

# Chapter 6

## Sex Differences in Social Cognition



Alice Mado Proverbio

**Abstract** Several studies have demonstrated sex differences in empathy and social abilities. This chapter reviews studies on sex differences in the brain, with particular reference to how women and men process faces and facial expressions, social interactions, pain of others, infant faces, faces in things (*pareidolia*), living vs. non-living information, purposeful actions, biological motion, erotic vs. emotional information. Sex differences in oxytocin-based attachment response and emotional memory are also discussed. Overall, the female and male brains show some neuro-functional differences in several aspects of social cognition, with particular regard to emotional coding, face processing and response to baby schema that might be interpreted in the light of evolutionary psychobiology.

**Keywords** Hemispheric asymmetries · Facial expressions · Parental response · Face pareidolia · Sex hormones

### Introduction

Genetic and hormonal influences are long known to affect the human brain and determine a variety of anatomical and functional differences between the two sexes (see Hines, 2020, for a review). The cerebral sexual dimorphism would support marked diversities in reproductive, parental, and social behavior. A rapidly increasing literature now documents significant sex differences in the reactivity to/efficacy of drugs and pharmaceutical molecules, as well as in the incidence of neurodegenerative, neurological, and psychiatric diseases (see the entire volume dedicated to sex differences in the brain, edited by Cahill, 2017).

Besides anatomical and physiological diversities, some functional and mental differences between men and women have been recently reported by neuroscientific

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A. M. Proverbio (✉)

Department of Psychology, University of Milano-Bicocca, Milan, Italy

e-mail: [mado.proverbio@unimib.it](mailto:mado.proverbio@unimib.it)

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studies (e.g. for the following abilities: verbal fluency (Sokolowski et al., 2020), emotion recognition (Connolly et al., 2019; Li et al., 2020), face perception (e.g., Zhou & Meng, 2020), and empathy, as shown by a recent survey examining the empathy quotients of 671,606 individuals (Greenberg et al., 2018).

Several studies have demonstrated sex differences in empathy and related capacities. This chapter reviews studies on sex differences in the brain, with particular reference to how women and men process faces and facial expressions, social interactions, pain of others, infant faces, faces in things (*pareidolia* phenomenon), opposite- vs. own-sex faces, living vs. non-living information, incongruent/inappropriate behavior, motor actions, biological motion, erotic vs. emotional information. Sex differences in oxytocin-based attachment response and emotional memory are also discussed. Overall, the female and male brains show some neuro-functional differences in several aspects of social cognition, with particular regard to emotional coding, face processing, and response to baby schema, which might be interpreted in the light of evolutionary psychobiology.

In this chapter, a recent and comprehensive review of neuroimaging, electrophysiological, and behavioral findings in the literature supporting the hypothesis of a sex difference in social cognition is provided and discussed, under the framework of cognitive neuroscience and evolutionary psychobiology theories.

The main sex differences in social brain possibly refer to:

- Hemispheric lateralization for face processing (Bourne, 2005; Proverbio et al., 2006a, b, 2010a, b, c, 2011a, b, c, 2012)
- Facial expression decoding (e.g., Orozco & Ehlers, 1988)
- Emotional response to negative affective information (empathic distress: Hofer et al., 2007; Klein et al., 2003; empathy for pain, sympathetic response: Singer et al., 2004; Han et al., 2008; Proverbio et al., 2009)
- Understanding body language and action goals (Canessa et al. 2012, Proverbio et al., 2011a, b, c)
- Interest in faces and social information (Pavlova et al., 2014, 2015; Proverbio et al., 2008)
- Parental response (Seifritz et al., 2003; Sander et al., 2007)

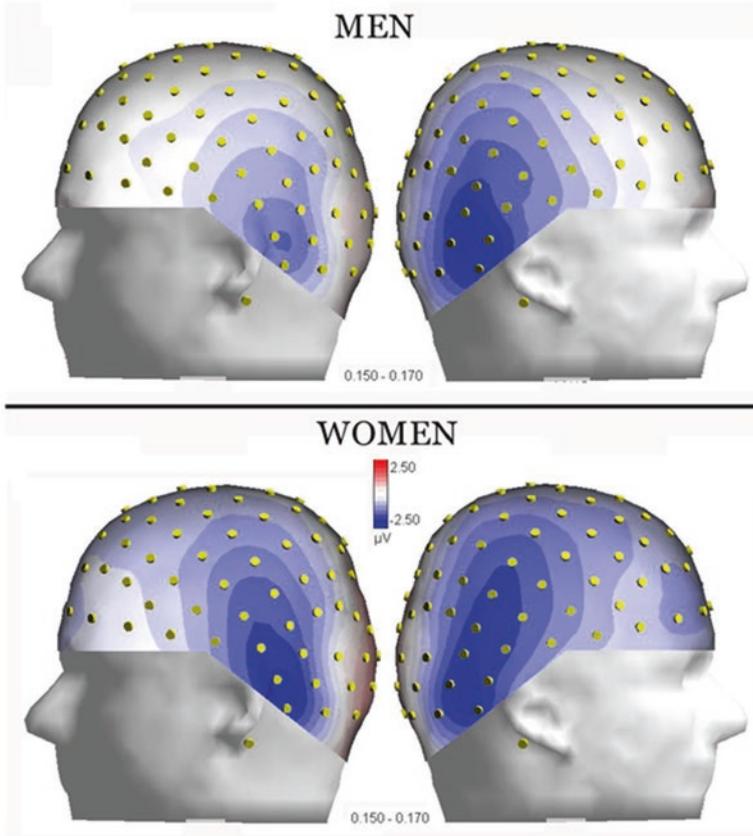
## Hemispheric Asymmetries for Face Processing

