pain. To this aim, a modified version of the original cyberball game (Williams et al., 2000), with the peculiarity of displaying videos of sexually objectified and non-sexually objectified (i.e. personalized) real women instead of animated cartoons, was used.

In line with previous research using the cyberball game to induce feelings of social rejection, the game was able to elicit negative emotions following exclusion trials and positive emotions following inclusion trials, as indicated by a significant main effect of condition on the emotional ratings.

Most importantly, in line with our initial predictions, we observed reduced empathic reactions toward objectified women as compared to personalized ones. In particular, a significant main effect of target on the emotional ratings was detected, indicating that the emotional intensity reported for the self was the highest, followed by the personalized targets, and the objectified targets as the lowest. Interestingly, the stronger difference between targets was observed for the inclusion condition, as indicated by the condition by target interaction. Such positive-negative asymmetry (PNAE) has been already documented in previous literature (Gaertner & McLaughlin, 1983; Mummendey & Otten 1998). Our behavioral results might be interpreted in line with this theoretical frame. In the current study, participants attribute more negative emotions during the exclusion condition of the objectified targets as compared to the personalized targets, but the positive emotions experienced during the inclusion of the objectified targets are less intense than for the personalized one. Notably, the intensity of emotions attributed to the personalized targets are always more similar to the emotions that participants are attributing to the self, compared to the objectified targets (see also Cogoni et al. 2016). It might be plausible that the explicitly exhibition of negative emotions when facing the exclusion of another individual, being this a sexually objectified or non-sexually objectified women, can be perceived to be socially inacceptable, and this might prompt participants to exert an intentional control over their responses. By contrast, modulating a positive emotional reaction as function of the target of inclusion might be construed as less clashing against social norms of non-discrimination and less triggering self-presentation concerns.

On the neurophysiological level, we chose to focus on the areas related to the firsthand and vicarious experience of pain processing. We were able to replicate the initial findings observed using a similar modified version of the cyberball game (Novembre et al., 2015). In particular, the firsthand experience of social exclusion revealed enhanced activity in brain regions related to the somatosensory-discriminative component of pain (pINS and SII). Contrary to the majority of studies on the neural basis of social exclusion, we did not observed activation of areas related to the affective component of pain, such as aINS and aMCC (Eisenberger, 2012). This result is in line with the study by Novembre and colleagues (2015), in which the lack of activation of the affective component has been related to the comparable activation of these regions observed both in inclusion and exclusion trials (therefore canceling each other during the main differential contrast).

Empathy for social pain, on the other hand, revealed an enhanced activation in areas involved in the processing of the affective experience of social pain, such as aINS and aMCC (Eisenberger et al., 2003; Dewall et al., 2010; Masten et al., 2010; Bolling et al., 2011), but also areas belonging to the mentalizing network such as the MFC (Mitchell et al., 2005; Amodio & Frith, 2006; Frith & Frith, 2006). More importantly, empathy for social exclusion of personalized targets as compared to the objectified ones was characterized by an increased activity in these regions (aINS, aMCC and MFC), extending to the sensory-discriminative component of pain, such as pINS, therefore suggesting a modulatory role of the perceived objectification on the neural marker of empathy.

A failure to empathize has been recently hypothesized as the motivator for the higher willingness to administered hypothetical painful tablets to objectified women compared to non-objectified ones (Loughnan et al., 2010). This hypothesis has been formally tested in a recent work investigating empathy for pleasant and unpleasant emotions towards women with different degree of sexualization (Cogoni et al., 2016). A reduction of empathy has been observed for objectified women as compared to personalized one, as indicated by reduced shared representations for the former.

On top of this behavioral evidence, the present study extends for the first time the observation of a reduction of empathic responses due to perceived objectification, to the same neurophysiological representation of the other's suffering.

In our study, the neural pattern of empathy was not associated with the degree of self-objectification of the participants, their level of dispositional empathy, their level of hostile or benevolent sexism, or their social dominance attitudes. However the empathic modulation at both the neural and behavioral level can be to a certain extent explained by the different evaluation of the targets provided by participants immediately after the scan. In line with previous research (Cikara et al., 2011; Gray et al., 2011) objectified women are seen indeed as less intelligent and with diminished agentic characteristic (hallmark of human abilities to act in the world) as compared to the personalized women. Therefore, social processes typically elicited by human targets such as empathy, can be disrupted if the target is seen as the objects of actions as opposed to being the agent enacting actions Notably, a reduction of empathic feelings may also lead to a change of people's attitudes toward a target, which in turn may influence social behaviors (Batson et al., 1997). For example, it can result in a biased judicial decisions on a defendant (Johnson et al., 2002) or in a reduced motivation to act prosocially (Hein et al. 2010). Therefore the failure to empathize with sexually objectified targets, observed in the present study both on a behavioral and neural level, may indicate a possible fundamental mechanism behind the motivation of gender-based violent behavior.

In conclusion this study represents the first attempt in examining whether social exclusion of objectified female targets elicits empathic feeling to the same extent as other social targets like personalized women. Results showed a stronger activation of the classical empathy for pain brain network (aINS, aMCC), extending to the mentalizing network (MFC) and the somatosensory component of the pain (SII, pINS), for personalized women than for objectified women. Although we were able to show a differential empathic behavioral and neural response toward objectified and personalized targets and a relation with the perception of physical vs. mental attributes, the motivation guiding such discrepancy remain still unknown. Further studies need to investigate the reason for such diminished empathy toward objectified women and how this relates to gender-based violence.

General Discussion

The work presented in this thesis aims at investigating the low and high cognitive level consequences of the sexual objectification phenomenon.

In summary, in Study 1 we examined the objectification from a visual perspective frame. Specifically, we tested the hypothesis that objectification can favor the adoption of an analytical style to process objectified targets (the same style adopted to process objects), instead of the configural style, which is generally adopted for processing of faces. This theory has been developed by Bernard in 2012 and it is known under the name of sexualized body inversion hypothesis (SBIH). It has been tested and contested already by other researchers (Tarr, 2013) without a final agreement on the generative mechanism of the sexualized body inversion effect (SBIE) and finally on the same existence. Specifically the inversion effect (i.e. a different recognition of the stimuli in the upright and inverted orientation) has been considered as the indirect evidence of the adoption of the configural mode, while its absence (i.e. equal recognition of the stimuli in the two orientations) has been considered as the indirect evidence of the adoption of the analytical mode. However previous studies (Bernard et al., 2012; Bernard et al., 2013; Bernard et al., 2015; Schmidt & Kistemaker, 2015) fail to agree on both the role of social and perceptual features, such as level of sexualization of the target and symmetry, in shaping the SBIE. To overcome this limitation, we showed in a series of 4 studies that the sexualization of the stimuli plays a role in modulating the inversion effect: sexualized stimuli are perceived with an analytical mode as indicated by the absence of the inversion effect, the same analytical mode adopted for the perception of the objects (houses). On the contrary personalized stimuli as well as human like objects (mannequin) are perceived with a configural mode as indicated by the presence of the inversion effect. This differential processing mode can be explained by a specific visual exploration of the images: sexualized stimuli are perceived with a prevalent focus on the chest region while personalized stimuli with a prevalent focus on the face region which trigger the analytical and configural mode respectively. However, the sexualization plays its role only when stimuli have low levels of asymmetries as compared to the high level of asymmetry. In this way we extended previous results demonstrating that symmetry of the stimuli does not have a mediating role per se explaining why the SBIE occurs, but it has a moderating role explaining when the effect is present and when it is not.

In study 2 we experimentally tested the hypothesis of a diminished empathy toward objectified target. We were able to prove, using real people acting as confederates instead of images, how the empathy for positive and negative emotions is influenced by the perceived sexualization of the target of the empathic feeling. Specifically, the empathic feeling, as indicated by the shared representation between the self and the other, is higher for objectified women in comparison to objects but it is lower than for the personalized women. This finding suggests that sexual objectified women are not assimilated to objects or inanimate entities but that the empathic responses typically displayed for human beings are reduced.

