Article

Revealing Clothing Does Not Make the Object: ERP Evidences That Cognitive Objectification is Driven by Posture Suggestiveness, Not by Revealing Clothing

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Abstract

Recent research found that sexualized bodies are visually processed similarly to objects. This article examines the effects of skin-to-clothing ratio and posture suggestiveness on cognitive objectification. Participants were presented images of upright versus inverted bodies while we recorded the N170. We used the N170 amplitude inversion effect (larger N170 amplitudes for inverted vs. upright stimuli) to assess cognitive objectification, with no N170 inversion effect indicating less configural processing and more cognitive objectification. Contrary to Hypothesis 1, skin-to-clothing ratio was not associated with cognitive objectification (Experiments 1-3). However, consistent with Hypothesis 2, we found that posture suggestiveness was the key driver of cognitive objectification (Experiment 2), even after controlling for body asymmetry (Experiment 3). This article showed that high (vs. low) posture suggestiveness caused cognitive objectification (regardless of body asymmetry), whereas high (vs. low) skin-to-clothing ratio did not. The implications for objectification and body perception literatures are discussed.

Keywords

sexualization, objectification, body-inversion, configural and analytic processing, N170, postures, revealing clothing

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Sexual objectification occurs when someone is seen as a sexual object or seen primarily as a body, sexual body parts, or sexual functions for the use of others (Bartky, 1990; Fredrickson & Roberts, 1997; Langton, 2009). Many studies inspired by theorizing on sexual objectification have found that the degree to which one is sexualized causes people to be perceived in object-like ways (see Heflick & Goldenberg, 2014; Ward, 2016, for reviews). For instance, sexualized people are perceived in the same way as ordinary objects at a neural level (Bernard, Content, Deltenre, & Colin, 2018; Bernard, Rizzo, Hoonhorst, Deliens, Gervais et al., 2017). Yet, sexualization appears to have different meanings depending on the researcher and specific investigation: Sexualization has been introduced through revealing clothing (Cikara, Eberhardt, & Fiske, 2010; Gray, Knobe, Sheskin, Bloom, & Barrett, 2011; Holland & Haslam, 2016; Loughnan, Pina, Vasquez, & Puvia, 2013), greater body-to-face ratio (Bernard, Loughnan, Godart, Marchal, & Klein, 2015; Loughnan et al., 2010; Vaes, Paladino, & Puvia, 2011), and posture suggestiveness (Bernard et al., 2018; Vaes et al., 2011) sometimes in separate studies and sometimes within the same investigation (e.g., Bernard et al., 2018; Bernard, Gervais, Allen, Campomizzi, & Klein, 2012, 2015; Bernard, Rizzo et al., 2017; Bernard, Gervais, Allen, Delmée, & Klein, 2015; Civile & Obhi, 2016; Gray et al., 2011; Loughnan et al., 2010; Loughnan et al., 2013; Vaes et al., 2011). This initial work has been informative, but the use of sexualization as an umbrella term leaves questions of which aspects of sexualization cause people to be perceived in object-like ways less clear.

Although research has shown that sexualization causes objectification, we do not know *why* this is the case. This is concerning because sexualization does not occur in a vacuum. It is a culturally situated phenomenon in which a form of sexuality is hoisted on girls and women to a greater degree

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than boys and men through media and interpersonal interactions in Western cultures (Fredrickson & Roberts, 1997). People are persistently exposed to images of sexualized bodies in revealing clothing and suggestive postures across various entertainment platforms (e.g., movies, TV series, music videos, magazines, video games) and through advertisements (Ward, 2016). There is also mounting evidence that girls and women sometimes present themselves in ways that correspond with this narrow view of sexuality (Smolak, Murnen, & Myers, 2014). Understanding the specific aspects of when sexualization causes objectification would have both scientific and practical utility. Researchers could pinpoint the specific aspects of sexualization that cause objectification. For example, if some aspects of sexualization promote objectification while others do not, this could shed light on when sexualization causes objectification and perhaps just as importantly when it does not. Objectification may not be an inevitable outcome of sexualization—for example, people may have sex with relationship partners in which their partner is sexualized without inevitably thinking of their partner as a sexual object.

In this article, we examined cognitive objectification because such indicators of objectification (e.g., event-related potentials [ERPs]) associated with visual processing, Bernard et al., 2018; Bernard, Rizzo, et al., 2017) are less influenced by demand and social desirability concerns than self-reports that are often used in objectification research (for a review, see Heflick & Goldenberg, 2014). Cognitive objectification can be defined as a reduction of a human figure to his or her constitutive parts. We will review evidence showing that human bodies are perceived more configurally (as Gestalts) while objects are perceived less configurally and more analytically (as an assemblage of parts). We will then introduce the inversion effect as an indicator of configural (vs. analytic) processing of bodies versus objects. Relying on this indicator, we will test whether revealing clothing, posture suggestiveness, or both cause cognitive objectification.

Focusing on the Body (Forest) Versus the Body Parts (Trees): Configural Versus Analytic Processing

When considering a stimulus, people tend to process it either as a holistic entity (focusing on the forest) or as an assemblage of parts (focusing on the trees). A large literature in cognitive psychology, using a variety of experimental paradigms including inversion, whole/parts, and scrambled bodies tasks, has shown that people rely on spatial configural information among parts when processing human bodies (and faces), whereas this configural information is not involved to the same extent in object recognition (for a review, see Maurer, Le Grand, & Mondloch, 2002). Each of the paradigms used in this research involves presenting participants with human body and/or object recognition tasks in which their ability to rely on configural information is disrupted. In the inversion task (Yin, 1969), for example, configural processing (e.g., one's ability to recognize spatial relations among a stimulus) is disrupted through planar inversion in which stimuli are presented upside down (instead of upright). Research consistently shows an inversion effect for human bodies with impaired recognition for inverted compared with upright bodies, whereas an inversion effect does no emerge for most objects (upright and inverted objects are recognized similarly), indicating that configural processing is more important for body recognition than for object recognition (Reed, Stone, Bozova, & Tanaka, 2003; Reed, Stone, Grubb, & McGoldrick, 2006; Yovel, Pelc, & Lubetsky, 2010).

Researchers using whole/parts tasks have similarly found a configural bias with people recognizing human body parts (e.g., arms) worse when the body part is presented alone compared with when the body part is presented with configural information in the context of the entire body, whereas object parts are recognized similarly regardless of whether the object part is presented in the context of the global object vs. in isolation (Seitz, 2002; see also Tanaka & Farah, 1993). Finally, functional magnetic resonance imaging (fMRI) studies using the scrambled bodies task (see also research on the composite body illusion, Robbins & Coltheart, 2012) showed that body-selective brain areas are activated more strongly when images of intact, whole bodies are presented to participants than images of scrambled bodies (i.e., bodies in which configural information has been disrupted because the body parts are physically scattered). Beyond the debate regarding whether differences in body versus object recognition are either the consequence of expertise or reflect different neural and cognitive processes (McKone, Kanwisher, & Duchaine, 2007), there is a consensus that human bodies are processed configurally and most objects less configurally and more analytically (de Gelder et al., 2010).

Although human bodies are usually recognized more configurally, in a series of behavioral studies, Bernard and colleagues have found that sexualized female bodies are recognized similarly to objects. Specifically, they have found no inversion effect for sexualized female bodies, whereas an inversion effect emerged for sexualized male bodies (Bernard et al., 2012; Bernard, Gervais, Allen, Delmée et al., 2015). This suggests that, at a behavioral level at least, sexualized female bodies are processed less configurally and more akin to objects than sexualized male bodies (see also Bernard, Gervais, Allen, Campomizzi et al., 2015, for similar findings with the whole/part paradigm). The tendency to engage in this cognitive objectification of sexualized women is tempered by diminishing the visibility of their sexual body parts, by providing individuating information about them, and by priming low social power (Bernard, Gervais, Allen, Delmée et al., 2015; Civile & Obhi, 2016), suggesting that cognitive objectification is a malleable phenomenon.

Complementing these behavioral studies, researchers have begun to examine configural processing of bodies (sexualized and nonsexualized) and objects at earlier stages of visual processing to examine whether configural processing of bodies is a more automatic phenomenon occurring at early stages of visual processing or whether it only occurs at later stages of person perception, implicating more controlled processing (Hasting & Kotz, 2008; Kubota & Ito, 2007). Toward that end, one valuable approach has been using electroencephalography (EEG) in conjunction with the body-inversion paradigm. Generally speaking, EEG studies examining the time-course associated with the visual processing of bodies (and faces) and objects have uncovered a negative amplitude ERP that is evoked by visual stimuli about 140 to 200 ms at occipitotemporal regions after stimulus onset referred to as the N170. The N170 is triggered by images of faces, bodies, and objects although faces are usually associated with larger N170s than bodies, and bodies are associated with larger N170s in comparison with objects (Bentin, Allison, Puce, Perez, & McCarthy, 1996; Stekelenburg & de Gelder, 2004). Thus, the N170 is more sensitive to faces and bodies than to objects (e.g., Righart & de Gelder, 2007; Stekelenburg & de Gelder, 2004) and differences in N170 amplitudes appear to be driven by activation of occipitotemporal brain areas that are specialized in the processing of human figures and objects. In addition, there is some evidence that N170 amplitude in general (i.e., for upright bodies) is modulated by body sexualization. Hietanen and Nummenmaa (2011) found that nude bodies generated larger N170s than bodies with swimsuits followed by fully clothed bodies, suggesting that sexually arousing stimuli elicit larger N170 amplitudes (see also Alho, Salminen, Sams, Hietanen, & Nummenmaa, 2015; Feng, Wang, Wang, Gu, & Luo, 2012). Although interesting, this line of work does not specifically speak to configural vs. analytic processing of these bodies and related cognitive objectification.

Integrating N170 ERP research with research on configural processing using the inversion paradigm, if a stimulus category is processed configurally, then presenting exemplars of this category in an inverted position should require more cognitive resources and trigger larger N170s in comparison with their upright counterparts (i.e., N170 inversion effect). In contrast, when similar N170 amplitudes are observed for inverted versus upright exemplars of a stimulus category, this indicates a lower involvement of configural processing for the stimulus category. Supporting the notion that bodies are processed more configurally and objects more analytically, researchers have found that N170 amplitudes are larger for inverted bodies than for their upright counterparts, indicating configural processing, whereas this pattern does not typically emerge for objects, indicating analytic processing or at least lower involvement of configural processing (e.g., Bauser & Suchan, 2013; Minnebusch, Suchan, & Daum, 2009; Stekelenburg & de Gelder, 2004).

To study cognitive objectification at early stages of visual processing, Bernard, Rizzo, et al. (2017) used the N170 body-inversion paradigm to examine whether sexualized bodies are processed less configurally than nonsexualized bodies and more analytically akin to objects. Consistently, larger N170 amplitudes were found for nonsexualized bodies presented in an inverted (vs. upright) position, whereas inversion did not modulate the N170 amplitudes for sexualized bodies and objects, evidencing cognitive objectification (see Bernard et al., 2018, for similar pattern of results with the scrambled body paradigm). Interestingly, these results emerged for sexualized female *and sexualized male* bodies, suggesting that sexualization rather than target gender per se was driving cognitive objectification at early stages of visual processing. The sexualized stimuli used in these behavioral and EEG studies examining cognitive objectification were taken from Internet and print advertisements of lingerie and underwear models (cf., Bernard et al., 2012; Bernard, Gervais, Allen, Delmée et al., 2015; Bernard, Rizzo, et al., 2017), and like other objectification researchers have observed, these sexualized stimuli are often shown both wearing revealing clothing and exhibiting suggestive postures (Vaes et al., 2011). Thus, although the work by Bernard and colleagues represents an important initial step toward understanding the predictors of cognitive objectification, sexualization is multifaceted (Hatton & Trautner, 2011) and, thus, which aspects of sexualization actually cause cognitive objectification remain unclear.