While it is currently believed that face processing predominantly activates the right hemisphere in humans, some data reveal a lesser degree of lateralization of brain functions related to face coding in women than men. For example, a left hemispheric involvement of the occipito/temporal cortex in women for the processing of human faces has been demonstrated in two independent studies, showing a bilateral pattern of activity of the face fusiform face area (FFA) indexed by N170 ERP response in females, as opposed to the typical male right-sided hemispheric

asymmetry (Proverbio et al., 2006b, 2012). In more detail, Proverbio and co-workers (2012) recorded ERPs in 50 right-handed women and men in response to 390 faces of male and female infants, children or adult, and technological objects, in a landscape detection task. Results showed no sex difference in the amplitude of N170 to objects, a much larger face-specific response over the right hemisphere in men and a bilateral response in women (see Fig. 6.1). Furthermore, a lack of the face-age coding effect was found over the left hemisphere in men, with no differences in N170 to faces as a function of age. Conversely, N170 showed to be sensitive to face age (e.g., differentiating children from adults), over both hemispheres in women.

Overall, these findings are in line with many studies that show differences between men and women in the degree of lateralization of cognitive and affective processes. Substantial data support greater hemispheric lateralization in men than women for linguistic tasks and for spatial tasks. Sex differences have also been found in the lateralization of visual-spatial processes such as object construction and mental rotation tasks, in which males are typically right hemisphere dominant and females bilaterally distributed. Consistent with this pattern of results are the data provided by Bourne (2005), who examined the lateralization of processing positive facial emotion in a group of 276 right-handed individuals. Subjects were asked to observe a series of chimeric faces with contrasting expressions and to decide which face they thought looked happier. The results showed that males were more strongly lateralized than women, showing a greater perceptual asymmetry in favor of the left visual field (RH). A similar pattern of results has been reported by Tiedt et al. (2013). Inter-hemispheric transfer-time of face-related inputs seems to be also asymmetric across sexes: N170 recorded in men have faster latencies in the left visual field (LVF)/RH  $\rightarrow$  LH (170 ms) direction than in the right-visual field (RVF)/LH  $\rightarrow$  RH (185 ms) direction, while it is symmetric in women (Proverbio et al., 2012). Figure 6.2 shows larger delays in N1 latency (due to callosal transfer) relative to the ipsilateral stimulation, for stimuli presented to the RVF (left hemisphere), in men.

In men, N170 was significantly earlier ( $p < 0.0007$ ) for ipsilateral (crossed) responses over the left than right hemisphere. This effect was not found in women, who showed an IHTT of equal latency in the two directions. As for contralateral (uncrossed) responses, N170 was earlier over the RVF/LH than LVF/RH in women and of equal latency for both hemispheres in men. One potential explanation of the findings is that interhemispheric transfer time (IHTT) would be more rapid and symmetric in women than men. Notwithstanding the large electrophysiological literature in favor of this hypothesis, in neuroimaging domain, the standard and to-be-expected pattern of lateralization for face processing is still considered to be the right-sided activation of the fusiform gyrus and of the right occipital face area for both sexes (e.g., Jacques et al., 2019).