In study 3 we investigated how the sexual objectification influences empathy for the social exclusion at both behavioral and neural level. We demonstrated that the empathic feeling toward an objectified woman is reduced as compared to the empathic feeling toward a personalized woman. The behavioral result is corroborated by a higher activation of the classical regions involved in the empathy for social exclusion when the target of the social discrimination is a personalized woman as compared to the objectified one: region responsible for the affective component of pain (aINS, MCC), for the sensory discrimination component of pain (pINS, SII) and region belonging from the mentalizing network (MFC).

The results of our studies bring new insights into the mechanisms of objectification, extending prior knowledge on the consequences of such a phenomenon. For the first time the hypothesis of a diminished empathy toward objectified women has been tested and proven. In our studies the simple portray of women in a sexualized manner, not only with a large amount of skin not cover by the dresses (images of study 1), but also with the simple short dresses and makeup (outfit of confederate in study 2 and 3), automatically induce a perception of the target women as less intelligent, less agentic in comparison with the personalized counterpart. The tendency showed in our studies reflects a general attitude outside the lab, with possible tremendous negative outcome. In fact, both the perception of women as objects from a visual point of view and also the reduction of empathy toward them are of particular interest when considered in light of the gender-based violence. Further researches should be done in order to better investigate the relation between the perceived objectification, empathy reduction and the violent behaviors.

References

American Psychological Association, T. F. o. t. S. o. G. (2007). Report of the APA Task Force on the Sexualization of Girls. . *Retrieved from* http://www.apa.org/pi/women/programs/girls/report-full.pdf

Amodio, D. M. and C. D. Frith (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nat Rev Neurosci* 7(4): 268-277. doi:10.1038/nrn1884

Avenanti, A., D. Bueti, G. Galati and S. M. Aglioti (2005). Transcranial magnetic stimulation highlights the sensorimotor side of empathy for pain. *Nat Neurosci* 8(7): 955-960. doi:10.1038/nn1481

Avenanti, A., A. Sirigu and S. M. Aglioti (2010). Racial bias reduces empathic sensorimotor resonance with other-race pain. *Curr Biol* 20(11): 1018-1022. doi:10.1016/j.cub.2010.03.071

Baron, R. M. and D. A. Kenny (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *J Pers Soc Psychol* 51(6): 1173-1182. doi:10.1037/0022-3514.51.6.1173

Baron-Cohen, S. (2011). Zero degrees of empathy: A new theory of human cruelty, Penguin UK

Bartky, S. L. (1990). Femininity and domination: Studies in the phenomenology of oppression, Psychology Press

Batson, C. D., M. P. Polycarpou, E. Harmon-Jones, H. J. Imhoff and a. et (1997). Empathy and attitudes: Can feeling for a member of a stigmatized group improve feelings toward the group? *J Pers Soc Psychol* 72(1): 105-118. doi:10.1037/0022-3514.72.1.105

Bernard, P., S. J. Gervais, J. Allen, S. Campomizzi and O. Klein (2012). Integrating sexual objectification with object versus person recognition: the sexualized-body-inversion hypothesis. *Psychol Sci* 23(5): 469-471. doi:10.1177/0956797611434748

Bernard, P., S. J. Gervais, J. Allen, A. Delmee and O. Klein (2015). From Sex Objects to Human Beings: Masking Sexual Body Parts and Humanization as Moderators to Women's Objectification. *Psychology of women quarterly* 39(4): 432-446. doi:10.1177/0361684315580125

Bolling, D. Z., N. B. Pitskel, B. Deen, M. J. Crowley, J. C. McPartland, L. C. Mayes and K. A. Pelphrey (2011). Dissociable brain mechanisms for processing social exclusion and rule violation. *Neuroimage* 54(3): 2462-2471. doi:10.1016/j.neuroimage.2010.10.049

Cadinu, M., M. Latrofa and A. Carnaghi (2013). Comparing Self-stereotyping with In-group-stereotyping and Out-group-stereotyping in Unequal-status Groups: The Case of Gender. *Self and Identity* 12(6): 582-596. doi:10.1080/15298868.2012.712753

Cikara, M., J. L. Eberhardt and S. T. Fiske (2011). From agents to objects: sexist attitudes and neural responses to sexualized targets. *J Cogn Neurosci* 23(3): 540-551. doi:10.1162/jocn.2010.21497

Cogoni, C., A. Carnaghi and G. Silani (2016). Can we empathize with sexually objectified women? Shared representations are reduced for objects and objectified women compared to personalized women. *Manuscript submitted for publication.*

Cosmides, L., J. Tooby and R. Kurzban (2003). Perceptions of race. *Trends Cogn Sci* 7(4): 173-179. doi:10.1016/S1364-6613(03)00057-3

Dallett, K., S. G. Wilcox and L. D'Andrea (1968). Picture memory experiments. *J Exp Psychol* 76(2): 312-320. doi:10.1037/h0025383

Davies, M. and T. Stone (1995a). Folk psychology: The theory of mind debate. *Blackwell Publishers, Oxford, UK*

Davies, M. and T. Stone (1995b). Mental simulation: Evaluations and applications. *Blackwell Publishers, Oxford, UK*

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology* Vol. 10, (No. 85.)

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *J Pers Soc Psychol* 44(1): 113-126. doi:10.1037/0022-3514.44.1.113

de Vignemont, F. and T. Singer (2006). The empathic brain: how, when and why? *Trends Cogn Sci* 10(10): 435-441. doi:10.1016/j.tics.2006.08.008

Dewall, C. N., G. Macdonald, G. D. Webster, C. L. Masten, R. F. Baumeister, C. Powell, D. Combs, D. R. Schurtz, T. F. Stillman, D. M. Tice and N. I. Eisenberger (2010). Acetaminophen reduces social pain: behavioral and neural evidence. *Psychol Sci* 21(7): 931-937. doi:10.1177/0956797610374741

Eisenberger, N. I. (2012). The pain of social disconnection: examining the shared neural underpinnings of physical and social pain. *Nat Rev Neurosci* 13(6): 421-434. doi:10.1038/nrn3231

Eisenberger, N. I., S. L. Gable and M. D. Lieberman (2007a). Functional magnetic resonance imaging responses relate to differences in real-world social experience. *Emotion* 7(4): 745-754. doi:10.1037/1528-3542.7.4.745

Eisenberger, N. I., M. D. Lieberman and K. D. Williams (2003). Does rejection hurt? An FMRI study of social exclusion. *Science* 302(5643): 290-292. doi:10.1126/science.1089134

Eisenberger, N. I., S. E. Taylor, S. L. Gable, C. J. Hilmert and M. D. Lieberman (2007b). Neural pathways link social support to attenuated neuroendocrine stress responses. *Neuroimage* 35(4): 1601-1612. doi:10.1016/j.neuroimage.2007.01.038

European Union Agency for Fundamental Rights (2014). Violence against Women: an EU-wide survey, Publications Office of the European Union Luxembourg.