What Are the Key Drivers of the Cognitive Objectification of Bodies?

Skin-to-Clothing Ratio

Sexualization can be envisioned as "the combination of a multitude of sexualized attributes—body position, extent of nudity, textual cues and more—the cumulative effect of which is to narrow the possible interpretations of the image to just, as de Beauvoir (1949) wrote, the sex" (Hatton & Trautner, 2011, p. 257). To date, most objectification research that has focused on sexualization has manipulated it via revealing clothing, presenting participants with human stimuli in various states of undress. Conceptually, this represents a skin-to-clothing ratio, which can be defined as the amount of skin versus clothing that is visible when a person is portrayed: People presented in bikinis or lingerie representing higher skin-to-clothing ratio and people presented fully dressed as representing lower skin-to-clothing ratio. People presented in swimsuits or lingerie are animalistically dehumanized (Vaes et al., 2011), denied mind and moral status (Loughnan et al., 2010; Loughnan et al., 2013), perceived as less agentic (Cikara et al., 2010) and seen similarly to everyday objects (e.g., shoes, Bernard, Rizzo, et al., 2017).

We first examined whether higher skin-to-clothing ratio caused cognitive objectification. This possibility is consistent with behavioral and self-report studies showing that skin-to-clothing ratio is associated with dehumanized perceptions of

people. For example, Cikara et al. (2010) found that people were slower to associate agentic words to female bodies with high skin-to-clothing ratios as compared with female bodies with low skin-to-clothing ratios. Similarly, Holland and Haslam (2016) found that people attribute lower mental capacity and lower moral status to girls wearing a swimsuit than to girls who are fully dressed. It is also consistent with recent research showing that sexualized females and males are processed less configurally and more analytically (Bernard et al., 2018; Bernard, Rizzo, et al., 2017) and with eye-tracking studies that revealed that target nudity is associated with an increased focus on sexual body parts (e.g., Nummenmaa, Hietanen, Santtila, & Hyönä, 2012).

It is somewhat inconsistent, however, with other research on cognitive objectification that presented images of nude men and women and showed no cognitive objectification (Schmidt & Kistemaker, 2015). One potential reason for the discrepancy in the impact of skin-to-clothing ratio on cognitive objectification in previous research is that some images of people with high skin-to-clothing ratios used in this research were in suggestive postures (Bernard et al., 2018; Bernard, Rizzo et al., 2017) while other images were not (Schmidt & Kistemaker, 2015).

Posture Suggestiveness

Sexually suggestive posture is a potentially important aspect of sexualization because they represent open body language that appears to invite sexual activity. They can be illustrated in subtle ways such as placing a hand on one's hips and not-so-subtle ways such as sitting with one's legs spread wide open (Hatton & Trautner, 2011). Although no work has explicitly focused on posture suggestiveness as a contributor to objectification, a close examination of the stimuli used in prior objectification studies reveals that people who are presented in revealing clothing are also often presented with body language that is sexually connoted (e.g., Civile & Obhi, 2016; Gray et al., 2011, Studies 4 and 5; Vaes et al., 2011), including recent EEG studies that investigated the cognitive objectification of sexualized bodies (Bernard et al., 2018; Bernard, Rizzo, et al., 2017).

The social meaning model of nonverbal communication underlines the notion that nonverbal behaviors possess relational message value and "consensually recognized meanings" (Burgoon, 1991). Burgoon (1991) showed that postural openness was deemed equivalent to touch with regard to providing feelings of increased intimacy, composure, informality, and less dominance compared with a closed posture. Posture is thus a powerful cue from which people extract meaning during social perception. More generally, studies support the notion that body postures are fundamental to social perception, with static whole-body configurations providing critical information about affective and emotional states (e.g., Coulson, 2004; Dael, Mortillaro, & Scherer, 2012).

Our investigation introduces the notion that a mere focus on physical attributes such as nudity may not be the only characteristic that leads to cognitive objectification. Our focus on sexualization expressed through body language while novel also parallels de Gelder's (2009) invitation to include body postures in the study of human emotion. Meeren, van Heijnsbergen, and de Gelder (2005) presented two facial expressions which were either congruent with the whole-body expressions (an angry face on an angry body and a fearful face on a fearful body) or an incongruent condition (an angry face on a fearful body and a fearful face on an angry body). Participants were told to indicate the facial expression while ignoring the body expression; yet, body expressions affected facial emotion recognition whereby the ratings of facial expression tended toward the emotion expressed by the body, highlighting the subtle and suggestive messages bodies can portray (de Gelder, 2009).

Furthermore, van Heijnsbergen, Meeren, Grezes, and de Gelder (2007) found that postures modulate the early stages of visual processing of fearful bodies as compared with neutral bodies (see also Stekelenburg & de Gelder, 2004), as indexed by larger N170 amplitudes for fearful bodies as compared with bodies with neutral postures. These findings suggest that occipitotemporal brain areas are sensitive to different body postures at early stages of visual processing, but they are not informative regarding whether postures can sometimes be associated with less configural processing and more analytic processing and whether sexualized body postures specifically cause less configural processing and more analytic processing. It might be that suggestive postures increase the salience of body parts, which would in turn cause less configural processing (similar N170s for inverted and upright bodies) and more cognitive objectification. Consistent with this hypothesis, Bernard, Gervais, Allen, Delmée et al. (2015) found no inversion effect for sexualized female bodies at a behavioral level, evidencing cognitive objectification, whereas an inversion effect did occur for the same targets when their body parts were rendered less salient (through pixelation).

Overview and Hypothesis

The main objective of this work was to examine whether skin-to-clothing ratio and/or posture suggestiveness caused cognitive objectification of bodies. We hypothesized that high skin-to-clothing ratios would cause more cognitive objectification than low skin-to-clothing ratios (Hypothesis 1 [H1]). We also hypothesized that suggestive postures would cause more cognitive objectification than nonsuggestive postures (Hypothesis 2 [H2]). To test these hypotheses, we manipulated skin-to-clothing ratio (Experiments 1-3) and posture suggestiveness (Experiments 2 and 3). To measure cognitive objectification, we relied on the N170 inversion effect (i.e., larger N170s for inverted stimuli than for upright stimuli): Larger N170 amplitudes for inverted bodies than for

upright bodies evidence configural processing or no cognitive objectification, whereas similar N170 amplitudes for inverted and upright bodies evidence less configural processing and more cognitive objectification. Note we did not use N170 latencies to assess cognitive objectification. Indeed, prior research found that N170 latencies are not well tailored to capture differences in the processing of bodies versus objects: Delayed N170s for inverted (vs. upright) bodies can be observed for both fully intact bodies and bodies with disrupted spatial relationships due to scrambling (e.g., Bauser & Suchan, 2013; Bernard et al., 2018) or the absence of head (Minnebusch et al., 2009). The results regarding N170 latencies related to the present set of experiments can be, however, consulted in the Supplementary Materials document.

Because our design and measure of objectification also allow us to test the main effects of sexualization on the N170 amplitude, we expected that sexualized targets would elicit greater N170s in general consistent with prior research, which might reflect that these targets are more arousing (Alho et al., 2015; Hietanen & Nummenmaa, 2011). Although this was admittedly a more secondary byproduct of our main focus on cognitive objectification, it may be valuable to replicate the main effects of skin-to-clothing ratio on N170s (Experiments 1-3) observed in prior work as well as extend these effects to posture suggestiveness (Experiments 2 and 3).

In Experiment 1, we presented participants with pictures of bodies in nonsuggestive postures with high and low skin-to-clothing ratios in upright and inverted picture positions while assessing N170s. We expected to find an interaction between skin-to-clothing ratio and picture position (Hypothesis 1): For bodies with low skin-to-clothing ratios, we predicted that larger N170s will be associated with inverted bodies in comparison with upright bodies, evidencing configural processing and no cognitive objectification. For bodies with high skin-to-clothing ratios (and objects), we expected to find similar N170 amplitudes for inverted and upright stimuli, evidencing less configural processing and more cognitive objectification.

In Experiment 2, we presented participants with pictures of bodies with high and low skin-to-clothing ratios as well as suggestive and nonsuggestive postures in upright and inverted picture positions while assessing N170s. Regarding the effect of skin-to-clothing ratio on cognitive objectification, we expected to replicate the same effects from Experiment 1. We also expected that posture suggestiveness would cause cognitive objectification, which would be evidenced by an interaction between posture suggestiveness and picture position (Hypothesis 2). Toward this end, we tested two competing hypotheses. The first hypothesis is that cognitive objectification only occurs for highly sexualized targets (Hypothesis 2a), which would be evidenced by similar N170 amplitudes for upright and inverted bodies with high skin-to-clothing ratios and suggestive postures at the same time. The second hypothesis is that posture suggestiveness is sufficient to trigger cognitive objectification (Hypothesis 2b), which would be evidenced by similar N170 amplitudes for inverted and upright bodies displaying suggestive postures (regardless skin-to-clothing ratio).

In Experiment 3, we replicated Experiment 2, but examined the robustness of these effects using another set of nonsuggestive postures as control stimuli. Suggestive postures (e.g., putting a hand on one's hip) are often naturally asymmetric, and one could make the argument that asymmetry, rather than posture suggestiveness per se could influence the inversion effect (Schmidt & Kistemaker, 2015; see also Tarr, 2013), which would represent a methodological confound rather than an indicator of cognitive objectification. It is possible that bodies with asymmetrical, suggestive postures require more cognitive resources to visually process, resulting in a ceiling effect in N170 amplitudes in both inverted and upright position (i.e., similar N170s for inverted vs. upright bodies), whereas bodies with symmetrical, nonsuggestive postures would be easier to visually process and, thus, more subjected to the effect of planar inversion (i.e., larger N170s for inverted bodies in comparison with their upright counterparts). Thus, to further test Hypothesis 2 that posture suggestiveness causes cognitive objectification regardless body asymmetry, we used bodies with suggestive versus nonsuggestive postures matched in terms of asymmetry in Experiment 3. We expected to find the same pattern of results in Experiment 3 as Experiment 2.

We explored the role of target gender in Experiments 1 to 3. Most studies inspired by objectification theory (e.g., Heflick & Goldenberg, 2009; Vaes et al., 2011), including behavioral research on cognitive objectification (Bernard et al., 2012; Bernard, Gervais, Allen, Campomizzi et al., 2015; Bernard, Gervais, Allen, Delmée et al., 2015), have found that sexualized female bodies are objectified to a greater degree than sexualized male bodies. Yet, other studies have found that sexualized male bodies are also sometimes objectified (Loughnan et al., 2010). Because postural suggestiveness was not examined in early work on cognitive objectification (e.g., Bernard et al., 2012; Civile & Obhi, 2016), it is possible that sexualized female bodies were processed less configurally and more cognitively objectified because they were higher on posture suggestiveness than sexualized male bodies. This explanation would also be compatible with recent EEG findings that found that both sexualized female and male bodies are processed less configurally and more cognitively objectified when male and female bodies are associated with similar (Bernard, Rizzo, et al., 2017) and identical (Bernard et al., 2018) levels of posture suggestiveness.