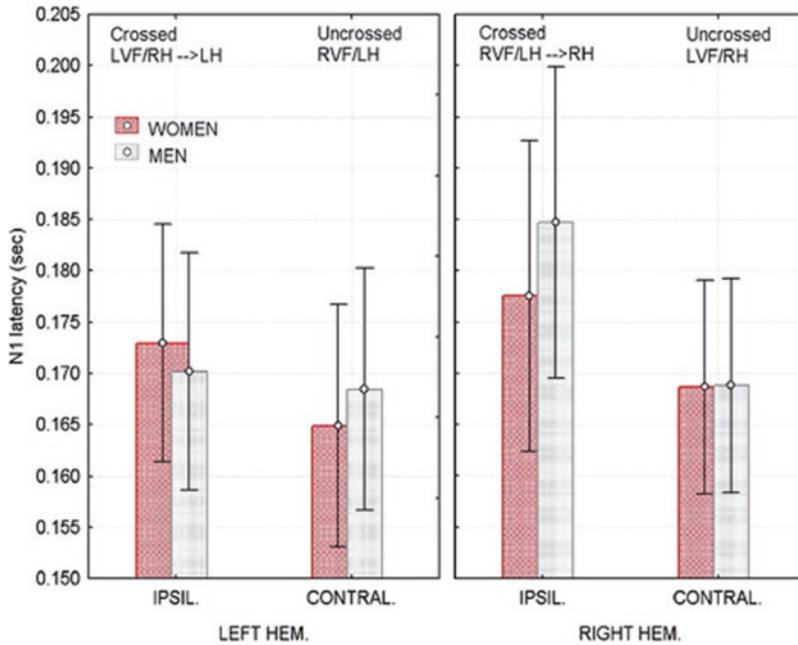


**Fig. 6.1** Isocolor voltage topographical maps (left- and right-side views) showing N170 scalp distribution in female and male observers. N170 response is relative to adult face processing. The time window corresponds to its peak (150–170 ms) of maximum activation. (Taken from Proverbio et al. (2012), with permission from the authors and the editor)

## Affective Facial Expressions and Emotions

Several studies have provided evidence of a woman's greater accuracy in interpreting emotional states and mind reading (Babchuk et al., 1985; Wingenbach et al., 2018). One potential explanation of these findings is that the primary role of female humans (and primates in general) in breastfeeding and rearing young offspring would have improved their ability to interact with them affectively and to understand their non-verbal behavior.

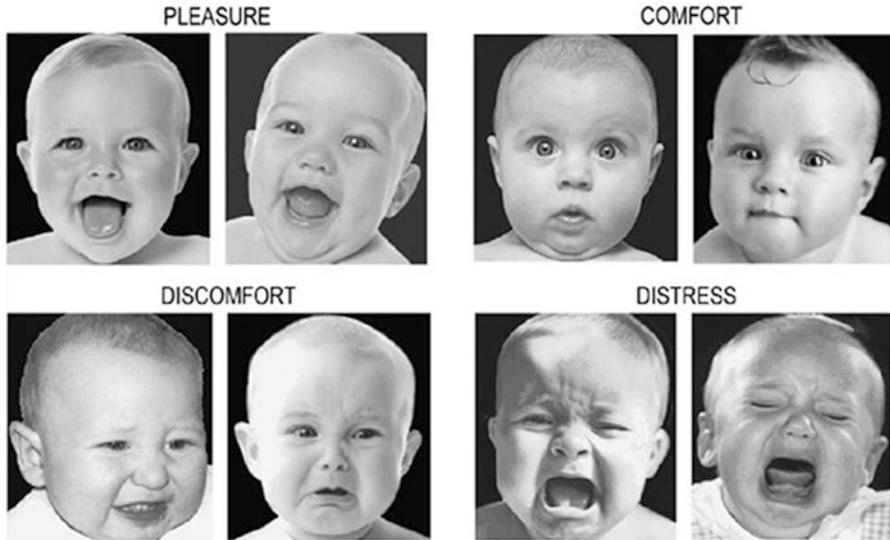
In this regard, Proverbio et al. (2007) examined the roles of sex and expertise in interpreting infant expression in a group of 34 men and women differing in their experience with infants (Fig. 6.3). The participants were subdivided into two groups (experts or non-experts) on the basis of their specific familiarity with infant facial



**Fig. 6.2** N170 latency values (along with SD) recorded in women and men in response to lateralized faces, as a function of cerebral hemisphere and stimulus contra-laterality (collapsed across occipito/temporal electrode sites). In this study, ERPs were recorded in strictly right-handed people (16 men and 17 women) engaged in a face-sex categorization task. Occipital P1 and occipito/temporal N170 were left lateralized in women and bilateral in men. N170 to contralateral stimuli was larger over the RH in men and the LH in women. Inter-hemispheric transfer time (IHTT) was approximately 4 ms at the P1 level and approximately 8 ms at the N170 level. It was asymmetric in men, with faster latencies in the left visual field (LVF)/RH → LH (170 ms) direction than in the right-visual field (RVF)/LH → RH (185 ms) direction and symmetric in women. These findings suggest that the asymmetry in callosal transfer times might be due to faster transmission times of face-related information via fibers departing from the more efficient to the less efficient hemisphere (Proverbio et al., 2012)

expressions. In detail, individuals considered “non-expert” were those without children, nieces or nephews, and without a specific familiarity/skill with neonates or pre-school age children acquired through professional activities. In contrast, individuals with natural or adopted children, nieces or nephews under the age of 5 years old, as well as nursery school teachers or infant school teachers were considered “experts.” Women showed a significantly higher level of decoding accuracy compared to men; furthermore, expertise positively affected facial expressions decoding among women only. These results suggest that in judging emotional facial expressions of infants, there is an interaction of biological (i.e., sex) and cultural factors (such as familiarity with infantile mimicry).