Fisher, H. E., L. L. Brown, A. Aron, G. Strong and D. Mashek (2010). Reward, addiction, and emotion regulation systems associated with rejection in love. *J Neurophysiol* 104(1): 51-60. doi:10.1152/jn.00784.2009

Fiske, S. T., A. J. C. Cuddy, P. Glick and J. Xu (2002). A model of (often mixed) stereotype content: Competence and warmth respectively follow from perceived status and competition. *J Pers Soc Psychol* 82(6): 878-902. doi:10.1037/0022-3514.82.6.878

Forgiarini, M., M. Gallucci and A. Maravita (2011). Racism and the empathy for pain on our skin. *Front Psychol* 2: 108. doi:10.3389/fpsyg.2011.00108

Fredrickson, B. L. and T. A. Roberts (1997). Objectification theory. *Psychology of women quarterly* 21(2): 173-206. doi:10.1111/J.1471-6402.1997.Tb00108.X

Frith, C. D. and U. Frith (2006). The neural basis of mentalizing. *Neuron* 50(4): 531-534. doi:10.1016/j.neuron.2006.05.001

Frith, K., P. Shaw and H. Cheng (2005). The Construction of Beauty: A Cross-Cultural Analysis of Women's Magazine Advertising. *Journal of communication* 55(1): 56-70. doi:10.1111/j.1460-2466.2005.tb02658.x

Gallese, V. and A. Goldman (1998). Mirror neurons and the simulation theory of mind-reading. *Trends Cogn Sci* 2(12): 493-501. doi:10.1016/S1364-6613(98)01262-5

Gervais, S. J., A. M. Holland and M. D. Dodd (2013). My Eyes Are Up Here: The Nature of the Objectifying Gaze Toward Women. *Sex Roles* 69(11-12): 557-570. doi:10.1007/s11199-013-0316-x

Gervais, S. J., T. K. Vescio, J. Förster, A. Maass and C. Suitner (2012). Seeing women as objects: The sexual body part recognition bias. *European Journal of Social Psychology* 42(6): 743-753. doi:10.1002/ejsp.1890

Glick, P. and S. T. Fiske (1996). The Ambivalent Sexism Inventory: Differentiating hostile and benevolent sexism. *J Pers Soc Psychol* 70(3): 491-512. doi:10.1037/0022-3514.70.3.491

Gordon, R. (1986). Folk psychology as simulation. *Mind and language* 1(2): 158-171. doi:10.1111/j.1468-0017.1986.tb00324.x

Gray, H. M., K. Gray and D. M. Wegner (2007). Dimensions of mind perception. *Science* 315(5812): 619-619. doi:10.1126/science.1134475

Gray, K., J. Knobe, M. Sheskin, P. Bloom and L. F. Barrett (2011). More than a body: mind perception and the nature of objectification. *J Pers Soc Psychol* 101(6): 1207-1220. doi:10.1037/a0025883

Haslam, N. (2006). Dehumanization: an integrative review. *Pers Soc Psychol Rev* 10(3): 252-264. doi:10.1207/s15327957pspr1003_4

Haslam, N., S. Loughnan, C. Reynolds and S. Wilson (2007). Dehumanization: A New Perspective. *Social and Personality Psychology Compass* 1(1): 409-422. doi:10.1111/j.1751-9004.2007.00030.x

Haxby, J. V., L. G. Ungerleider, V. P. Clark, J. L. Schouten, E. A. Hoffman and A. Martin (1999). The effect of face inversion on activity in human neural systems for face and object perception. *Neuron* 22(1): 189-199. doi:10.1016/S0896-6273(00)80690-X

Heflick, N. A. and J. L. Goldenberg (2009). Objectifying Sarah Palin: Evidence that objectification causes women to be perceived as less competent and less fully human. *Journal of Experimental Social Psychology* 45(3): 598-601. doi:10.1016/j.jesp.2009.02.008

Heflick, N. A., J. L. Goldenberg, D. P. Cooper and E. Puvia (2011). From women to objects: Appearance focus, target gender, and perceptions of warmth, morality and competence. *Journal of Experimental Social Psychology* 47(3): 572-581. doi:10.1016/j.jesp.2010.12.020

Hein, G., G. Silani, K. Preuschoff, C. D. Batson and T. Singer (2010). Neural responses to ingroup and outgroup members' suffering predict individual differences in costly helping. *Neuron* 68(1): 149-160. doi:10.1016/j.neuron.2010.09.003

Hein, G. and T. Singer (2008). I feel how you feel but not always: the empathic brain and its modulation. *Curr Opin Neurobiol* 18(2): 153-158. doi:10.1016/j.conb.2008.07.012

Holroyd, J. (2011). Sexual Solipsism: Philosophical Essays on Pornography and Objectification, by Rae Langton. *European Journal of Philosophy* 19(2): 327-334. doi:10.1111/j.1468-0378.2011.00478.x

Hu, L. t. and P. M. Bentler (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal* 6(1): 1-55. doi:10.1080/10705519909540118

Janssens, K., M. Pandelaere, B. Van den Bergh, K. Millet, I. Lens and K. Roe (2011). Can buy me love: Mate attraction goals lead to perceptual readiness for status products. *Journal of Experimental Social Psychology* 47(1): 254-258. doi:10.1016/j.jesp.2010.08.009

Johnson, J. D., C. H. Simmons, A. Jordav, L. Maclean, J. Taddei, D. Thomas, J. F. Dovidio and W. Reed (2002). Rodney King and O. J. Revisited: The Impact of Race and Defendant Empathy Induction on Judicial Decisions. *Journal of Applied Social Psychology* 32(6): 1208-1223. doi:10.1111/j.1559-1816.2002.tb01432.x

Kant, I. (1780). The metaphysical elements of ethics. *Fairford, England: Echo Library*.

Kersting, A., P. Ohrmann, A. Pedersen, K. Kroker, D. Samberg, J. Bauer, H. Kugel, K. Koelkebeck, J. Steinhard, W. Heindel, V. Arolt and T. Suslow (2009). Neural activation underlying acute grief in women after the loss of an unborn child. *Am J Psychiatry* 166(12): 1402-1410. doi:10.1176/appi.ajp.2009.08121875

Keysers, C., J. H. Kaas and V. Gazzola (2010). Somatosensation in social perception. *Nat Rev Neurosci* 11(6): 417-428. doi:10.1038/nrn2833

Kiebel, S. and A. Holmes (2003). The general linear model, Academic Press

Köhler, W. (1940). Dynamics in psychology. Vital applications of Gestalt psychology. *Liveright, New York, NY*

Krach, S., F. Hegel, B. Wrede, G. Sagerer, F. Binkofski and T. Kircher (2008). Can machines think? Interaction and perspective taking with robots investigated via fMRI. *PLoS One* 3(7): e2597. doi:10.1371/journal.pone.0002597

Lamm, C., G. Silani and T. Singer (2015). Distinct neural networks underlying empathy for pleasant and unpleasant touch. *Cortex* 70: 79-89. doi:10.1016/j.cortex.2015.01.021

Latrofa, M., J. Vaes, M. Cadinu and A. Carnaghi (2010). The cognitive representation of self-stereotyping. *Pers Soc Psychol Bull* 36(7): 911-922. doi:10.1177/0146167210373907

Leder, H. and V. Bruce (2000). When inverted faces are recognized: the role of configural information in face recognition. *Q J Exp Psychol A* 53(2): 513-536. doi:10.1080/713755889

Leder, H. and C. C. Carbon (2006). Face-specific configural processing of relational information. *Br J Psychol* 97(Pt 1): 19-29. doi:10.1348/000712605X54794

Loughnan, S., N. Haslam, T. Murnane, J. Vaes, C. Reynolds and C. Suitner (2010). Objectification leads to depersonalization: The denial of mind and moral concern to objectified others. *European Journal of Social Psychology* 40(5): 709-717. doi:10.1002/ejsp.755

Loughnan, S., A. Pina, E. A. Vasquez and E. Puvia (2013). Sexual Objectification Increases Rape Victim Blame and Decreases Perceived Suffering. *Psychology of women quarterly* 37(4): 455-461. doi:10.1177/0361684313485718

Majdandzic, J., S. Amashaufer, A. Hummer, C. Windischberger and C. Lamm (2016). The selfless mind: How prefrontal involvement in mentalizing with similar and dissimilar others shapes empathy and prosocial behavior. *Cognition* 157: 24-38. doi:10.1016/j.cognition.2016.08.003

Masten, C. L., N. I. Eisenberger, J. H. Pfeifer and M. Dapretto (2010). Witnessing peer rejection during early adolescence: neural correlates of empathy for experiences of social exclusion. *Soc Neurosci* 5(5-6): 496-507. doi:10.1080/17470919.2010.490673

Masten, C. L., S. A. Morelli and N. I. Eisenberger (2011). An fMRI investigation of empathy for 'social pain' and subsequent prosocial behavior. *Neuroimage* 55(1): 381-388. doi:10.1016/j.neuroimage.2010.11.060

Masten, C. L., E. H. Telzer, A. J. Fuligni, M. D. Lieberman and N. I. Eisenberger (2012). Time spent with friends in adolescence relates to less neural sensitivity to later peer rejection. *Soc Cogn Affect Neurosci* 7(1): 106-114. doi:10.1093/scan/nsq098

Mathur, V. A., T. Harada, T. Lipke and J. Y. Chiao (2010). Neural basis of extraordinary empathy and altruistic motivation. *Neuroimage* 51(4): 1468-1475. doi:10.1016/j.neuroimage.2010.03.025

Maurer, D., R. L. Grand and C. J. Mondloch (2002). The many faces of configural processing. *Trends Cogn Sci* 6(6): 255-260. doi:10.1016/1364-6613(02)01903-4

McNemar, Q. (1962). Psychological statistics. *Oxford, England: Wiley.*: vii 364 pp.