Experiment 1: Skin-to-Clothing Ratio and Cognitive Objectification

We tested whether high (vs. low) skin-to-clothing ratios caused cognitive objectification. We hypothesized an interaction between skin-to-clothing ratio and picture position

(Hypothesis 1). For bodies with low skin-to-clothing ratios, inverted bodies will be associated with larger N170s compared with their upright counterparts (i.e., N170 amplitude inversion effect), indicating configural processing and no cognitive objectification. For bodies with high skin-to-clothing ratios, N170s will not be modulated by picture position (i.e., no N170 inversion effect), indicating less configural processing and more cognitive objectification.

We explored whether the interaction between skin-to-clothing and picture position was qualified by target gender. We also examined whether skin-to-clothing is encoded at an early stage of visual processing, which would be evidenced by a main effect of skin-to-clothing ratio on N170 amplitudes, with larger N170s for bodies with high skin-to-clothing ratios in comparison with bodies with low skin-to-clothing ratios (see Hietanen & Nummenmaa, 2011).

Method

Participants. Bernard, Rizzo et al. (2017) found a large effect size ($d = 1.09$) associated with the interaction between target sexualization and picture position. However, we relied on a more conservative and moderate expected effect size ($d = 0.80$), given that no research has considered the specific role of skin-to-clothing ratio on cognitive objectification. To detect an interaction effect of $d = 0.80$, $\alpha = .005$, with a power of .90, for our within-participants design, a sample size of minimum 19 participants was required. Twenty-four participants were tested. However, three participants were eliminated prior to analysis. A *Median Absolute Deviation* (*MAD*) outlier analysis (Leys, Ley, Klein, Bernard, & Licata, 2013) completed before analyses with a conservative outlier detection criterion (±3 *MAD*) revealed that three participants displayed extremely high N170 amplitudes in all blocks (>3 *MAD*). Thus, the final sample was $N = 21$ participants (12 men; $M_{age} = 22.29$, $SD = 2.08$).

Two ethical committees approved the present research. Participants had no psychiatric/neurologic conditions. When they arrived in the experimental room, participants read and signed an informed consent document. Participants were debriefed at the end of their participation and received €20 (US$22). We have retained raw data from the three experiments included in this article and agree to retain it for confirmation purposes for a minimum of 5 years after publication. We also agree to share anonymized data files from this research with other qualified professionals on request to confirm the conclusions of the research.

Procedure. The experiment included three blocks that were presented in a quasi-randomized order: male and female bodies with low skin-to-clothing ratios, male and female bodies with high skin-to-clothing ratios, and objects (i.e., shoes). Within each block (including objects), four pictures appeared 60 times in upright positions and 60 times in inverted positions (i.e., 480 trials per block; see Bernard, Rizzo, et al., 2017, for similar procedure). For each trial, a centered fixation cross appeared for 500 ms, followed by an image that was presented for 250 ms. Next, a blank screen appeared for 1,500 ms. To maintain participants' attention, they were asked during this blank screen to indicate via a keypress whether the image they just viewed had been presented either in an upright or inverted position.

Stimuli. For the low skin-to-clothing ratio condition, we photographed two men and two women wearing a black t-shirt and black jeans who were approximately the same age (i.e., young adults) as our participants (see Figure 1 for examples). We selected stimuli that were similar to our participants because it was possible that people would show a greater tendency to see dissimilar others in more dehumanized ways (Haslam, 2006). All targets displayed a neutral posture (i.e., standing upright with no suggestive posture; Hatton & Trautner, 2011) and gazed directly at the camera. Faces were blurred to minimize face processing and to protect the identity of the targets. For the high skin-to-clothing ratio condition, we photographed the same men and women displaying the same neutral posture while wearing a black swimsuit. Following Bernard, Rizzo et al. (2017), we used picture of shoes as a control object stimulus category (Stekelenburg & de Gelder, 2004). For all images, picture size was the same (500 × 750 pixels; 8.57 cm × 12.7 cm).

EEG recording and analysis. The electroencephalogram (EEG) was recorded with an ASA EEG/ERP system (ANT®) using 32 electrodes embedded according to the 10 to 20 system in a waveguard cap (ANT®) with the left mastoid as online reference. We took the average of the left and right mastoid as offline reference. We monitored electro-ocular activity (EOG) from two bipolar pairs of Bluesky® electrodes located at the outer lateral canthi and the infraorbital and supraorbital areas of the left eye. Impedances were kept below 5 kΩ. The signal was amplified (×20 for EEG and EOG channels), band-pass filtered (0.1-200 Hz) and continuously digitized with a sampling rate of 512 Hz. Offline, the EEG was digitally filtered with a 0.1 to 30 Hz band-pass filter. Before averaging, we corrected blinks with the second-order blind identification algorithm (SOBI: Belouchrani, Abed-Meraim, Cardoso, & Moulines, 1997). We rejected eye-movement artifacts using a 100 μV threshold for vertical and horizontal EOG. We segmented continuous EEG in 500 ms epochs (including 100 ms baseline on which baseline correction was performed). We computed averaged waveforms for each participant and then across participants to obtain grand averaged waveforms for each stimulus category.

N170 amplitudes and latencies were recorded at occipito-temporal electrodes sites P7 and P8 because the N170 inversion effect is stronger at lateral posterior sites (Rossion & Jacques, 2008). We averaged ERPs separately for each stimulus category and each picture position. We determined the N170 peak amplitude as the peak amplitude within the 140 to

Figure 1. Examples of stimuli used in Experiment 1.

200 ms poststimulus latency window relative to baseline at electrode positions P7/P8 (e.g., Stekelenburg & de Gelder, 2004). Amplitude minima were used to calculate N170 peak latencies relative to mean prestimulus baseline.

Results

There was neither a main effect of participant gender nor critical interactions involving participant gender (e.g., interaction between skin-to-clothing ratio, picture position and participant gender) in any experiments. Consequently, we excluded participant gender from further analysis across experiments. We submitted N170 amplitudes to a 2 (skin-to-clothing ratio: high, low) × 2 (target gender: female, male) × 2 (picture position: upright, inverted) × 2 (hemispheric lateralization: left, right) repeated-measures ANOVA.

In Experiment 1, we tested Hypothesis 1 that bodies with high skin-to-clothing ratios would be processed less configurally and more objectified in comparison with bodies with low skin-to-clothing ratios. We found a main effect of picture position with larger N170 amplitudes for inverted bodies (M = −4.36 μV, SE = .46) compared with upright bodies (M = −3.49 μV, SE = .34), $F(1, 20) = 12.93$, $p = .002$, 95% confidence interval (CI) = [–1.38, –0.37], $\eta_p^2 = .39$, which indicated that bodies with both low and high skin-to-clothing ratios were processed configurally and not objectified. That is, inconsistent with Hypothesis 1, skin-to-clothing ratio did not qualify the effect of picture position (Figure 2), $F(1, 20) = 0.31$, $p = .59$, $\eta_p^2 = .02$, and the interaction between picture position, skin-to-clothing ratio, and target gender was also nonsignificant, $F(1, 20) = 2.08$, $p = .17$, $\eta_p^2 = .09$. Thus, skin-to-clothing ratio did not cause cognitive objectification and this was further corroborated by one-sample t tests revealing significant inversion effects for bodies with both high skin-to-clothing ratios, $t(20) = 3.58$, $p = .002$, and bodies with low skin-to-clothing ratios, $t(20) = 3.32$, $p = .003$, but not for objects, $t(20) = 0.89$, $p = .39$.

One potential interpretation of the lack of interaction between skin-to-clothing ratio and picture position is that the N170 was not sensitive to our manipulation of skin-to-clothing ratio. However, this did not appear to be the case. Differences in skin-to-clothing ratio were indeed encoded in this study as evidenced by a main effect of skin-to-clothing ratio, $F(1, 20) = 55.67$, $p < .001$, $\eta_p^2 = .74$. Replicating prior research (Alho et al., 2015; Hietanen & Nummenmaa, 2011) with the novel stimuli created for this research, larger N170 amplitudes for bodies with high skin-to-clothing ratios (M = −5.04 μV, SE = .43) were found in comparison with bodies with low skin-to-clothing ratios (M = −2.81 μV, SE = .39). Interestingly, this main effect was qualified by an interaction between target gender and skin-to-clothing ratio, $F(1, 20) = 16.67$, $p = .001$, $\eta_p^2 = .46$. For male targets, males with high skin-to-clothing ratios (M = −4.37 μV, SE = .34) were associated with larger N170 amplitudes in comparison with males with low skin-to clothing ratios (M = −2.56 μV, SE = .37), $F(1, 20) = 38.39$, $p < .001$, $\eta_p^2 = .66$. For female targets, the pattern was the same although more pronounced: Females with high skin-to-clothing ratios (M = −5.71 μV, SE = .52) were associated with larger N170 amplitudes in comparison with males with low skin-to clothing ratios (M = −3.05 μV, SE = .42), $F(1, 20) = 60.89$, $p < .001$, $\eta_p^2 = .75$. Finally, we found a main effect of target gender, $F(1, 20) =$