In an electrophysiological study performed on the same set of stimuli (Proverbio et al., 2006b), it was investigated whether viewers’ sex affected the visual cortical

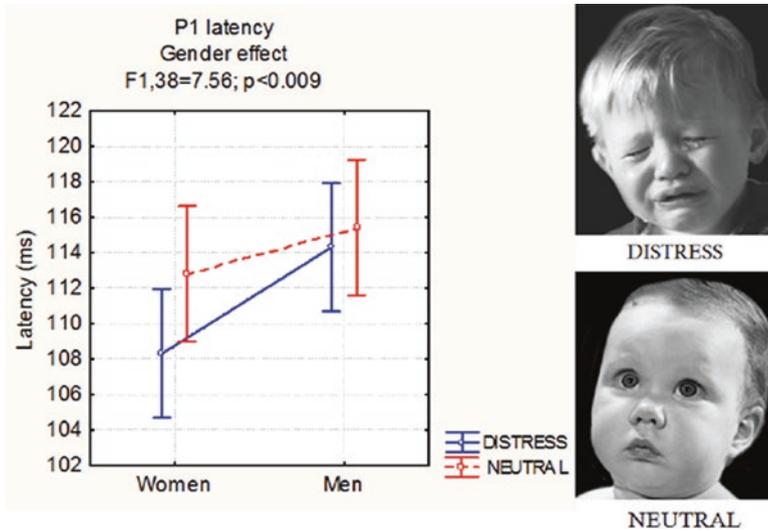


**Fig. 6.3** Examples of photographs used as stimuli, as a function of facial expressions (Proverbio et al., 2007). The upper row shows positive emotional states with strongly positive emotions, such as joy on the left, and mildly positive ones, such as comfort or peacefulness, on the right. The lower row shows negative emotional states with the mildly negative emotions, such as discomfort or disappointment, on the left and strongly negative ones, such as displeasure or pain, on the right

response at various stages of perceptual processing during a judgment task of infant happy/distressed expression. All infants were unfamiliar to viewers. The lateral occipital P110 response was much larger and occurred earlier in women than in men, regardless of facial expression, thus indicating a sex difference in early visual processing. Furthermore, P110 latency was earlier in response to distressed than neutral children in women only, thus possibly showing a prioritized processing of biologically relevant information in the female brain (Fig. 6.4).

The role of viewer sex in the emotional evaluation and psychological reactivity to human faces of various age, sex, and typology has been deeply explored. Table 6.1 shows some of the main gender differences in facial expression processing.

In general, perception of aversive faces would activate an amygdala-based arousal response able to affect general stimulus processing (Phelps & LeDoux, 2005). Furthermore, stimuli inducing greater arousal in the percipient would be subjected to a prioritized processing because of their biological relevance, for example, infant faces would trigger an instinctive parental response. In this respect, it has been reported that erotic stimuli are particularly arousing for men as compared to women. Sabatinelli et al. (2004) provided fMRI evidence that perception of erotic pictures is associated with a much larger activation of the extra-striate visual cortex in men vs. women, while Huynh et al. (2012) showed the opposite effect in women, with high-intensity erotic visual stimuli de-activating the primary visual cortex as compared to low-intensity erotic movies and neutral movies. Conversely,



**Fig. 6.4** Mean latency (in ms) of the P1 component (along with SD) recorded at the lateral occipital area (independent of hemispheric site) and analyzed according to subjects' sex and type of facial expression. (Taken and modified from Proverbio et al., 2006b study, with permission of the authors and the editor)

**Table 6.1** Main gender differences related to facial expression and decoding abilities

<b>Women</b>
<ul style="list-style-type: none"> <li>• Better decoding ability and emotion recognition (Connolly et al., 2019; Thomson and Voyer, 2014)</li> <li>• More expressive (e.g., crying, smiling: frequency and intensity) (McDuff et al., 2017)</li> <li>• More interested in faces and social information (Proverbio et al., 2008)</li> </ul>
<b>Men</b>
<ul style="list-style-type: none"> <li>• Slower response times (RTs) in recognizing expressions (Wingenbach et al., 2018)</li> <li>• React stronger than females to angry faces (Sawada et al., 2014)</li> <li>• Learn how to mask feelings (also use mustaches or beard to appear more aggressive, Craig et al., 2019)</li> </ul>

perception of body mutilations (stimulating the empathic circuits) would be associated with a stronger activation of the extra-striate visual cortex in women vs. men. These findings have been interpreted by the authors of the studies according to the hypothesis that the degree of cerebral arousal and mobilization of attentional resources devoted to stimulus processing would depend on its biological relevance for the observers. It is well known that women respond differently than man to erotic information. Some women feel repulsed by muscular, erotic male photos. In general, while men are more sexually aroused by visual stimuli, women seem to be more sexually aroused by auditory, tactile, or emotionally relevant information (see Chung et al., 2013).