Miller, J. (1991). Short report: Reaction time analysis with outlier exclusion: Bias varies with sample size. *The Quarterly Journal of Experimental Psychology Section A* 43(4): 907-912. doi:10.1080/14640749108400962

Mitchell, J. P., M. R. Banaji and C. N. Macrae (2005). General and specific contributions of the medial prefrontal cortex to knowledge about mental states. *Neuroimage* 28(4): 757-762. doi:10.1016/j.neuroimage.2005.03.011

Monro, F. and G. Huon (2005). Media-portrayed idealized images, body shame, and appearance anxiety. *Int J Eat Disord* 38(1): 85-90. doi:10.1002/eat.20153

Moradi, B. and Y.-P. Huang (2008). Objectification Theory and Psychology of Women: A Decade of Advances and Future Directions. *Psychology of women quarterly* 32(4): 377-398. doi:10.1111/j.1471-6402.2008.00452.x

Mori, M. (1970). Bukimi no tani [The uncanny valley], Energy,[Online] 7 (4), 33-35.

Mori, M., K. F. MacDorman and N. Kageki (2012). The uncanny valley [from the field]. *IEEE Robotics & Automation Magazine* 19(2): 98-100. doi: 10.1109/MRA.2012.2192811

Morris, K. L. and J. L. Goldenberg (2015). Women, objects, and animals: Differentiating between sex- and beauty-based objectification. *Revue Internationale De Psychologie Sociale-International Review of Social Psychology* 28(1): 15-38

Nichols, T., M. Brett, J. Andersson, T. Wager and J. B. Poline (2005). Valid conjunction inference with the minimum statistic. *Neuroimage* 25(3): 653-660. doi:10.1016/j.neuroimage.2004.12.005

Noll, S. M. and B. L. Fredrickson (1998). A Mediational Model Linking Self-Objectification, Body Shame, and Disordered Eating. *Psychology of women quarterly* 22(4): 623-636. doi:10.1111/j.1471-6402.1998.tb00181.x

Novembre, G., M. Zanon and G. Silani (2015). Empathy for social exclusion involves the sensory-discriminative component of pain: a within-subject fMRI study. *Soc Cogn Affect Neurosci* 10(2): 153-164. doi:10.1093/scan/nsu038

Nummenmaa, L., J. K. Hietanen, P. Santtila and J. Hyona (2012). Gender and visibility of sexual cues influence eye movements while viewing faces and bodies. *Arch Sex Behav* 41(6): 1439-1451. doi:10.1007/s10508-012-9911-0

Nussbaum, M. C. (1995). Objectification. *Philosophy & Public Affairs* 24(4): 249-291. doi:10.1111/J.1088-4963.1995.Tb00032.X

Penny, W., A. Holmes and K. Friston (2003). Random effects analysis. Human Brain Function, Academic Press, San Diego**:** 843-850.

Piccoli, V., C. Fantoni, F. Foroni, M. Bianchi and A. Carnaghi (2016). Automatic female dehumanization across the menstrual cycle. *Br J Soc Psychol*. doi:10.1111/bjso.12178

Poldrack, R. A., J. A. Mumford and T. E. Nichols (2011). Handbook of functional MRI data analysis, Cambridge University Press

Pratto, F., J. Sidanius, L. M. Stallworth and B. F. Malle (1994). Social-Dominance Orientation - a Personality Variable Predicting Social and Political-Attitudes. *J Pers Soc Psychol* 67(4): 741-763. doi:Doi 10.1037//0022-3514.67.4.741

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin* 114(3): 510. doi:10.1037/0033-2909.114.3.510

Reed, C. L., V. E. Stone, S. Bozova and J. Tanaka (2003). The body-inversion effect. *Psychol Sci* 14(4): 302-308. doi:10.1111/1467-9280.14431

Reed, C. L., V. E. Stone, J. D. Grubb and J. E. McGoldrick (2006). Turning configural processing upside down: part and whole body postures. *J Exp Psychol Hum Percept Perform* 32(1): 73-87. doi:10.1037/0096-1523.32.1.73

Rigutti, S., C. Fantoni and W. Gerbino (2015). Web party effect: a cocktail party effect in the web environment. *PeerJ* 3: e828. doi:10.7717/peerj.828

Rorden, C., H. O. Karnath and L. Bonilha (2007). Improving lesion-symptom mapping. *J Cogn Neurosci* 19(7): 1081-1088. doi:10.1162/jocn.2007.19.7.1081

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software* 48(2): 1-36

Scapinello, K. F. and A. D. Yarmey (1970). The role of familiarity and orientation in immediate and delayed recognition of pictorial stimuli. *Psychonomic Science* 21(6): 329-330. doi:10.3758/BF03335807

Schmidt, A. F. and L. M. Kistemaker (2015). The sexualized-body-inversion hypothesis revisited: Valid indicator of sexual objectification or methodological artifact? *Cognition* 134: 77-84. doi:10.1016/j.cognition.2014.09.003

Shanton, K. and A. Goldman (2010). Simulation theory. *Wiley Interdiscip Rev Cogn Sci* 1(4): 527-538. doi:10.1002/wcs.33

Silani, G., C. Lamm, C. C. Ruff and T. Singer (2013). Right supramarginal gyrus is crucial to overcome emotional egocentricity bias in social judgments. *J Neurosci* 33(39): 15466-15476. doi:10.1523/JNEUROSCI.1488-13.2013

Singer, T. and C. Lamm (2009). The social neuroscience of empathy. *Ann N Y Acad Sci* 1156(1): 81-96. doi:10.1111/j.1749-6632.2009.04418.x

Singer, T., B. Seymour, J. P. O'Doherty, K. E. Stephan, R. J. Dolan and C. D. Frith (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature* 439(7075): 466-469. doi:10.1038/nature04271

Suzuki, Y., L. Galli, A. Ikeda, S. Itakura and M. Kitazaki (2015). Measuring empathy for human and robot hand pain using electroencephalography. *Sci Rep* 5: 15924. doi:10.1038/srep15924

Tanaka, J. W. and M. J. Farah (1993). Parts and wholes in face recognition. *Q J Exp Psychol A* 46(2): 225-245. doi:10.1080/14640749308401045

Tanaka, J. W. and M. Taylor (1991). Object categories and expertise: Is the basic level in the eye of the beholder? *Cognitive psychology* 23(3): 457-482. doi:10.1016/0010-0285(91)90016-h

Tarr, M. J. (2013). Perception isn't so simple: commentary on Bernard, Gervais, Allen, Campomizzi, and Klein (2012). *Psychol Sci* 24(6): 1069-1070. doi:10.1177/0956797612474669

Tarr, M. J. and S. Pinker (1989). Mental rotation and orientation-dependence in shape recognition. *Cogn Psychol* 21(2): 233-282. doi:10.1016/0010-0285(89)90009-1

Vaes, J., P. Paladino and E. Puvia (2011). Are sexualized women complete human beings? Why men and women dehumanize sexually objectified women. *European Journal of Social Psychology* 41(6): 774-785. doi:10.1002/ejsp.824

van Beest, I. and K. D. Williams (2006). When inclusion costs and ostracism pays, ostracism still hurts. *J Pers Soc Psychol* 91(5): 918-928. doi:10.1037/0022-3514.91.5.918