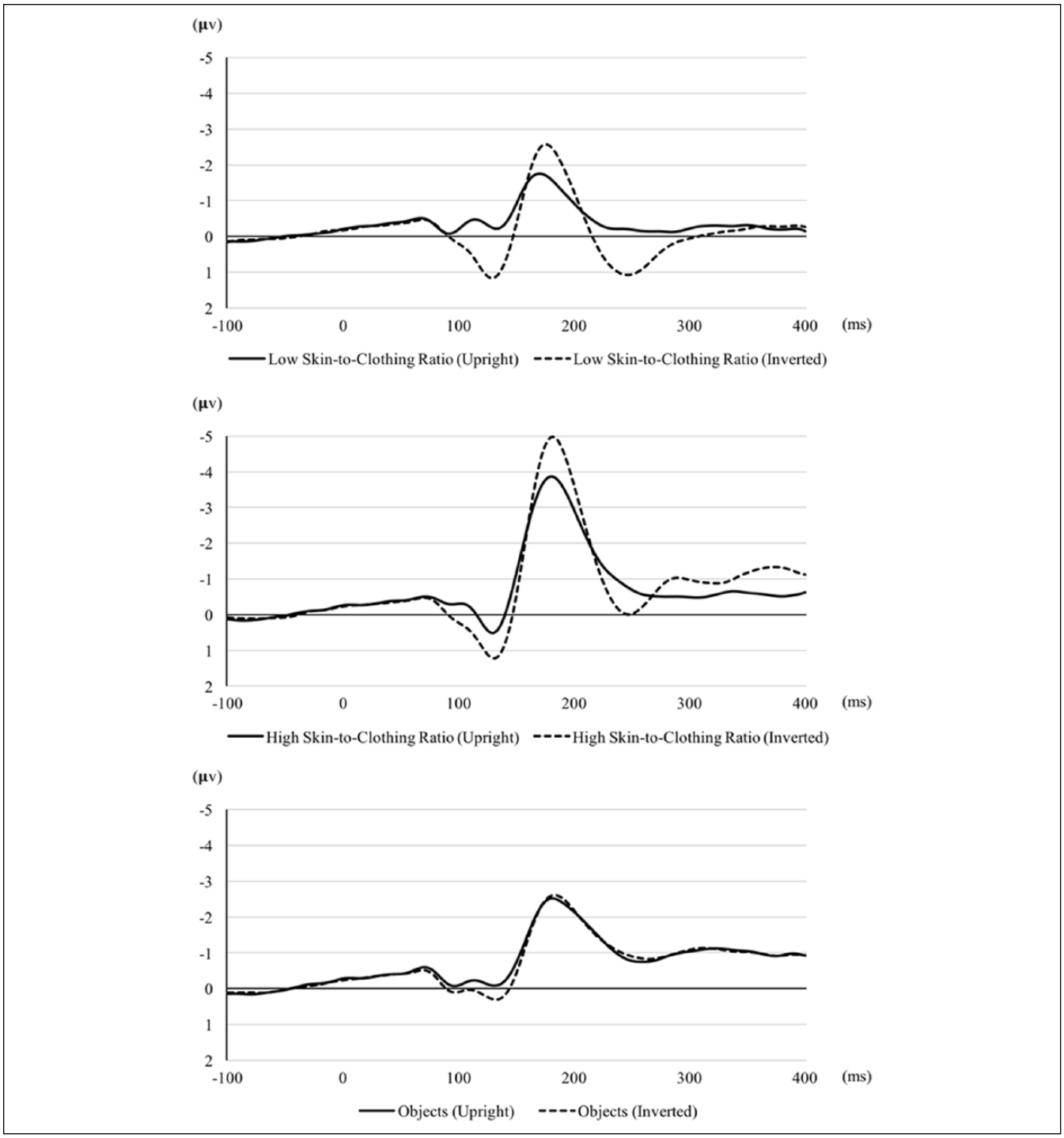

Figure 2. Grand-averaged event-related potentials at occipitotemporal electrodes sites (P7/P8) to upright (solid line) and inverted (dotted line) bodies with low skin-to-clothing ratios (top), bodies with high skin-to-clothing ratios (middle) and objects (bottom).

49.89, $p < .001$, $\eta_p^2 = .71$, indicating larger N170 amplitudes for female bodies ($M = -4.38$ μV, $SE = .44$) than for male bodies ($M = -3.47$ μV, $SE = .33$). Additional secondary results can be consulted in the Supplementary Materials document.

Discussion

Given that most research on the role of sexualization in objectification has included images of people in revealing clothing, we initially focused on skin-to-clothing ratio in Experiment 1. Inconsistent with Hypothesis 1, we found that

skin-to-clothing ratio did *not* cause cognitive objectification. Inverted bodies were associated with larger N170 amplitudes in comparison with upright bodies regardless of skin-to-clothing ratios, evidencing that bodies with high and low skin-to-clothing ratios were both processed configurally and not cognitively objectified. These results replicated prior research showing that nude bodies (displaying nonsuggestive postures) were processed configurally akin to fully clothed bodies at a behavioral level (Schmidt & Kistemaker, 2015).

It is important to note that these effects (or lack thereof) were not due to participants simply failing to encode differences in skin-to-clothing ratio. Even though picture position did not qualify the effect, there were still larger N170 amplitudes for bodies with high (vs. low) skin-to-clothing ratios and this was particularly pronounced for female bodies. In the light of recent studies that showed that viewing sexualized targets activates affective and arousal brain areas (Alho et al., 2015), our results suggest that bodies with high skin-to-clothing ratios, especially female bodies, are indeed more arousing than bodies with low skin-to-clothing ratios.

Experiment 2: Skin-to-Clothing Ratio, Posture Suggestiveness, and Cognitive Objectification

Experiment 1 provided preliminary evidence that skin-to-clothing does not predict cognitive objectification. At first blush, this finding is inconsistent with recent research showing that target sexualization causes less configural processing and more cognitive objectification (Bernard et al., 2018; Bernard, Rizzo et al., 2017). Yet, in these prior studies, sexualized targets differed from nonsexualized targets in terms of both skin-to-clothing and posture suggestiveness. In this second experiment, we manipulated skin-to-clothing ratio as well as posture suggestiveness and examined their respective effects on cognitive objectification. Thus, we tested Hypothesis 1 again, but based on the results from Experiment 1, we explored whether skin-to-clothing ratio did (or did not) cause less configural processing and cognitive objectification. The second objective of Experiment 2 was to examine whether posture suggestiveness causes cognitive objectification. Toward this end, we tested two competing hypotheses. The first hypothesis is that cognitive objectification only occurs for highly sexualized targets (Hypothesis 2a), which would be evidenced by similar N170 amplitudes for upright and inverted bodies with high skin-to-clothing ratios and suggestive postures at the same time. The second hypothesis is that posture suggestiveness is sufficient to trigger cognitive objectification (Hypothesis 2b), which would be evidenced by similar N170 amplitudes for inverted and upright bodies displaying suggestive postures (regardless skin-to-clothing ratio).

Finally, as in Experiment 1, we examined whether skin-to-clothing ratio is encoded at an early stage of visual processing, as indexed by larger N170 amplitudes for bodies with high (vs. low) skin-to-clothing ratios consistent with prior research (Hietanen & Nummenmaa, 2011). We extended prior research and Experiment 1 beyond skin-to-clothing ratio and examined whether similar effects emerged for posture suggestiveness. Based on the notion that enhanced N170s reflect arousal (Alho et al., 2015), we thus expected that suggestive postures would be associated with larger N170 amplitudes.

Method

Given that the new posture suggestiveness condition is a within-participants condition variable, we followed the a priori power analysis made from Experiment 1 and thus tested 20 participants (10 women; M_{age} = 23.21; *SD* = 3.17). The *MAD* analysis (Leys et al., 2013) conducted prior to analysis revealed the absence of any outlier while relying on a conservative outlier detection criterion (±3 *MAD*). The method was the same as in Experiment 1, except the stimuli were comprised of pictures of the same persons having high (vs. low) skin-to-clothing ratios and displaying suggestive (vs. nonsuggestive) postures. Among these pictures, half of them have already been used by Bernard et al. (2018) in a recent ERP investigation (i.e., bodies with low skin-to-clothing ratios and displaying nonsuggestive postures and bodies with high skin-to-clothing ratios and displaying suggestive postures). Miniaturized versions of all pictures appear below (Figure 3).

Pretest of the images. We conducted a pretest of the images with 43 participants (22 women, M_{age} = 28.60, *SD* = 4.07) who did not take part in the main study. They were asked to rate a series of four pictures of people having either a low (*n* = 21) or high (*n* = 22) skin-to-clothing ratio. The four pictures were the same man and woman displaying either a nonsuggestive posture or a suggestive posture (Figure 3). Participants were asked to indicate, on a 7-point scale (1 = *not at all*; 7 = *very much*), their level of agreement regarding skin-to-clothing ratio (i.e., this man/woman wears clothes that reveal her or his body), posture suggestiveness (i.e., this man/woman displays a sexually suggestive body posture), and sexualization (i.e., this man/woman is depicted in a sexualized way).

For posture suggestiveness, targets displaying suggestive postures were indeed rated as displaying a more suggestive posture (*M* = 5.14, *SE* = .19) than targets displaying nonsuggestive postures (*M* = 1.42, *SE* = .16), $F(1, 41) = 294.82$, $p < .001$, $\eta_p^2 = .88$. For revealing clothing, targets with high skin-to-clothing ratios (*M* = 5.32, *SE* = .38) were rated as wearing clothes that reveal their bodies to a greater extent than targets with low skin-to-clothing ratios (*M* = 2.17, *SE* = .39), $F(1, 41) = 33.67$, $p < .001$, $\eta_p^2 = .45$. Regarding target sexualization, the main effects of posture suggestiveness, $F(1, 41) = 193.63$, $p < .001$, $\eta_p^2 = .83$, and skin-to-clothing ratio, $F(1, 41) = 13.79$, $p = .001$, $\eta_p^2 = .25$, were associated with higher target sexualization. The former effect reflects that bodies with suggestive

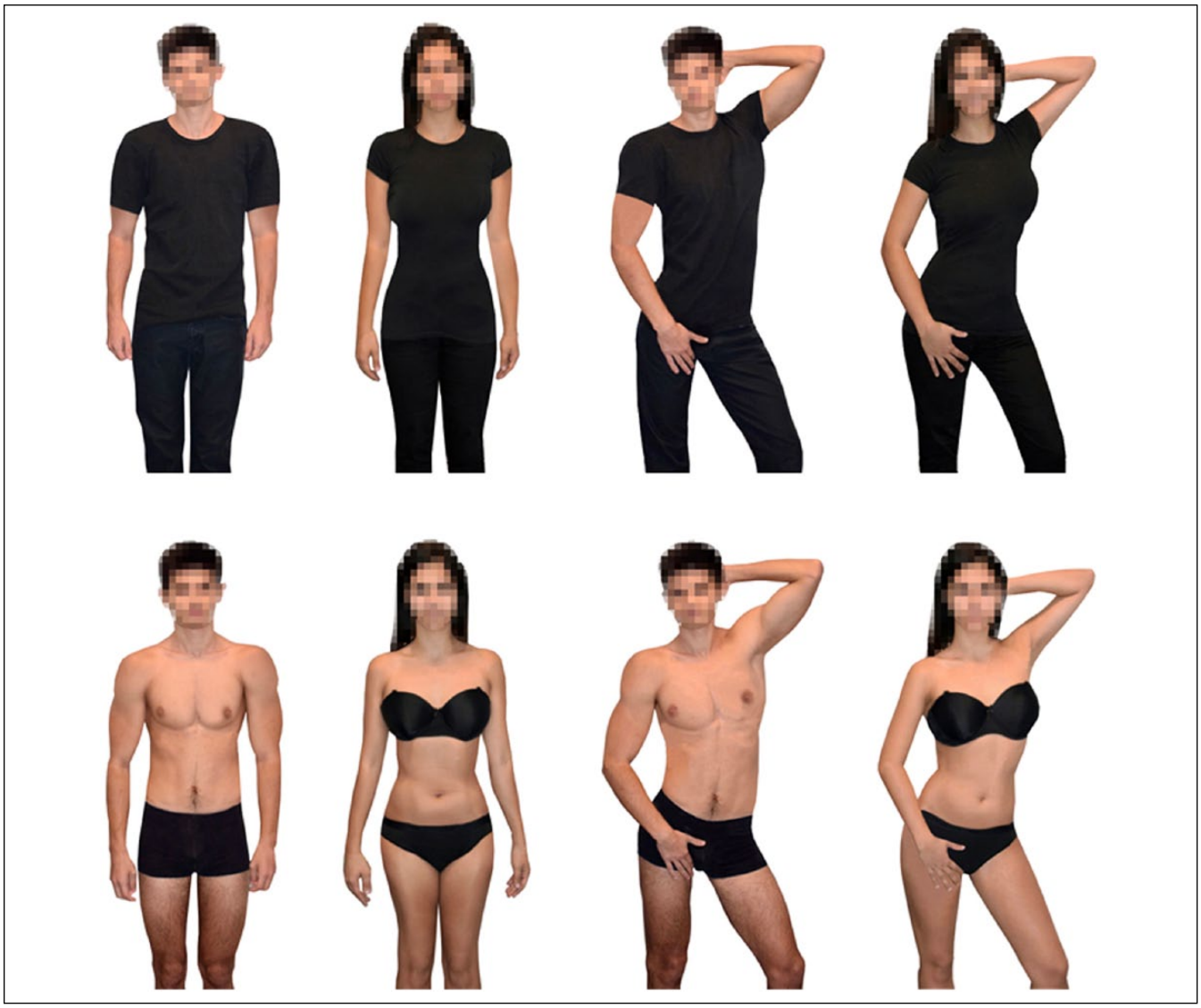

Figure 3. Stimuli used in Experiment 2.

postures were rated as being more sexualized ($M = 4.73$, $SE = .20$) than bodies with nonsuggestive postures ($M = 1.78$, $SE = .16$). The latter effect revealed that bodies with high skin-to-clothing ratios ($M = 3.82$, $SE = .21$) were rated as being more sexualized than bodies with low skin-to-clothing ratios ($M = 2.69$, $SE = .22$). Interestingly, however, the interaction between posture and skin-to-clothing ratio was not significant, $F(1, 41) = 1.75$, $p = .19$, $\eta_p^2 = .04$, indicating that posture suggestiveness or skin-to-clothing ratio alone was sufficient to trigger sexualized self-reports.