In a recent study (Proverbio, 2017), 15 male and female university students evaluated 400 human faces of various age and sex according to the parameters of arousal and valence. The same face set was preliminary validated (and sex-matched) by a group of 20 independent judges (10 men and 10 women) who were asked to evaluate the degree of trust inspired by each face by means of a 3-points Likert scale. The aim was to explore the possible interaction of facial characteristics with judges' sex and age. Participants shared their ethnicity (which was Caucasian) with that of the observed faces (therefore, ethnicity or "race" was not a factor in this study, nor was the so-called "*other-race effect*" (ORE; Caldara et al., 2004; Proverbio et al., 2011a).

Overall, the data collected in this study (Proverbio, 2017), relative to heterosexual young adults, showed a sex difference in the evaluation of human faces along the arousal and valence dimensions. Specifically, an opposite-sex preference (with higher valence ratings) was found only in men, in favor of female adolescents (but not mature women), thus strongly interacting with face age. There was only a tendency for women participants in preferring male faces, possibly because of a lack of specific aesthetic value (faces were selected as normotypical) and the presence of negative facial expressions (such as hate, hostility, disgust) making some faces not particularly attractive. Female subjects showed a preference for the faces of children and the elderly (as compared to other age ranges) in the arousal evaluation. The female appreciation of elderly faces might be interpreted in the light of a greater empathetic attitude for fragile persons, whereas the female preference for children faces would rely on specific neural mechanisms sensitive to child-like cues in face stimuli. Overall, women rated all human faces as more arousing and more positive than men, possibly indicating a preference, or greater interest, for faces, facial expressions, and social information in general (Proverbio et al., 2008). This piece of evidence fits with the Baron-Cohen model of sexual dimorphism in empathy and facial expression coding ability (Baron-Cohen et al., 2001; Baron-Cohen and Wheelwright, 2004). In the light of this framework, it can be proposed that the higher female ratings of valence and arousal found in the present study might reflect a greater attentional allocation to (or interest for) human faces as sensory signals (Pavlova et al., 2014, 2015).

While it seems that females generally are significantly faster and more accurate at emotion recognition, some studies failed to show consistent gender differences while varying experimental conditions (Klein & Hodges, 2001).

## Parental Response

The viewers' age and the possible interaction with face age are also explored in the literature on the so-called *baby schema* effect, which predicts a preference for, and a perceptual advantage of infant vs. adult faces (Brosch et al., 2007; Glocker et al., 2009a; Luo et al., 2011; Proverbio et al., 2011a, b), as nicely reported in a review by Hahn and Perrett (2014).

The literature shows that the adult visual and the orbitofrontal cortices are specifically activated and aroused by the view of infants, also providing a pleasant sensation through the dopaminergic reward circuitry. This would happen to a greater extent in women than men, according to some authors (Hahn et al., 2013; Nitschke et al., 2004; Parsons et al., 2011, 2013). Indeed, behavioral studies showed how women might be more responsive to baby schema than men and better able to decode infant expressivity (Proverbio et al., 2007; Babchuk et al., 1985). In an electrophysiological study (Proverbio et al. 2006a, b) aimed at investigating the neural response to baby schema in female and male adult individuals, ERP results revealed a larger sensory P100 response to faces in women than in men (irrespective of whether they were parents themselves or nulliparous). These findings may possibly be interpreted as a sign of greater perceptual sensitivity (or increased arousal response) in women than men at the view of unrelated infants. Similar studies have shown that infant faces hold greater incentive salience for women than they do for men (Hahn et al., 2013; Parsons et al., 2011, 2013). Again, infant faces have been shown to capture women's attention to a greater extent than adult faces, whereas infant faces capture men's attention more so than same-sex faces, but much less than opposite-sex faces (Cárdenas et al., 2013).

Several recent neuroimaging studies (Glocker et al., 2009b; Kringelbach et al., 2008; Leibenluft et al., 2004) have investigated the neural circuits subtending the so-called "parental response" to infants and identified a set of structures predominantly involving the orbito/frontal cortex devoted to social cognition and belonging to the dopaminergic reward system. The neural correlates of "maternal love" have been investigated by recording the brain activation of mothers viewing pictures of their own children. The results showed activation of brain areas linked to affect (amygdala) and in particular positive emotions (orbitofrontal cortex and connected regions belonging to the pleasure/reward circuitry such as the periaqueductal gray matter). The possible role of oxytocin in maternal love has also been determined in an electrophysiological study (Peltola et al., 2014) testing the associations of motherhood and oxytocin receptor genetic variation with neural and behavioral responses to emotional expressions of infants and adults. It was found that mothers (vs. non-mothers) and individuals carrying the rs53576 GG variant of the *OXTR* gene (vs. A-carriers) showed enhanced ERP differentiation of infants' strong versus mild intensity facial expressions (i.e., pleasure and distress vs. comfort and discomfort).