Walby, S., J. Towers and B. Francis (2016). Is Violent Crime Increasing or Decreasing? a New Methodology to Measure Repeat Attacks Making Visible the Significance of Gender and Domestic Relations. *British Journal of Criminology* 56(6): 1203-1234. doi:10.1093/bjc/azv131

Waytz, A., K. Gray, N. Epley and D. M. Wegner (2010). Causes and consequences of mind perception. *Trends Cogn Sci* 14(8): 383-388. doi:10.1016/j.tics.2010.05.006

Williams, A. C. d. C. (2003). Facial expression of pain, empathy, evolution, and social learning. *Behavioral and brain sciences* 25(04): 475-480. doi:10.1017/s0140525x02430087

Williams, K. D., C. K. T. Cheung and W. Choi (2000). Cyberostracism: Effects of being ignored over the Internet. *J Pers Soc Psychol* 79(5): 748-762. doi:10.1037/0022-3514.79.5.748

Xu, X., X. Zuo, X. Wang and S. Han (2009). Do you feel my pain? Racial group membership modulates empathic neural responses. *J Neurosci* 29(26): 8525-8529. doi:10.1523/JNEUROSCI.2418-09.2009

Yin, R. K. (1969). Looking at upside-down faces. *J Exp Psychol* 81(1): 141-145. doi:10.1037/h0027474

Zadro, L., K. D. Williams and R. Richardson (2004). How low can you go? Ostracism by a computer is sufficient to lower self-reported levels of belonging, control, self-esteem, and meaningful existence. *Journal of Experimental Social Psychology* 40(4): 560-567. doi:10.1016/j.jesp.2003.11.006

Zaki, J. (2014). Empathy: a motivated account. *Psychol Bull* 140(6): 1608-1647. doi:10.1037/a0037679

Appendix of Chapter 1

Figure S1. Exemplar stimulus for the House control condition.

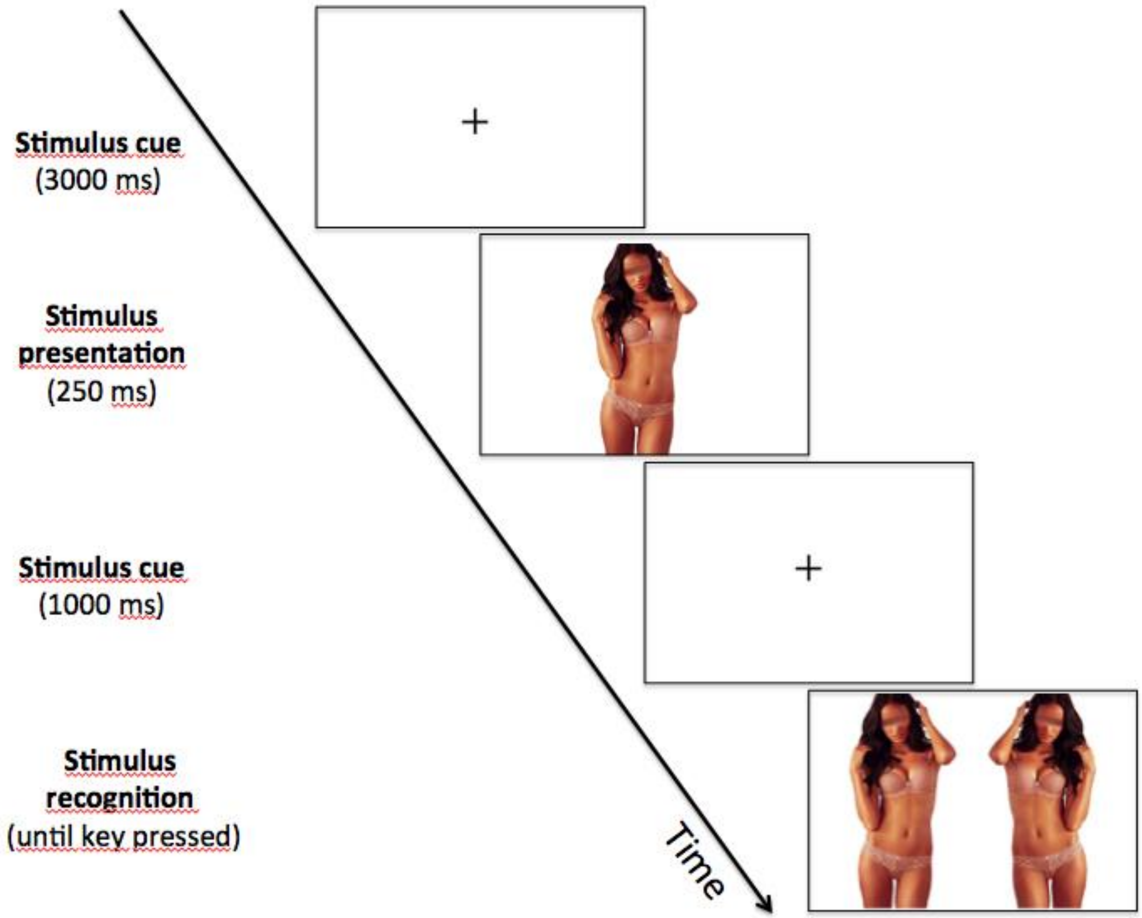

Figure S2. *Exemplar trial for the visual recognition task.* For each trial, a picture appeared in the middle of the computer screen for 250 ms, followed by a blank screen for 1000 ms. Immediately after, participants were presented with two pictures, one on the left side of the screen and one on the right, in which one of the two was the original picture, and the other was its left-right mirrored version. Participants were requested to indicate which one of the two pictures was the one they had previously seen. All stimuli were presented without the distortion bars on the face.