Results

We submitted N170 amplitudes to a 2 (skin-to-clothing ratio: high, low) × 2 (posture suggestiveness: nonsuggestive, suggestive) × 2 (target gender: female, male) × 2 (picture position: upright, inverted) × 2 (hemispheric lateralization: left, right) repeated-measures ANOVA. Inconsistent with Hypothesis 2a positing that cognitive objectification only occurs for highly sexualized targets (i.e., bodies with high skin-to-clothing ratios and displaying suggestive postures at the same time), the interaction between skin-to-clothing ratio, posture suggestiveness, and picture position was not significant, $F(1, 19) = 0.047$, $p = .83$, $\eta_p^2 < .01$. As in Experiment 1, bodies with low skin-to-clothing ratios and displaying nonsuggestive postures were associated with larger N170 amplitudes when presented inverted than when presented upright and, surprisingly, this pattern was more pronounced for bodies with high skin-to-clothing ratios and displaying nonsuggestive postures than for bodies with low skin-to-clothing ratios and displaying nonsuggestive postures, $F(1, 19) = 10.05$, $p = .005$, $\eta_p^2 = .35$.

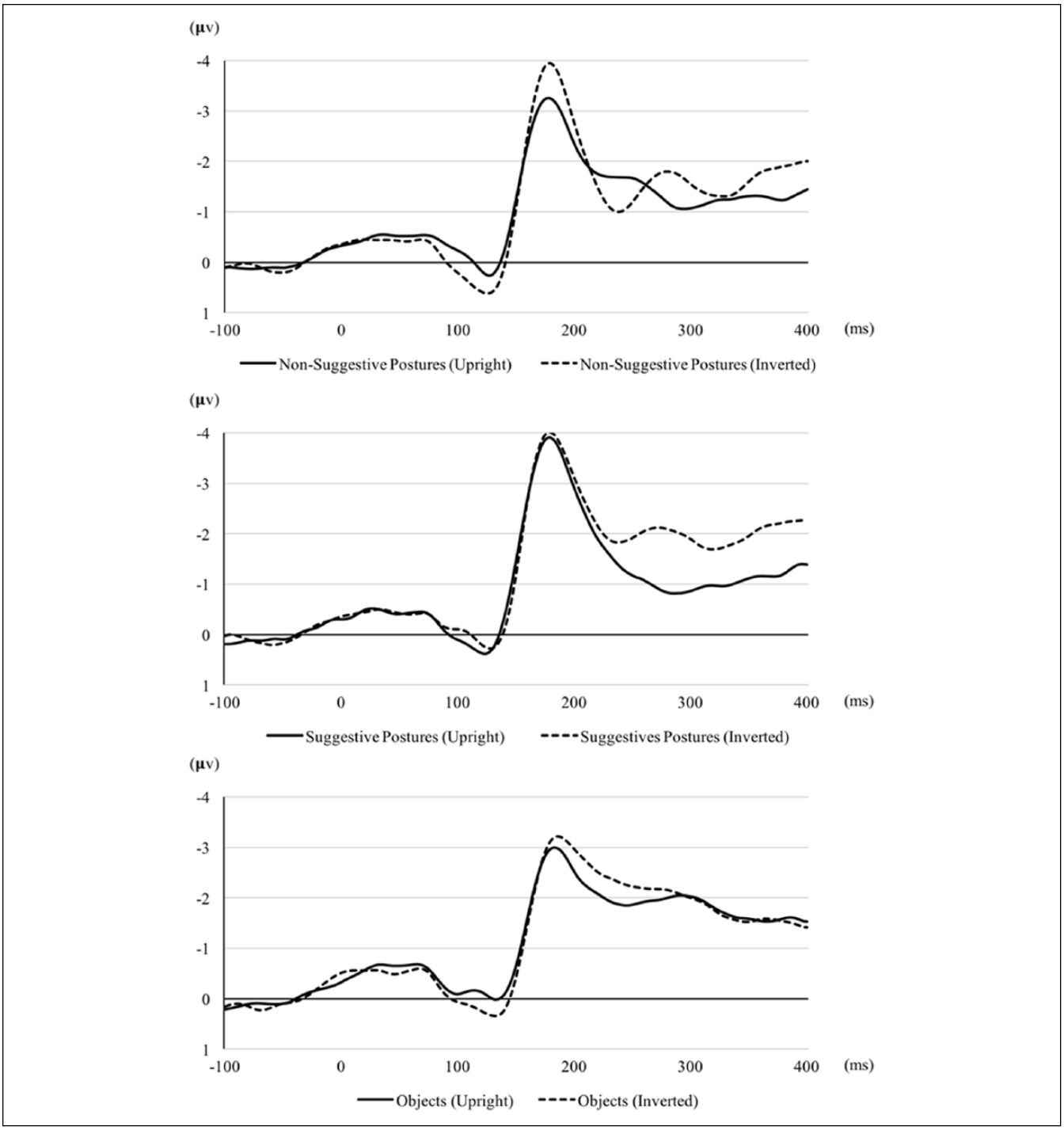

Figure 4. Grand-averaged event-related potentials at occipitotemporal electrodes sites (P7/P8) to upright (solid line) and inverted (dotted line) bodies displaying nonsuggestive postures (top), bodies displaying suggestive postures (middle) and objects (bottom).

Supporting Hypothesis 2b positing that posture suggestiveness is the key driver of cognitive objectification, we found an interaction between posture suggestiveness and picture position, $F(1, 19) = 14.18$, $p = .001$, $\eta_p^2 = .43$ (Figure 4). For bodies displaying nonsuggestive postures, inverted bodies were associated with larger N170 amplitudes ($M = -4.96$ μV, $SE = .54$) compared with their upright counterparts ($M = -4.15$ μV, $SE = .49$), $F(1, 19) = 5.49$, $p = .03$, 95% CI = [–1.52, –0.09], $\eta_p^2 = .22$, evidencing configural processing and no cognitive objectification. In contrast, we did not find such a N170 inversion effect for bodies displaying suggestive postures, with inverted ($M = -4.97$ μV, $SE = .53$) and upright

bodies (M = −4.81 μV, SE = .49) triggering similar N170 amplitudes, $F(1, 19) = 0.27$, $p = .61$, 95% CI = [–0.78, 0.47], $\eta_p^2 = .01$, indicating less configural processing and more cognitive objectification.

We also found additional support for Hypothesis 2b using one-sample t tests to assess whether inversion effects were significantly different from zero. Higher scores indicate a larger inversion effect and more configural processing, whereas inversion effects that do not differ from zero indicate less configural processing and more objectification. The N170 amplitude inversion effect was significantly different from zero for targets displaying nonsuggestive postures, $t(19) = 2.34$, $p = .03$, indicating configural processing and no cognitive objectification. In contrast, the N170 inversion effects for bodies displaying suggestive postures, $t(19) = 0.52$, $p = .61$, and objects, $t(19) = 0.82$, $p = .42$, were not different from zero, indicating less configural processing and more cognitive objectification.

As in Experiment 1, and consistent with the hypothesis that skin-to-clothing is encoded at an early stage of visual processing, we found a main effect of skin-to-clothing ratio, $F(1, 19) = 27.46$, $p < .001$, $\eta_p^2 = .59$: Bodies with high skin-to-clothing ratios were associated with larger N170s (M = −5.91 μV, SE = .63) than bodies with low skin-to-clothing ratios (M = −3.54 μV, SE = .42). This is consistent with prior research suggesting that higher skin-to-clothing ratio causes enhanced N170s due to the arousing nature of this type of stimuli (Alho et al., 2015).

Extending prior work in this area to postural suggestiveness, the ANOVA also revealed a main effect of posture suggestiveness, $F(1, 19) = 12.94$, $p = .002$, $\eta_p^2 = .41$: Bodies displaying suggestive postures were associated with larger N170 amplitudes (M = −4.89 μV, SE = .49) than bodies displaying nonsuggestive postures (M = −4.55 μV, SE = .49). These results suggest that posture suggestiveness is encoded at an early stage of visual processing (as indexed by larger N170s for suggestive postures), which might reflect that suggestive postures are more arousing than nonsuggestive postures. Finally, the ANOVA revealed a main effect of target gender, $F(1, 19) = 25.31$, $p < .001$, $\eta_p^2 = .57$, with female bodies (M = −5.04, SE = .51) associated with larger N170 amplitudes than male bodies (M = −4.40, SE = .47). Additional secondary results can be consulted in the Supplementary Materials document.

Discussion

The results from Experiments 1 and 2 corroborated the notion that skin-to-clothing ratio alone does not cause cognitive objectification of bodies. People with high and low skin-to-clothing ratios were processed configurally (larger N170s for inverted bodies in comparison with upright bodies) and not cognitively objectified. Instead, posture suggestiveness was the key driver of cognitive objectification. Bodies with nonsuggestive postures were processed configurally and not objectified. In contrast, inverted and upright bodies with suggestive postures triggered similar N170s, evidencing less configural processing and more cognitive objectification. This pattern was the same for male and female targets. To our knowledge, this is the first empirical evidence that suggestive postures cause objectification in general and cognitive objectification specifically.

Moreover, replicating Experiment 1's findings, bodies with high skin-to-clothing ratios were associated with enhanced N170 amplitudes. Likewise, suggestive postures were also associated with enhanced neural responses. In line with Alho et al. (2015), we interpret these findings as reflecting arousal. Taken together, our findings suggest that skin-to-clothing and posture suggestiveness induced enhanced N170s, but cognitive objectification appears to be specifically driven by posture suggestiveness.