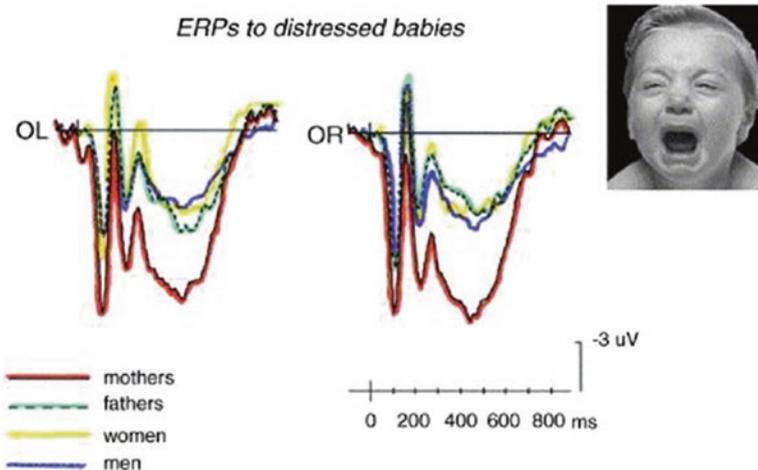
Overall, the parental role (having own children) has been associated with a greater sensitivity to infant facial expression. In an electrophysiological study performed in parent vs. nulliparous adults, it was shown that the perceptual N160 response reflected the earliest discrimination of mild vs. strong painful facial expressions in parents (especially in mothers) but not in nulliparous individuals. These findings possibly suggest a strong interactive influence of genetic predisposition and parental status on the responsiveness of visual brain areas (Proverbio et al., 2006a). Again, the data showed larger P3 responses in mothers versus all other groups (including fathers and nulliparous women), possibly indicating a greater perceptual sensitivity (or increased arousal response) in mothers, at the view of unrelated infants (Fig. 6.5).

As for the auditory modality, other studies have demonstrated a female vs. male enhanced response to the infant vocalizations (cry and laughter) (Sander et al. 2007; Seifritz et al., 2003) supporting the hypothesis of a sex difference in the parental response to infantile communicative signals.

## Interest in Social Stimuli

In Proverbio's (2017) previously described study, regardless of faces' sex, women's ratings were significantly higher for both arousal and valence dimensions, thus suggesting that women might be more interested or aroused by the specific sensory stimulus (the human face). This data fits with some electrophysiological literature providing evidence of a greater female electro-cortical responsivity to faces and people than to inanimate scenarios such as landscapes.

In a study by Proverbio et al. (2008), 24 men and women viewed 220 images portraying persons or landscapes (see Fig. 6.6 for some examples of stimuli) and ERPs were recorded from 128 sites. In women, but not in men, the N2 component (210–270 ms of latency) was much larger to persons than to scenes. Inverse solution (swLORETA) showed significant bilateral activation of face-devoted areas (namely, the fusiform gyrus, BA19/37) in both sexes when viewing persons as opposed to scenes. However, only women showed a source of activity in the superior temporal gyrus (STG) and in the right middle occipital gyrus (MOG), extrastriate body area (EBA), and only men in the left parahippocampal area (PPA). This was interpreted



**Fig. 6.5** ERPs signals recorded over left and right lateral occipital sites following presentations of infant facial expressions exhibiting strongly negative emotions, according to viewer group. Smaller P300 amplitudes were recorded in fathers vs. mothers, especially with infant expressions of suffering. (Taken from Proverbio et al., 2006a, with authors' and editors' permission)



**Fig. 6.6** Examples of social and nonsocial stimuli used to evaluate the interest in social information, regardless of stimulus color richness and perceptual complexity. (Taken from Proverbio et al. (2008)'s study)

as an index of a greater female interest in, or attention to, this class of biologically relevant signals (human faces and bodies).