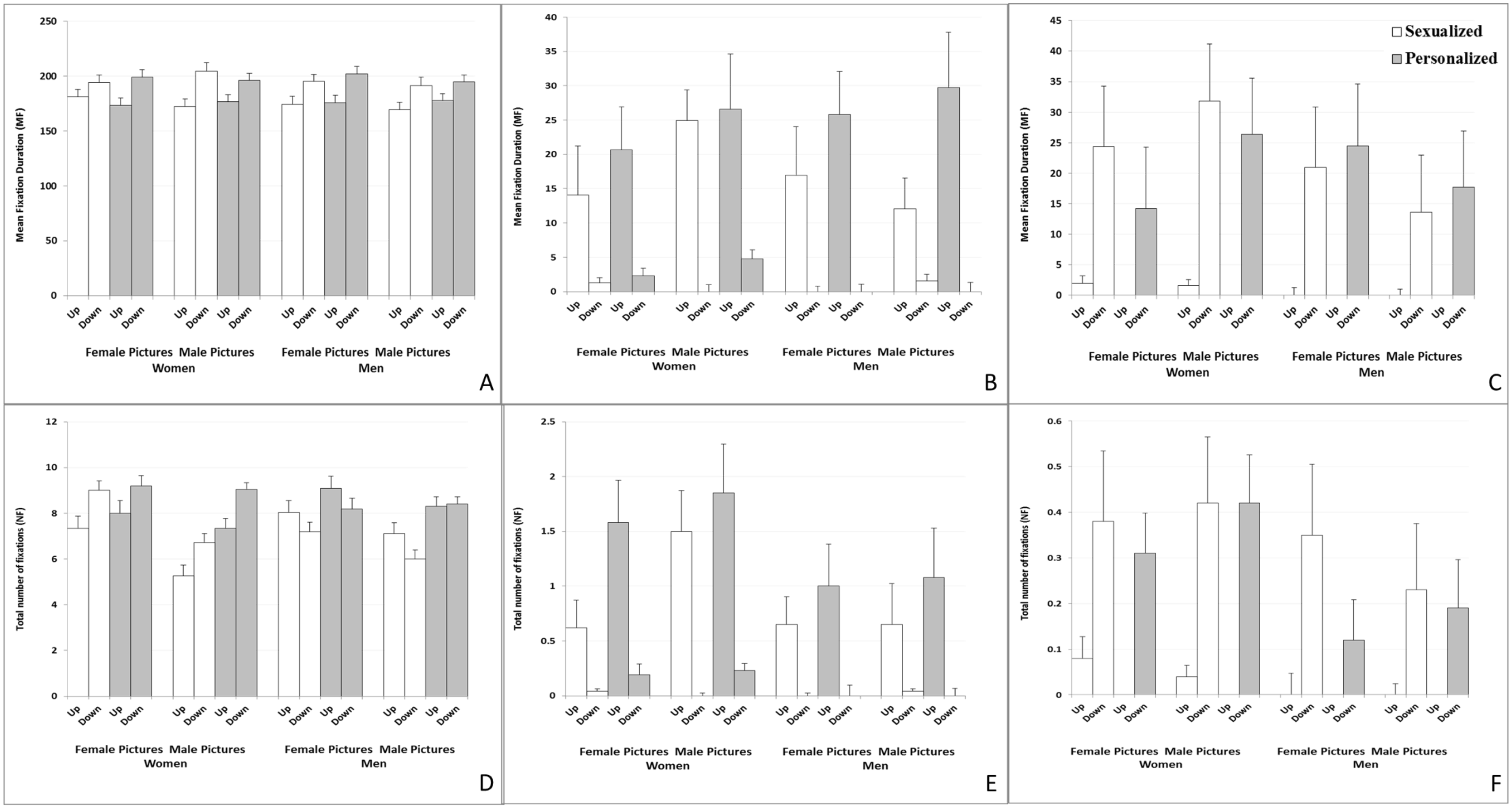

Figure S3. Mean values of the Mean fixation duration (Panel A, B, C) and the Number of fixation (Panel D, E, F) split by Gender of the participant (women, men) Gender of the picture (male, female), Condition (sexualized, personalized) and Orientation (up and down), are reported separately for each AOI. Panel A-D Breast AOI, Panel B-E Face AOI, Panel C-F Pelvic AOI. Error bars with standard deviation.

Analysis of the pretest Experiment 1 and 2

Participants' ratings were analyzed by one-way ANOVA with the between participant factors Group (Sexualized, Personalized and Mannequins) and Gender of the participant (Male, Female) separately for the Sexy, Attractive, Intelligent and Familiar dimensions as showed in Table S1.

Participants' ratings on the Sexy dimension were affected by the factor Group F (2, 69) = 448.71, p < .001, η_p^2 = .93. Sexualized pictures were rate as sexier than the personalized p < .001, and the mannequins p < .001; the personalized pictures were rated as sexier than the mannequins p < .001. A main effect of the Gender was significant, F (1, 69) = 42.38, p < .001, η_p^2 = .38 with the female participants rating the pictures as sexier than the male participant. A significant interaction of Group and Gender of the participant was also significant F (2, 69) = 28.72, p < .001, η_p^2 = .45 with male participants rating both the sexualized and personalized pictures as sexier as compared to the female participant p < .001. The female participants rated instead the mannequins pictures as sexier than the male participants p = .04.

Participants' ratings on the Attractive dimension were affected by the group variable F (2, 69) = 415.08, p < .001, η_p^2 = .92. Sexualized pictures were rate as more attractive than the personalized p = .04, and the mannequins p < .001; the personalized pictures were rated as more attractive than the mannequins p < .001. A main effect of the Gender was significant, F (1, 69) = 23.27, p < .001, η_p^2 = .25 with the male participants rating the pictures as more attractive than the female participant. A significant interaction of Group and Gender of the participant was also significant F (2, 69) = 24.03, p < .001, η_p^2 = .41 with male participants rating both the sexualized and personalized pictures as more attractive as compared to the female participant p < .001. The female participants rated instead the mannequins pictures as more attractive than the male participants p = .01.

Participants' ratings on the Intelligence dimension were affected by the factor Group F (2, 69) = 324.25, $p < .001$, $\eta_p^2 = .90$. Personalized pictures were rated as more intelligent than the sexualized pictures $p < .001$, and the mannequins $p < .001$. The sexualized pictures were rated as more intelligent than the mannequins $p < .001$. A main effect of the Gender was not significant, F (1, 69) = .667, $p = .42$, $\eta_p^2 = .01$ with the male and female participants rating the pictures as similarly intelligent. However a significant interaction of Group and Gender of the participant was found significant F (2, 69) = 7.10, $p = .002$, $\eta_p^2 = .17$ with male participants rating the sexualized pictures as more intelligent than the female participants $p = .02$. The female participant rated instead the mannequin pictures as more intelligent than the male participant $p = .01$. Personalized pictures were rate as similarly intelligent by the female and male participants $p = .15$.

Participants' ratings on the Familiarity dimension were affected by the factor Group F (2, 69) = 38.66, $p < .001$, $\eta_p^2 = .53$. Personalized pictures were rated as more familiar than the mannequins $p < .001$, and the sexualized pictures $p < .001$; no significant difference was found between sexualized and mannequins pictures $p = .10$. Note that a separate analysis for pictures in the upward and downward orientations was not necessary given that every picture was randomly assigned to both conditions. A main effect of the Gender was significant, F (1, 69) = 247.98, $p < .001$, $\eta_p^2 = .78$ with the male participants rating the pictures as more familiar than the female participant. A significant interaction of Group and Gender of the participant was also significant F (2, 69) = 24.03, $p < .001$, $\eta_p^2 = .41$ indicating that female participants rated the sexualized pictures as familiar as the mannequins pictures $p = .18$, but the personalized pictures as more familiar than the sexualized one $p < .001$ and then the mannequins. The male participants rated the personalized pictures as more familiar than both the sexualized *p* = .01 and the mannequin pictures *p* < .001, and the sexualize pictures as more familiar than the mannequins *p* < .001.

Table S1.

Dimensions	Gender of Participants	Sexualized	Personalized	Mannequins
Sexy	Women	31,39 (0,51)	30,31 (0,46)	28,54 (0,23)
	Men	31,86 (0,48)	30,59 (0,38)	28,43 (0,18)
Attractive	Women	31,11 (0,52)	30,96 (0,46)	28,65 (0,16)
	Men	31,51 (0,39)	31,21 (0,48)	28,49 (0,22)
Intelligent	Women	30,00 (0,54)	30,86 (0,37)	28,64 (0,16)
	Men	30,15 (0,39)	30,94 (0,35)	28,49 (0,12)
Familiar	Women	29,72 (0,35)	30,45 (0,38)	29,85 (0,20)
	Men	30,77 (0,35)	31,01 (0,36)	30,40 (0,23)

Note. Mean values and standard errors (in brackets) for the ratings for each dimension split by group and gender of the participant.

Analysis of the pretest Experiment 3

Participants' ratings were analyzed by a 2 (Condition: sexualized, personalized) x 2 (Gender of the picture: male, female) x 2 (Gender of the participants: male, female) repeated measures ANOVA separately for the Sexy, Attractive, Intelligent and Familiar dimensions as showed in Table S2.

Participants' ratings on the Sexy dimension were affected by the factor Gender of the participants F (1, 92) = 13.93, p < .001, η_p^2 = .13 meaning that pictures were rated as sexier by the female participants than the male one.

A main effect of Gender of the picture was found to be significant F (1, 92) = 30.29, p < .001, η_p^2 = .25 meaning that female pictures were rated as sexier than the male one.

A main effect of Condition was found to be significant F (1, 92) = 14.45, p < .001, η_p^2 = .14 meaning that sexualized pictures were rate as sexier than the personalized one.

The interaction of Gender of the picture x Condition was also found to be significant F (1, 92) = 7.81, p = .01, η_p^2 = .08 meaning that only the sexualized female pictures were rated as sexier than the personalized one p < .001 but the same was not true for the male pictures p = .59. The other main effect and interaction did not approach the significance level p > .25.

Participants' ratings on the Attractive dimension were affected by the factor Gender of the participants F (1, 92) = 28.89, p < .001, η_p^2 = .24 meaning that pictures were rated as more attractive by the female participants than the male one.