Experiment 3: Replication While Controlling for Body Asymmetry

Taken together, Experiments 1 and 2 suggested that cognitive objectification of bodies is driven by posture suggestiveness, not by skin-to-clothing ratio. However, even though we used the same targets displaying suggestive and nonsuggestive postures, reflecting natural variability between these postures, it might be that cognitive objectification is influenced by body asymmetry (e.g., it may be easier to mentally rotate asymmetric stimuli—and therefore visually process inverted vs. upright stimuli similarly—relative to symmetric stimuli). Indeed, suggestive postures were more asymmetric than nonsuggestive postures. One may argue that the cognitive objectification that emerged in Experiment 2 could be related to body asymmetry rather than posture suggestiveness. Stated differently, it might be that bodies with suggestive postures caused larger N170 amplitudes because asymmetrical bodies require more cognitive resources to visually process them (i.e., ceiling effect in N170 amplitudes for both inverted and upright bodies with suggestive postures) as compared with bodies displaying symmetrical nonsuggestive postures.

To rule out this possibility and examine the robustness of the effect of posture suggestiveness, we designed a third experiment that aimed to investigate whether posture suggestiveness, rather than body asymmetry is the key factor that causes the cognitive objectification of bodies. Because postures that are sexually suggestive are often asymmetric, we created in Experiment 3 suggestive versus nonsuggestive postures that were similarly asymmetric. We expected to replicate results found in Experiment 2 while using pictures differing in terms of posture suggestiveness but matched in terms of asymmetry. That is, consistent with Hypothesis 2, we expected that the newly created images of asymmetrical bodies displaying nonsuggestive postures would be processed configurally (larger N170s for inverted vs. upright bodies), whereas the asymmetry-matched bodies displaying suggestive postures would be processed less configurally (similar N170s for inverted and upright bodies) and more cognitively objectified.

Figure 5. Nonsuggestive posture (Left) matched in terms of asymmetry with suggestive posture (Right) in Experiment 3.
Note. Female targets displayed the exact same nonsuggestive versus suggestive postures.

Method

As in Experiment 2, we tested 20 participants. Based on a *MAD* analysis (Leys et al., 2013) with a conservative outlier detection criterion (±3 *MAD*), one participant was excluded from the sample prior to analysis given extremely high N170 amplitudes (>3 *MAD*). The final sample thus included 19 participants (10 women; M_{age} = 22.26, *SD* = 1.66). However, note that the data file of one participant for one block (objects) was corrupted and we were not able to analyze it, which resulted in 18 participants for this specific block. The method was the same as in Experiment 2, except that the targets displaying nonsuggestive postures were matched (via an image editing software) in terms of asymmetry with the targets displaying suggestive postures (Figure 5). Following the procedure suggested by Schmidt and Kistemaker (2015), we calculated body-posture asymmetry by drawing five body-axes through parallel body parts (eyes, shoulders, elbows, hands, and hips). Both suggestive and nonsuggestive postures were associated with the same mean asymmetry index, that is, 29°.

Results

We submitted N170 amplitudes to a 2 (skin-to-clothing ratio: high, low) × 2 (posture suggestiveness: nonsuggestive, suggestive) × 2 (target gender: female, male) × 2 (picture position: upright, inverted) × 2 (hemispheric lateralization: left, right) repeated-measures ANOVA. Overall, we replicated the results found in Experiment 2 while using asymmetry-matched bodies. As in Experiment 2, and consistent with Hypothesis 2b that posited that posture suggestiveness drives cognitive objectification of bodies, we found an interaction between posture suggestiveness and picture position (Figure 6), $F(1, 18) = 10.43$, $p = .005$, $\eta_p^2 = .37$: Inverted bodies displaying nonsuggestive postures ($M = -3.17$ μV; $SE = .55$) were associated with larger N170s compared with their upright counterparts ($M = -2.49$ μV; $SE = .49$), $F(1, 18) = 6.58$, $p = .019$, 95% CI = [–1.23, –0.12], $\eta_p^2 = .27$, evidencing configural processing and no cognitive objectification. In contrast, picture position did not modulate the N170 amplitudes associated with bodies displaying suggestive postures, $F(1, 18) = 0.08$, $p = .78$, 95% CI = [–0.57, 0.43], $\eta_p^2 = .005$, evidencing less configural processing and more cognitive objectification.

One-sample *t* tests also replicated results found in Experiment 2, providing additional evidence for Hypothesis 2b: The inversion effect for bodies displaying nonsuggestive postures was significantly greater than zero, $t(18) = 2.57$, $p = .019$, whereas this was not the case either for objects, $t(17) = 2.03$, $p = .059$, or bodies displaying suggestive postures, $t(18) = 0.29$, $p = .78$. Overall, these results evidenced that bodies displaying nonsuggestive postures were processed configurally (as indexed by the significant N170 inversion effect), whereas bodies with suggestive postures were processed less configurally and cognitively objectified (as indexed by the absence of N170 inversion effect). Given bodies displaying suggestive postures are associated with the same asymmetry index as compared with bodies displaying nonsuggestive postures, this indicates that bodies displaying suggestive postures are processed less configurally and objectified because of posture suggestiveness, not because of body asymmetry.

Moreover, as in Experiments 1 and 2, we found a main effect of skin-to-clothing ratio, $F(1, 18) = 14.90$, $p = .001$, $\eta_p^2 = .45$, with bodies with high skin-to-clothing ratios ($M = -3.75$ μV; $SE = .66$) associated with larger N170s in comparison with bodies with low skin-to-clothing ratios ($M = -2.06$ μV; $SE = .42$). This main effect was qualified by a skin-to-clothing ratio and target gender interaction, $F(1, 18) = 18.25$, $p < .001$, $\eta_p^2 = .50$. For female bodies, females with high skin-to-clothing ratios ($M = -4.01$ μV; $SE = .71$) caused larger N170 amplitudes than females with low-skin-to-clothing ratios ($M = -2.07$ μV; $SE = .44$), $F(1, 18) = 18.12$, $p < .001$ $\eta_p^2 = .50$. Likewise, males with high skin-to-clothing ratios were associated with larger N170s ($M = -3.50$ μV; $SE = .62$) in comparison with males with low skin-to-clothing ratios ($M = -2.06$ μV; $SE = .41$), $F(1, 18) = 11.36$, $p = .003$, $\eta_p^2 = .39$, although this pattern was significantly less pronounced in comparison with females. We also found a main effect of posture suggestiveness, $F(1, 18) = 9.58$, $p = .006$, $\eta_p^2 = .35$: Bodies with suggestive (vs. nonsuggestive) postures were associated with enhanced N170 amplitudes in comparison with bodies with nonsuggestive postures, suggesting that bodies with suggestive postures were more arousing. Finally, a main effect of target gender on N170 amplitude did emerge, $F(1, 18) = 5.09$, $p = .037$, $\eta_p^2 = .22$, with larger N170s for female versus male bodies. Additional secondary results can be consulted in the Supplementary Materials document.

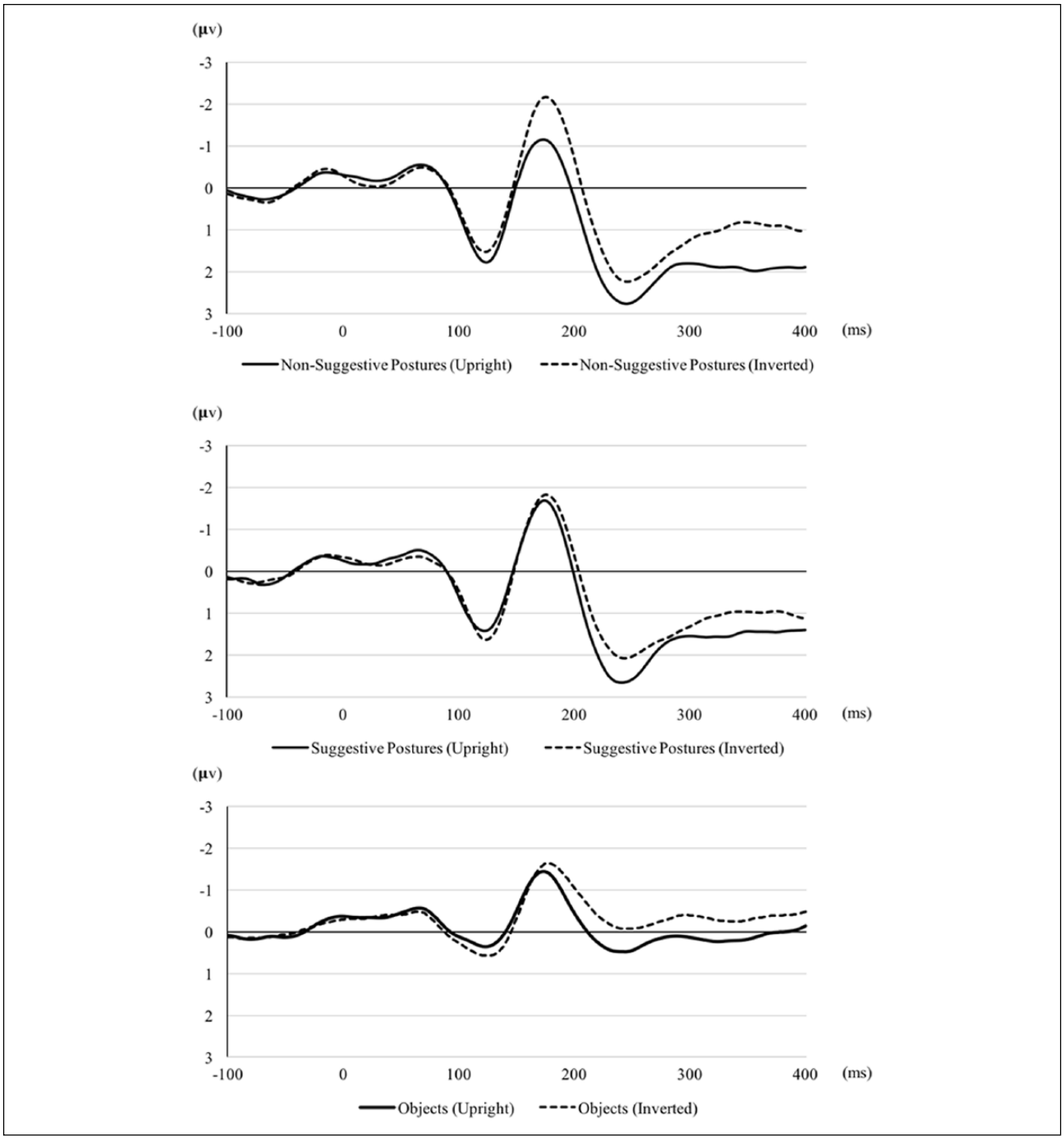

Figure 6. Grand-averaged event-related potentials at occipitotemporal electrodes sites (P7/P8) to upright (solid line) and inverted (dotted line) bodies displaying nonsuggestive postures (top), bodies displaying suggestive postures (middle) and objects (bottom).

Discussion

The results from Experiment 3 replicated Experiments 1 and 2, revealing that posture suggestiveness, but not skin-to-clothing ratio caused cognitive objectification. Importantly, Experiment 3 showed that the effects of postural suggestiveness on cognitive objectification (i.e., similar N170s for inverted vs. upright bodies) hold even when asymmetry remains constant. Moreover, as in Experiments 1 and 2, participants were sensitive to changes in skin-to-clothing ratio, as was evidenced by larger N170s

for people with high (vs. low) skin-to-clothing ratios, but this did not manifest in cognitive objectification. In a similar vein, participants were also sensitive to posture suggestiveness as evidenced by larger N170s for bodies with suggestive (vs. nonsuggestive) postures.