Whatever the cause, little neuroscientific evidence of such preference of the female brain for social stimuli has been reported, in contrast to the large body of behavioral evidence showing that females have greater social and affective competence. For example, substantial literature has accumulated indicating that women are better than men at decoding facial expressions of emotion (Thomson & Voyer, 2014). Various studies have demonstrated differences between the ways in which

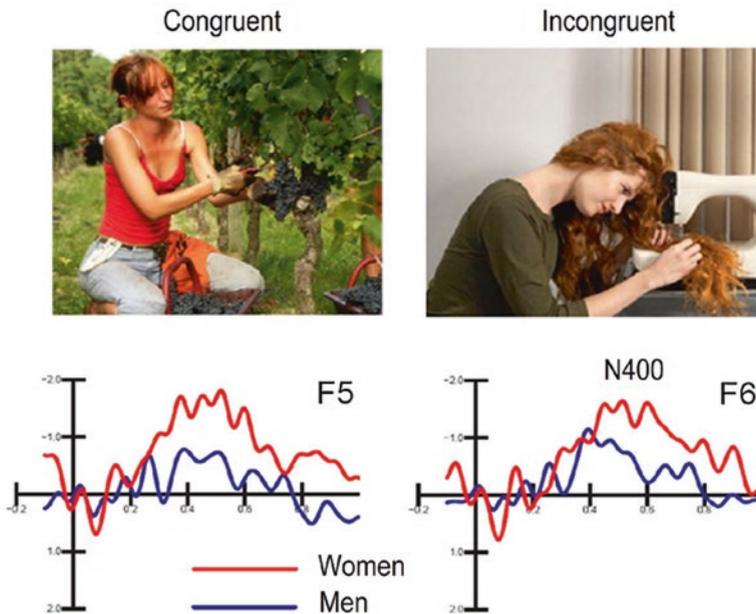
men and women perceive (Proverbio et al., 2016), process (Canessa et al., 2012), express (McDuff et al., 2017), and experience emotions (Proverbio et al., 2009). Research generally suggests that women are more able, as well as more inclined, to express their own emotions to conspecifics (McDuff et al., 2017). Furthermore, they show greater ease in decoding non-verbal indicators connected to the expression of emotions. It has been reported that female children across various human cultures are prone to spend more time with their younger siblings, or their simulacra (baby dolls), than are their male counterparts. It is quite difficult to determine whether this socially oriented behavior is entirely due to cultural factors (such as the style of upbringing) or to a biological difference dependent on genetic factors. Since, in Proverbio's study (2008), showing a greater interest for social stimuli, no behavioral response or attention allocation to social information was required by the task (consisting in detecting rare Mondrian pictures), the stronger responsivity to persons than landscapes in women would reflect a privileged processing of images depicting conspecifics in the female brain. Consistent with this hypothesis, numerous studies (e.g., Wingenbach et al., 2018) have demonstrated that women are provided with a greater ability to decipher the emotions through facial expressions or other non-verbal communication than man and are more inclined and more competent in expressing their emotional experiences to others (Dimberg & Lundquist, 1990). Further evidence has demonstrated that women, as compared to men, react more strongly when viewing affective stimuli (such as IAPS) involving human beings, thus showing higher empathic responses (Proverbio et al., 2009). In this regard, some authors have established a link between sex, social skills, and action processing because of the strong association between the known action observation/execution properties of the motor mirror system and the theorized social functions of the human mirror system (Oberman et al., 2007).

## Action and Body Language Understanding

Several sex differences have been reported in action understanding tasks. Female participants have been found to be better at understanding the action purpose as compared to men, as indexed by earlier and larger discriminative ERP responses to incongruent and purposeless behavior (Proverbio et al., 2010c). Perception of plausible and understandable actions (e.g., smiling couple clinking glasses of champagne) was contrasted with that of implausible and unintelligible actions (e.g., businesswoman balancing on one foot in the desert). ERP data showed early processing of the action's purpose in the female brain, with a larger parietal N200 to understandable behavior. Source reconstruction (swLORETA) located the neural generators of this effect in the inferior/parietal, left inferior/frontal, left and right premotor areas, right cingulate cortex, right superior/temporal and extra-striate cortex belonging to the so-called "human mirror-neuron system (MNS)." Anterior

N400 discriminative response (implausible–plausible) was greater in women than men (see Fig. 6.7). The data suggest that congruent/incongruent actions are processed differently from the two sexes, with a prevalence of limbic and cingulate activation in women, and orbito/frontal one in men, along with a right STG activation of comparable amplitude in men and women.

Consistently, the combined fMRI and ERP study by Canessa et al. (2012) and Proverbio et al. (2011c) found differences across male and female participants involving a stronger activation of the action understanding system, the STS, and the ventral premotor cortex (associated with the mirror resonance of others' actions) during the observation of cooperative (vs. affective) scenes in women. Again, other studies provided evidence of sex differences in the development of brain mechanisms for processing biological motion (Anderson et al., 2013). In an fMRI study involving the visual perception of point-light displays of coherent and scrambled biological motion, enhanced activity during coherent biological motion perception was found in females relative to males in a network of brain regions possibly implicated in social perception, including amygdala, medial temporal gyrus, and temporal pole (Anderson et al., 2013). All in all, these pieces of evidence indicate a female superiority in social skills and sex differences in action/behavior processing.