A main effect of Gender of the picture was found significant F (1, 92) = 40.20, $p < .001$, η_p^2 = .30 meaning that female pictures were rated as more attractive than the male one. The other main effect and interaction did not approach the significance level $p > .12$.

Participants' ratings on the Intelligence dimension were affected by the factor Gender of the participants F (1, 92) = 83.33, $p < .001$, $\eta_p^2 = .48$ meaning that pictures were rated as more intelligent by the female participants than the male one.

A main effect of Condition was found to be significant F (1, 92) = 29.08, $p < .001$, $\eta_p^2 = .24$ meaning that personalized pictures were rate as more intelligent than the sexualized one. The other main effect and interaction did not approach the significance level $p > .08$.

Participants' ratings on the Familiarity dimension were affected by the factor Gender of the picture F (1, 92) = 20.21, $p < .001$, $\eta_p^2 = .18$ meaning that female pictures were rated as more familiar than the male one. The other main effect and interaction did not approach the significance level $p > .16$.

Table S2.

Picture Gender	Dimension	Participant Gender	Sexualized	Personalized
Female	Sexy	Women	4.30 (0.53)	3.62 (0.6)
		Men	4.13 (0.41)	3.38 (0.59)
	Attractive	Women	4.49 (0.5)	4.23 (0.56)
		Men	4.1 (0.44)	4.08 (0.59)
	Intelligent	Women	3.68 (0.27)	4.06 (0.36)
		Men	2.96 (0.34)	3.53 (0.34)
	Familiar	Women	1.89 (0.65)	1.9 (0.76)
		Men	1.92 (0.43)	1.81 (0.37)
Male	Sexy	Women	3.38 (0.55)	3.37 (0.65)
		Men	3.26 (0.67)	3.05 (0.73)
	Attractive	Women	3.7 (0.53)	3.8 (0.63)
		Men	3.23 (0.66)	3.48 (0.84)
	Intelligent	Women	3.48 (0.35)	3.87 (0.46)
		Men	2.94 (0.99)	3.36 (0.55)
	Familiar	Women	1.52 (0.19)	1.53 (0.19)
		Men	1.68 (0.35)	1.49 (0.33)

Note. Mean values and standard errors (in brackets) for the ratings for each dimension split by Condition, Gender of the picture and Gender of the participant.

Similarity analysis of the pretest scores between the Experiment 1 and 2 and the Experiment 3.

The different symmetries of the pictures between Experiment 1 and 2 and the Experiment 3, are due to different kind of position of the bodies that could impact also the way in which the pictures are perceived in terms of the Sexy, Attractive, Intelligent and Familiar dimensions. A separate analysis was conducted to compare the four dimensions analyzed in the pretest among the set of female stimuli used in the Experiment 1 and 2 and the Experiment 3.

Participants' ratings were analyzed by a 2 (Condition: sexualized, personalized) x 2 (Experiment: Experiment1-2, Experiment 3) x 2 (Gender of the participants: male, female) univariate ANOVA separately for the Sexy, Attractive, Intelligent and Familiar dimensions. Since each of the stimuli set has already been analyzed separately we report here only the results on the three-way interaction (Condition x Experiment x Gender of the participants) as it best addresses our research question.

The interaction of Condition x Experiment x Gender of the participants was found not significant for the Sexy F (1, 184) = .17, p = .68, η_p^2 = .001, the Attractive (1, 184) = 1.83, p = .18, η_p^2 = .01, the Intelligent (1, 184) = 1.33, p = .25, η_p^2 = .01, and the Familiar dimension (1, 184) = 1.74, p = .19, η_p^2 = .01.

These results show how, despite the changed symmetrical features, the two stimuli dataset are still perceived similar in terms of Sexy, Attractive, Intelligent and Familiar dimensions.

Analysis of symmetries Experiment 1 and 2

Table S3

Axes	Mannequins	Sexualized	Personalized
Shoulders	6.14 (3.58)	10.41 (7.12)	11.04 (6.66)
Hands	14.51 (11.53)	44.03 (25.82)	27.72 (27.35)
Elbows	6.73 (4.46)	19.86 (20.50)	12.38 (9.53)
Hips	8.48 (5.33)	15.492 (7.19)	8.51 (4.52)
Ass_Index	8.97 (4.48)	22.49 (10.03)	14.91 (9.32)

Note. Mean values and standard errors (in brackets) for each Axes value separated by the Condition.

Analysis of symmetries Experiment 3

Table S4

Axes	Picture Gender	Sexualized	Personalized
Shoulders	Women	9.05 (5.52)	10.71 (6.34)
	Men	10.51 (5.66)	8.63 (8.77)
Eyes	Women	7.7 (11.14)	9.87 (11.16)
	Men	9.65 (8.75)	5.28 (4.06)
Hands	Women	22.29 (24.6)	26.44 (25.24)
	Men	22.38 (23.06)	18.39 (23.74)
Elbows	Women	7.14 (8.7)	11.61(9.36)
	Men	11.83 (14.02)	11.3 (16.82)
Hips	Women	11.72 (4.8)	9.7 (4.5)
	Men	5.44 (3.33)	4.46 (2.84)
Ass_Index	Women	11.58 (6.85)	13.66 (7.84)
	Men	11.97 (7.71)	9.61 (9.88)

Note. Mean values and standard errors (in brackets) for each Axes values split by Condition and gender of the picture.

Analysis of symmetries Experiment 4

Table S5.

Axes	Assymetry	Sexualized	Personalized
Eyes	Low	3.31 (2.58)	4.16 (4.13)
	High	8.60 (8.88)	16.78 (14.77)
Shoulders	Low	6.73 (2.57)	4.88 (4.01)
	High	11.04 (8.31)	11.90 (5.82)
Elbows	Low	3.36 (3.6)	4.17 (2.89)
	High	33.33 (21.49)	22.78 (15.74)
Hands	Low	5.68 (4.25)	5.86 (5.49)
	High	59.58 (14.21)	60.52 (17.43)
Hips	Low	10.43 (3.37)	7.26 (4.79)
	High	17.24 (7.55)	12.43 (5.26)
Ass_Index	Low	5.9 (1.72)	5.26 (2.24)
	High	25.96 (3.87)	24.88 (3.68)

Note. Mean values and standard errors (in brackets) for each Axes value separated by the Condition and Asymmetry.

Appendix of Chapter 3

Figure S1. Exemplar images of the “Self” videos.