Meta-Analysis and Bayesian Analysis (Experiments 1-3)

Meta-Analysis

We combined datasets for bodies having low versus high skin-to-clothing ratio (Experiments 1-3), for bodies displaying nonsuggestive versus suggestive postures (Experiments 2-3) and for objects (Experiments 1-3).

First, we submitted N170 amplitudes to a 2 (skin-to-clothing ratio: high, low) × 2 (picture position: upright, inverted) repeated-measures ANOVA. The interaction between skin-to-clothing ratio and picture position was not significant, $F(1, 59) = 0.63$, $p = .43$, $\eta_p^2 = .01$. However, the main effect of picture position was significant, $F(1, 59) = 23.45$, $p < .001$, 95% CI = [–1.11, –0.46], $\eta_p^2 = .28$, with inverted bodies associated with larger N170s in comparison with their upright counterparts. Overall, this means that bodies with nonsuggestive postures were processed configurally and not objectified, regardless of the level of skin-to-clothing ratio. The ANOVA also corroborated the hypothesis that skin-to-clothing was encoded at an early stage of visual processing and perceived as arousing stimuli, with larger N170 amplitudes for bodies with high skin-to-clothing ratios ($M = -4.85$ μV, $SE = .34$) in comparison with bodies with low skin-to-clothing ratios ($M = -2.72$ μV, $SE = .25$), $F(1, 59) = 85.08$, $p < .001$, 95% CI = [–2.60, –1.67], $\eta_p^2 = .59$.

Second, we submitted N170 amplitudes to a 2 (posture suggestiveness: nonsuggestive, suggestive) × 2 (picture position: upright, inverted) repeated-measures ANOVA. The main effect of picture position reflecting larger N170s for inverted bodies in comparison with upright bodies, $F(1, 38) = 4.89$, $p = .033$, $\eta_p^2 = .11$, was qualified by the interaction between posture suggestiveness and picture position, $F(1, 38) = 25.04$, $p < .001$, $\eta_p^2 = .40$. For bodies with nonsuggestive postures, N170s were larger for inverted ($M = -4.08$ μV, $SE = .41$) than for their upright bodies ($M = -3.34$ μV, $SE = .37$), $F(1, 38) = 11.87$, $p = .001$, 95% CI = [–1.17, –0.31], $\eta_p^2 = .24$. In contrast, this pattern did not emerge for bodies displaying suggestive postures, $F(1, 38) = 0.36$, $p = .56$, 95% CI = [–0.50, 0.27], $\eta_p^2 = .009$. This further supports the notion that bodies displaying nonsuggestive postures were processed configurally and not objectified, whereas bodies displaying suggestive postures were processed less configurally and objectified. The main effect of posture suggestiveness was also significant, presumably because suggestive postures are more arousing in comparison with nonsuggestive postures. Larger N170 amplitudes emerged for bodies with suggestive postures ($M = -3.96$ μV, $SE = .38$) in comparison with bodies with nonsuggestive postures ($M = -3.71$ μV, $SE = .37$), $F(1, 38) = 20.23$, $p < .001$, 95% CI = [–0.36, –0.14], $\eta_p^2 = .35$.

Third, we compared whether N170 inversion effects associated with the different categories of bodies were significantly greater than the inversion effect associated with objects. The inversion effects of bodies displaying nonsuggestive postures (having either low or high skin-to clothing ratios) were significantly greater than the inversion effect associated with objects, ps < .01. However, the inversion effect associated with bodies displaying suggestive postures did not differ from the inversion effect associated with objects, $t(37) = -0.24$, $p = .81$. This confirms that bodies displaying suggestive postures were processed less configurally than bodies with nonsuggestive postures and cognitively objectified; bodies with suggestive postures were processed similarly to objects, with no N170 inversion effect (i.e., similar N170 amplitudes for inverted and upright stimuli), evidencing cognitive objectification.

Bayesian Analysis

Finally, given that we relied on the absence of the N170 amplitude inversion effect (i.e., no difference in N170 amplitudes for inverted and upright bodies) to examine cognitive objectification, we performed a Bayesian assessment of the extent to which the null result supports the null hypothesis. We used Dienes's (2011) calculator and based our analysis of the lowest effect size observed in the previous literature (Minnebusch, Keune, Suchan, & Daum, 2010) for the body-inversion effect ($\eta_p^2 = .25$). This assumes greater amplitudes for inverted versus upright bodies. The mean difference between upright and inverted bodies on the N170 amplitude should follow a half-normal distribution with a mean of zero and a standard deviation of 1.71. The inversion effect for bodies with suggestive postures was associated with a Bayes factor of .19, which is considered as substantial evidence for the null hypothesis (Jeffreys, 1961), i.e., the absence of inversion effect in the context of the present investigation. In contrast, inversion effects for bodies with nonsuggestive postures were associated with Bayes factors (11-159) that are considered as strong to extreme evidence for H1, evidencing configural processing and no cognitive objectification. In sum, Bayesian statistics provided complementary evidence that bodies displaying nonsuggestive postures were processed configurally (i.e., larger N170s for inverted vs. upright bodies), regardless of skin-to-clothing ratio, whereas bodies displaying suggestive postures were associated with similar N170s when presented in an inverted versus upright position, evidencing less configural processing and cognitive objectification.

General Discussion

The primary purpose of the present work was to examine the effects of two key dimensions of sexualization—skin-to-clothing ratio and posture suggestiveness—on cognitive objectification (Experiments 1-3). Objectification research has revealed that sexualization is a critical target feature that triggers objectification at both behavioral (e.g., Loughnan et al., 2013; Vaes et al., 2011) and neural levels (Bernard et al., 2018; Bernard, Rizzo et al., 2017). However, sexualization has remained an umbrella term that includes several sexualized features that are often confounded in objectification research. Consequently, researchers know that sexualization causes objectification, but with little understanding of why this effect occurs or which specific sexualizing characteristics cause objectification. To begin to fill this gap in the literature, we tested the effect of skin-to-clothing ratio (Experiments 1-3) and posture suggestiveness (Experiments 2 and 3) on cognitive objectification.

This is the first research to reveal that suggestive postures specifically cause objectification. In Experiment 1, we found that bodies with nonsuggestive postures were processed configurally (i.e., larger N170s for inverted vs. upright bodies), regardless of whether they had a high or low skin-to-clothing ratio. In Experiment 2, we orthogonally manipulated skin-to-clothing ratio and posture suggestiveness. As in Experiment 1, Experiment 2 revealed that bodies displaying nonsuggestive postures were processed configurally and not objectified (larger N170s for inverted vs. upright bodies), regardless of skin-to-clothing ratio. However, bodies displaying suggestive postures were processed less configurally (similar N170s for inverted and upright bodies)—akin to objects. Finally, asymmetry did not explain the effect of posture suggestiveness on cognitive objectification. It was possible that cognitive objectification was driven less by sexualization and more due to a methodological confound in which sexualized postures are often represented with asymmetric bodies (Schmidt & Kistemaker, 2015; Tarr, 2013; see also Bernard, Gervais, Allen, & Klein, 2015; Bernard, Gervais, Allen, & Klein, 2013; Schmidt, 2015, for a detailed discussion). In Experiment 2, people in suggestive postures had indeed more asymmetric body positions than people in nonsuggestive postures, which may make it appear that they have been cognitively objectified because it might be easier to process inverted asymmetric stimuli (allowing differences between inverted and upright stimuli to be eliminated, which we have argued here and elsewhere represents cognitive objectification). To illustrate, placing a hand on one's hips—a key means through which sexualization is conveyed—may make the body appear more asymmetric than placing one's hands by one's sides. This, in turn, may make inverted asymmetric bodies easier to process, eliminating the classic benefit that upright (relative to inverted stimuli) possess. Yet, Experiment 3 showed that when bodies with nonsuggestive postures were presented to participants in an asymmetric manner (and matched in terms of asymmetry with suggestive postures), there was no increase in cognitive objectification, whereas bodies with suggestive postures were processed less configurally and objectified, as indexed by similar N170s for inverted and upright bodies. This provides strong evidence that posture suggestiveness, rather than body asymmetry, is the key driver of cognitive objectification. The meta-analysis and Bayesian analysis we performed also confirmed our claims regarding the significant effect of posture suggestiveness on cognitive objectification.

Behavioral experiments relying on the inversion paradigm indicated that sexualized female bodies were processed less configurally than sexualized male targets (Bernard et al., 2012; Bernard, Gervais, Allen, Campomizzi et al., 2015; Bernard, Gervais, Allen, Delmée et al., 2015; Civile & Obhi, 2016), whereas EEG studies showed that both sexualized male and female bodies were processed less configurally (Bernard, Rizzo et al., 2017) and more analytically (Bernard et al., 2018), evidencing cognitive objectification. These discrepancies in the moderating role of target gender in cognitive objectification might suggest that the processes tapped by the behavioral measures at later processing stages (e.g., seconds after stimulus onset) do not map completely onto the neural measures evidenced at this early visual processing stage (e.g., 170 ms after stimulus onset). However, the results uncovered in this article are consistent with another alternative explanation, namely variations in posture suggestiveness. At a behavioral level, because researchers (Bernard et al., 2012; Bernard, Gervais, Allen, Delmée et al., 2015; Civile & Obhi, 2016) did not measure or control for posture suggestiveness among sexualized male and female bodies, it might be that sexualized females were more cognitively objectified than males as a result of higher posture suggestiveness. As noted in the introduction, and consistent with this explanation, images in these behavioral experiments stemmed from advertisements and we know that females are more likely to be portrayed as hypersexualized—including in more suggestive postures—than males (Hatton & Trautner, 2011). Also consistent with this possibility, EEG studies, including the experiments in this article, show that both sexualized female and male bodies are processed less configurally and more cognitively objectified when male and female targets are associated with similar (Bernard, Rizzo et al., 2017) and identical (Bernard et al., 2018) levels of posture suggestiveness. Although the current research and past research are consistent with this interpretation, future behavioral research that orthogonally considers target gender and postural suggestiveness would be necessary to directly test this possibility.

It is important to note that both skin-to-clothing ratio and posture suggestiveness were encoded by participants in the current research (i.e., larger N170s for bodies with high vs. low skin-to-clothing ratios; larger N170s for bodies with suggestive vs. nonsuggestive postures). This finding replicates recent research that has found that high skin-to-clothing ratio was associated with larger N170 amplitudes as compared with low skin-to-clothing ratio (Alho et al., 2015;

Bernard et al., 2018; Bernard, Rizzo et al., 2017; Feng et al., 2012; Hietanen & Nummenmaa, 2011). To our knowledge, this is the first research to show similar effects of postural suggestiveness with suggestive postures causing larger N170s relative to nonsuggestive postures. In line with Alho et al. (2015), we interpreted these larger N170s as reflecting sexual arousal. The meta-analysis further corroborated that posture suggestiveness and, to a greater extent, skin-to-clothing ratio elicited enhanced neural responses and more arousal.

Altogether, our results deliver a clear message. Both skin-to-clothing and posture suggestiveness (and target gender) are associated with larger N170s, indicating that bodies with high (vs. low) skin-to-clothing ratios, bodies with suggestive (vs. nonsuggestive) postures, and female (vs. male) targets are more arousing. However, only posture suggestiveness caused less configural processing and cognitive objectification (as indexed by similar N170s for inverted and upright bodies with suggestive postures).

Limitations and Future Directions

First of all, our results thus suggest that cognitive objectification is driven by the sexual connotation conveyed by body posture, not by the mere extent of nudity as previously assumed. It is now incumbent in future research to examine why high skin-to-clothing causes enhanced neural responses, but no cognitive objectification, whereas posture suggestiveness does cause cognitive objectification. A first possibility is that N170 amplitudes are sensitive to the amount of skin that is visible, whereas cognitive objectification only occurs in case of high level of target sexualization, which is only observable for bodies with suggestive postures (cf., pretest of the images in Experiment 2). Consistently, the pretest of the images revealed that the effect of posture suggestiveness (vs. skin-to-clothing ratio) on target sexualization is associated with a larger effect size. Stated differently, it might be that high skin-to-clothing ratio causes enhanced N170s due to a particular sensitivity to the amount of skin that is visible (see also Hietanen & Nummenmaa, 2011), whereas this factor does not cause cognitive objectification because the targets are not rated as highly sexualized in target sexualization self-reports.

Relatedly, a second possibility is that posture suggestiveness causes cognitive objectification because suggestive postures render sexual body parts more visually salient than bodies with nonsuggestive postures. Consistent with this explanation, Bernard, Gervais, Allen, Delmée et al. (2015) relied on a behavioral adaptation of the inversion paradigm and found no inversion effect for sexualized female bodies when body parts were salient, whereas an inversion effect did occur for the same targets when these body parts were made less salient (i.e., pixelated). To elucidate the role of sexual body parts salience in the visual processing of bodies with low skin-to-clothing ratio and displaying suggestive versus nonsuggestive postures, future research might want to replicate our findings while including nonsuggestive postures associated with low versus high body parts salience (e.g., with the arms behind the head) while the level of target sexualization remains constant. Finally, a third possibility is that body posture might be used as an indicator of sexual agency and intentionality to a greater extent than skin-to-clothing and we know that reminders of sex contributes to analytic appraisal of social targets (Förster, Epstude, & Özelsel, 2009). Future research should consider whether the effect of posture suggestiveness on cognitive objectification is mediated by the attribution of, for example, sexual agency to the targets.

In all the three experiments, we used a small number of pictures that were repeated many times (i.e., 60 times). The number of trials that are necessary to properly assess a given component varies as a function of the characteristics of that component such as the noise-to-signal ratio (i.e., difference in amplitude of a given component between conditions prior vs. after stimuli onset) and its amplitude (Woodman, 2010). Applied to our research, the N170 is an early component, the amplitude of the N170 is relatively large (in comparison, for example, with the vertex positive potential [P100], a positive component that precedes the N170 and occurs around 100 ms after stimulus onset), and the noise-to-signal ratio of the N170 is small (Bernard et al., 2018; Bernard, Rizzo et al. 2017). Besides time constraint, and given the amplitude is quite large and the noise level is low, previous research examining the N170 has revealed sufficient power with small numbers of stimuli (e.g., Minnebusch et al., 2009; Stekelenburg & de Gelder, 2004). In addition, following the recommendations made by Woodman (2010), we further limited the noise-to-signal ratio by randomizing trials and blocks (and thus images) that were presented within participants in random order. Participants also performed a simple behavioral task (i.e., indicating via a keypress whether the pictures were presented either in an upright or inverted position), not to mention the inclusion of short breaks every 10 min to maintain attention and limit feelings of boredom. Taking all of this into account, presenting each target 60 times was a meaningful methodological choice. As a result of this decision, we thus favored the creation of a small number of pictures that were well controlled and representative of a given stimulus category. Moreover, repetitive presentation does not cause the body images to be processed like objects. If presenting the same bodies many times caused objectification, all types of bodies regardless of skin-to-clothing ratio or posture would have been cognitively objectified. This possibility is not corroborated by a large literature—including the studies in this article—that documents that repetitive presentation of nonsexualized bodies is associated by default with configural processing (for a review, see de Gelder et al., 2010).

We used images of bodies with pixelated faces to minimize face processing and one might wonder whether these pixelated faces might have influenced body processing and resulting objectification. We find this unlikely. First, it is

worth noting that we monitored vertical and horizontal eye movements and excluded trials during which substantial eye movements were recorded. These methodological precautions render the possibility that participants made more attempts to decipher the blurred face of bodies with suggestive postures (vs. nonsuggestive postures) unlikely. Second, disrupting the physical integrity of bodies through the presentation of headless bodies causes bodies to be processed less configurally, as indicated by the absence of inversion effects for headless bodies at both neurophysiological (N170; Minnebusch et al., 2009) and behavioral levels (Yovel et al., 2010). In contrast, configural processing of nonsexualized bodies is preserved when faces are made less salient through pixelation (e.g., Bernard et al., 2018) or blurring (e.g., Stekelenburg & de Gelder, 2004). This indicates that bodies with either blurred and pixelated faces still match the typical body templates, whereas headless bodies do not (Minnebusch et al., 2009). The pixelating technique, thus, was a meaningful compromise given that it both minimizes face processing and preserves the physical integrity of body stimuli.

Importantly, we believe the role of pixelated faces on our results is minimal. The absence of the N170 inversion effect in this article only emerged for bodies with suggestive postures and, yet, faces remained pixelated across conditions and experiments. In addition, similar results have been found while relying on highly sexualized bodies with clearly visible faces (Bernard, Rizzo et al., 2017), with highly sexualized male and female bodies associated with no N170 inversion effect, indicating cognitive objectification. Altogether, this suggests that using bodies with fully visible versus pixelated/blurred faces does not play a critical role in cognitive objectification. At most, the use of bodies with pixelated faces might have slightly reinforced body focus, a tendency that people spontaneously display when assessing men's (Bernard, Gervais, Holland, & Dodd, 2017) and women's physical appearance (Gervais, Holland, & Dodd, 2013) and when looking at sexualized bodies (Nummenmaa et al., 2012). From this account, we encourage researchers to investigate the role of the face in cognitive objectification. We would expect that removing the face would not modulate the N170 inversion effect for bodies with suggestive postures (given that similar N170 amplitudes for inverted vs. upright bodies are observed by default), whereas removing the head would be associated with diminished N170 inversion effect and less configural for bodies with nonsuggestive postures.

Relatedly, even when suggestive and nonsuggestive postures were matched in terms of asymmetry (Experiment 3), targets did differ on at least another perceptual dimension. To illustrate, bodies with suggestive postures self-touch at the level of the genitals, whereas bodies with nonsuggestive postures do not. If this is true that self-touching is a component that contributes to target sexualization (Hatton & Trautner, 2011), yet, recent research found no N170 inversion effect for highly sexualized targets (with high skin-to-clothing ratios and suggestive postures) who do not self-touch (Bernard, Rizzo et al., 2017). This suggests that it is unlikely that self-touch, rather than suggestive posture, might have drove the reported results. More generally, we focused on two key features related to sexualization—skin-to-clothing ratio and posture suggestiveness; future research could systematically examine additional sexualizing characteristics to see which attributes drive objectification and which do not. For instance, Hatton and Trautner (2011) outlined 11 separate ways (e.g., facial expressions, depicting a sexual act) that people can be sexualized. Future research could systematically examine additional sexualizing characteristics to further understand which attributes drive objectification and which do not.

In addition, the stimuli used in the present study were all young, White, relatively thin, and well-proportioned people. The rationale for the inclusion of these stimuli was twofold. First, our participants were relatively young people, and we wanted to keep the stimuli and participants similar as to not heighten the possibility of objectification based on dissimilarity or out-group status (see Haslam, 2006). Prior objectification work has mostly included images of relatively attractive individuals (e.g., underwear and lingerie models) and we followed this approach so that our findings would be as informative with respect to other objectification studies. However, future research could systematically vary features such as attractiveness, similarity (based on the individual or group) but also ethnicity, age, or body types to further assess additional predictors or boundary conditions of cognitive objectification. Not only would this help shed further light on the sexualization and objectification phenomena but it could be also critical for identifying key aspects of sexualization that could be targeted to prevent sexualization-related objectification from occurring in the first place.

Our finding that posture suggestiveness causes objectification could provide a foundation for important additional next steps in objectification research more generally. A growing body of objectification research examined how sexualization shapes the way we attribute mind- and humanness-related personality traits to others (for a review, see Ward, 2016). An important next step for future research will be to investigate the putative links between cognitive objectification and attribution of mind to others. We believe that perceiving a person similarly to an object at a basic cognitive level might lead to seeing that person as possessing less humanness and related personality traits. Consistent with this possibility, recent research shows that disrupting configural processing of faces by presenting them in an inverted (vs. upright) position is associated with lower attribution of humanness-related traits (e.g., Hugenberg et al., 2016). We thus believe that the cognitive measure of objectification we used in this article (see also Bernard et al., 2018; Bernard, Rizzo et al., 2017) might predict the way we attribute mind to others. We are not aware of studies that have linked the N170 body or face inversion effect to social impression formation. However, EEG studies have showed that the N170 is related to traits involved in the ascription of mind to others. For instance, trait

empathy correlates positively with faster recognition and larger N170s for facial expressions (Soria Bauser, Thoma, & Suchan, 2012). It is now incumbent on researchers to examine how cognitive objectification is related to impression formation and behaviors toward others.

Practical Implications

The finding that only some aspects of sexualization—posture suggestiveness—but not others—revealing clothing—cause objectification is important from a scientific as well as a practical perspective. First, this is one of the first studies to illustrate that although sexualization is an important predictor of objectification, objectification is not an inevitable consequence of sexualization. Although we did not have *a priori* hypotheses regarding the importance of revealing clothing compared with posture suggestiveness in objectification, it is possible that posture suggestiveness activates sexual goals in the minds of perceivers to a greater degree than revealing clothing and that people are reduced to their parts as a means toward using them to attain activated sexual goals. Future research that measures activated goals could test this possibility.

Second, from a practical perspective, this research suggests that efforts to reduce objectification due to sexualization should focus on sexual suggestiveness, rather than revealing clothing. Although suggestive postures and revealing clothing often go hand-in-hand, it may be possible to decouple these elements in the media and interpersonal interactions. For example, underwear and swimsuit advertisers could promote their products in ways that would reduce risk of objectification by presenting models in revealing clothing, but nonsuggestive postures.

Like other research (e.g., Bernard et al., 2018; Bernard, Rizzo et al., 2017), we found that cognitive objectification of bodies was not moderated by target gender. At least at early stages of visual processing, it appears that target gender does not modulate the effects of posture suggestiveness on cognitive objectification. This finding, however, must be considered within the larger cultural context in which girls and women are much more frequently presented in suggestive postures (e.g., in advertisements, Hatton & Trautner, 2011; through self-sexualization, Smolak et al., 2014) than boys and men (Ward, 2016; see American Psychological Association, 2008). Thus, although the effects may be similar for men and women when they are presented in suggestive postures, females are still at greater risk to be objectified relative to their male counterparts.

The present research is the first to deconstruct sexualization and showed that posture suggestiveness causes objectification and exerts a more powerful influence on objectification than skin-to-clothing ratio. In sum, body language may be very telling (in the minds of social perceivers anyway) in why people see others as objects even when people are not saying a word.

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Supplemental Material

Supplementary material is available online with this article.

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