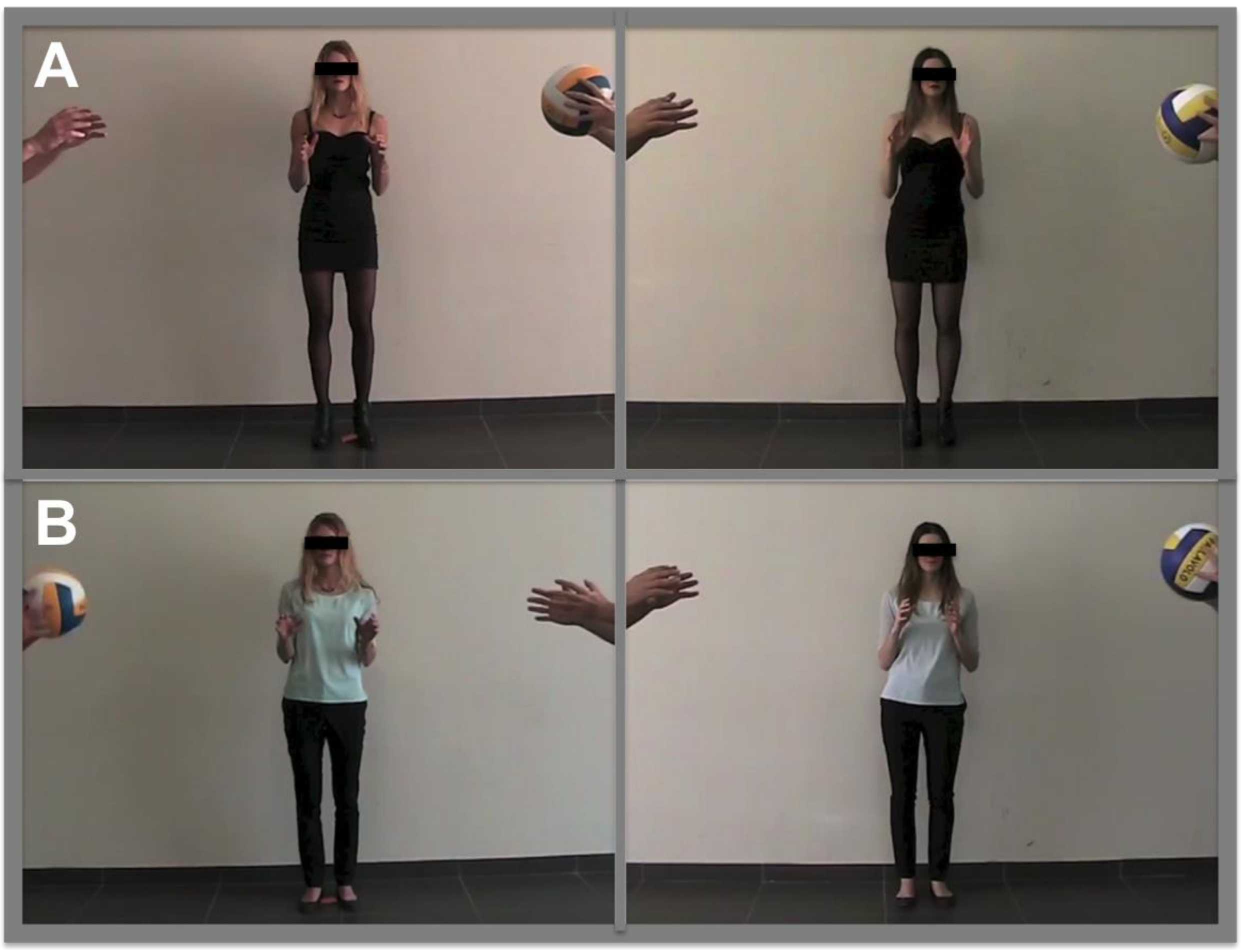

Figure S2. Exemplar images of the “Other target” videos. Objectified confederates in the upper part of the figure (A), Personalized confederates in the lower part of the figure (B). Note that in the videos the confederates were displayed without the black bar on the face.

Table S1.

Self (Inclusion > Exclusion).

	Anatomical Region	cluster K	p(FWE-corr)	T	Z score	x,y,z
L	Superior Frontal Gyrus	1142	0.001	13.78	Inf	-27 -7 56
L	Precentral Gyrus		0.001	9.99	Inf	-54 5 35
L	Supplementary Motor Cortex		0.001	7.77	7.19	-3 5 53
L	Inferior Parietal Lobule	14906	0.001	13.56	Inf	-39 -37 44
L	Inferior Parietal Lobule		0.001	13.08	Inf	-33 -46 53
L	Inferior Parietal Lobule		0.001	12.98	Inf	-45 -40 56
R	Superior Frontal Gyrus	2751	0.001	12.01	Inf	30 2 62
R	Opercular Part Of The		0.001	11.48	Inf	48 11 23
R	Anterior Insula		0.001	8.25	7.57	33 20 2
L	Middle Frontal Gyrus	218	0.001	8.44	7.72	-42 32 32
L	Anterior Insula	90	0.001	8.4	7.69	-30 17 2
L	Thalamus	115	0.001	7.32	6.83	-15 -22 8
R	Thalamus	176	0.001	6.91	6.49	12 -16 8
R	Middle Frontal Orb Cortex	50	0.001	6.42	6.07	24 47 -19
L	Middle Cingulate Cortex	14	0.001	6.04	5.75	-12 -22 38
L	Middle Frontal Gyrus	5	0.022	4.93	4.76	-36 56 14

Table S2.

Other (Inclusion > Exclusion).

	Anatomical Region	cluster K	p(FWE-corr)	T	Z score	x,y,z [mm]
R	Middle Temporal Gyrus	768	0.001	11.3	Inf	45 -67 2
R	Superior Temporal Gyrus		0.001	9.05	Inf	51 -40 14
L	Middle Occipital Gyrus	402	0.001	10.61	Inf	-45 -73 5
L	Middle Temporal Gyrus		0.003	5.45	5.23	-45 -46 8
L	Superior Occipital Pole	101	0.001	6.46	6.11	-6 -100 8
R	Fusiform Gyrus	35	0.001	5.78	5.53	42 -40 -19
R	Orb. Inferior Frontal Gyrus	23	0.001	5.75	5.49	51 35 -4
R	Middle Frontal Gyrus	20	0.002	5.51	5.28	39 8 41

Acknowledgements

Many people have been important for me during these last four years, without you all I wouldn't be able to finish my PhD and write this thesis.

Thanks to my supervisor **Giorgia Silani** for having seen the potential in me to become a PhD student, for her supervision during the master and the doctoral years. I am very grateful to **Andrea Carnaghi** for having always found a solution and also to have been my motivator and my lifeline during these years.

Mum and **Dad**, you've always be my first supporters, life teaching, you've followed me in my crazy movements around the world and you convinced me to believe that I could be whatever I wanted. Thanks for believing in me throughout the ups and downs that brought me here. I know that this PhD is the best achievement through which I can thank you for all your sacrifices. **Roby**, I don't even know how to define what I feel for you because it cannot even be contained in a human heart. You're part of me, it was hard to leave you for studying abroad but at least now you can be a little bit proud of me. **Grandma** and **Grandpa**, thanks for having raised me as a daughter, you're the mainstay of our family. **Ilaria**, thanks to be one certainty, or maybe I should thank the telephone companies for all the hours spent talking and analyzing our lives every single day! Thanks to be at least as weird as I am and for having walked next to me in this journey. **Carol**, thanks for being my surrogate girlfriend with all the fights and the love of our relationship, for the dreams about the trash stories that we are addicted to, and for everything you gave to me: Tony, dancehall, solo trips and all the craziness that characterizes you. **Alice**, they gave us the name "Carlice" and it was so representative of us. Thanks for making me drink the first entire glass of wine, for the trips together, for the thousands of houses that we changed, for having shared the life with me in any condition. We started together and we are ending together, this triestinian experience would not be the same without you. **Lavinia** and **Giulia**, my two roommates, if I considered via Diaz as my second home now it is especially because of you. **Marco**, **Lutzu**, **Ponna** and **Lotty**, thanks for the days spent together, laughing, eating and preparing exams. You were the best team I could ever have. **Massimo**, thanks for the time spent exiled in the *casetta*, for our karaoke, for the hours at the telephone talking about our lives, for our fights and our *merenda* together. **Cinzia** and **Luca** thanks for all the time that you encouraged me when I entered in your office, for the shared lunches and despairing moments, we really did it together. **Seba**, I'm very grateful for the help you gave me with the matlab codes, with the moral support when I wanted to study abroad and when I wanted to give up and you made me see my situation from different perspectives. **Fede** and **Vanni**, members of my lab, close friends even if physically distant, the "Grazia and Graziella" group make me always smile. **Lorenzo**, thanks for your scooter at the third place with mine in the broken one, thanks for the "eureka" that were never said and for all the moments that we shared in these years. **Richard**, thanks for taking care of the avocado plant, for being my first Brazilian friend and an incredible storyteller. **Mattia**, thanks to have patiently listened to me saying your *orospoco* every week and helped me to enjoy again the Trieste life with your freshness. **Marina**, thanks for all the responsibility that you gave me in the Library work, thanks because you trusted me and you've taken care of me since the first moment. **Fabri**, thanks for being my soul mate, you've always been my inspiration, you teach me how to be enthusiastic, you made our tour of the world the best that I could ever have, and unfortunately also an addiction that is really hard to break. You gave me some of the best laughs, you forgave me and you love me like no one before. Thanks for being part of my life. And finally thank to **Trieste**, a city that I hate and love, it has been my home for six years and I know that I’m going to miss it when I will be away.