**Fig. 6.7** ERP difference waves obtained by subtracting ERPs to congruent from ERPs to incongruent actions separately for men and women, over anterior scalp sites. A much larger N400 response occurred to incongruent actions in women than men. (Taken and modified from Proverbio et al., 2010c)

## Face Pareidolia

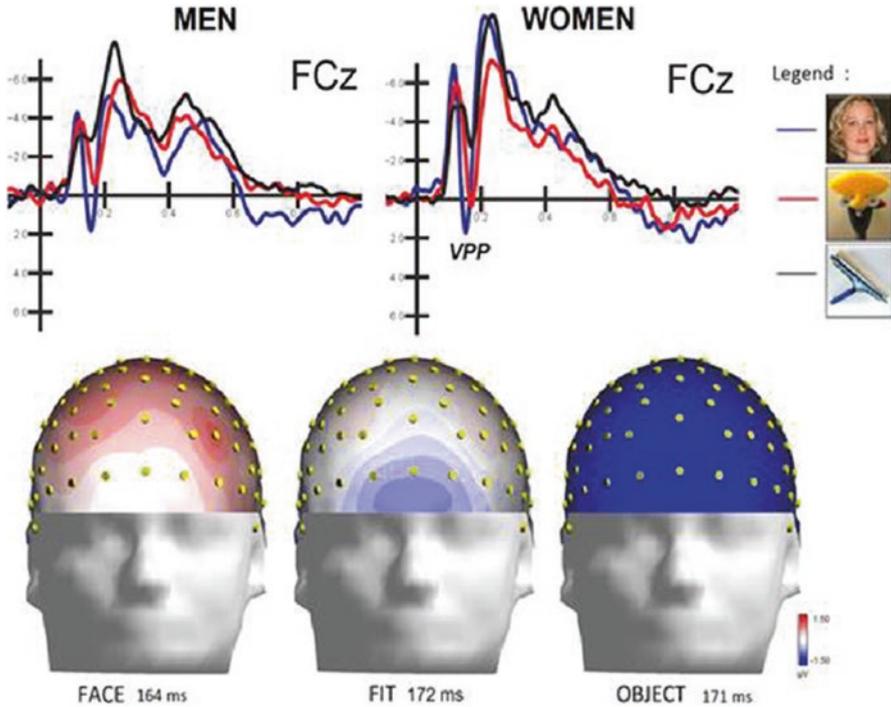
Recent behavioral and electrophysiological research has shown that women are better at seeing faces, even when there are none, a perceptual illusory phenomenon called “face pareidolia” (i.e., the illusory perception of non-existent faces). Sometimes, while observing the clouds in the sky, coffee foam, or random decorative patterns, we might be struck by the impression of clearly perceiving a face that is so well defined and yet so illusory. This perceptual effect has precise neural underpinnings based on the face fusiform area.

Pavlova et al. (2015) carried out a spontaneous recognition task in which adult females and males were presented with a set of food plate images resembling faces (Arcimboldo style). Not only did women more readily recognize the images as a face (they reported images as resembling a face, on which males still did not), but gave overall more face responses. Proverbio et al. (2016) investigated the neural correlates of this sex difference, in a study in which ERPs were recorded while participants viewed pictures of animals intermixed with that of familiar objects, faces, and faces-in-things. Overall, compared to the men, the women were significantly more inclined to perceive faces in perfectly real object photographs, as shown in the preliminary face-likeness ratings assessment.

Furthermore, face-specific Vertex Positive Potential (VPP, 150–190 ms) showed a difference in the processing of faces-in-things between males and females at frontal sites; while for men VPP was of intermediate amplitude between faces and objects, for women there was no difference in VPP response to faces or faces-in-things, thus suggesting a marked anthropomorphization of objects in the latter group (Fig. 6.8). SwLORETA source reconstruction showed how in the female brain, face *pareidolia* was associated with the activation of brain areas involved in the affective processing of faces (right STS, BA22; posterior cingulate cortex, BA22; orbitofrontal cortex, BA10), which was not found in men. Normally the visual cortex separates face processing from object processing so that faces are automatically processed in ways that are inapplicable to objects (e.g., gaze detection, gender detection, and facial expression coding). However, the present data showed sexual dimorphism, with this dichotomy being much stricter in men than women because of an anthropomorphizing bias in the female brain.

## Empathy for Pain

Recent findings have demonstrated that women might be more responsive than men to the sight of painful stimuli (triggering a vicarious response to pain), and therefore more empathic (Han et al., 2008). We investigated whether the two sexes differed in their cerebral responses to affective pictures portraying humans in different positive or negative contexts compared to natural or urban scenarios (Proverbio et al., 2009). Four-hundred-forty IAPS slides were presented to 24 Italian students (12 women

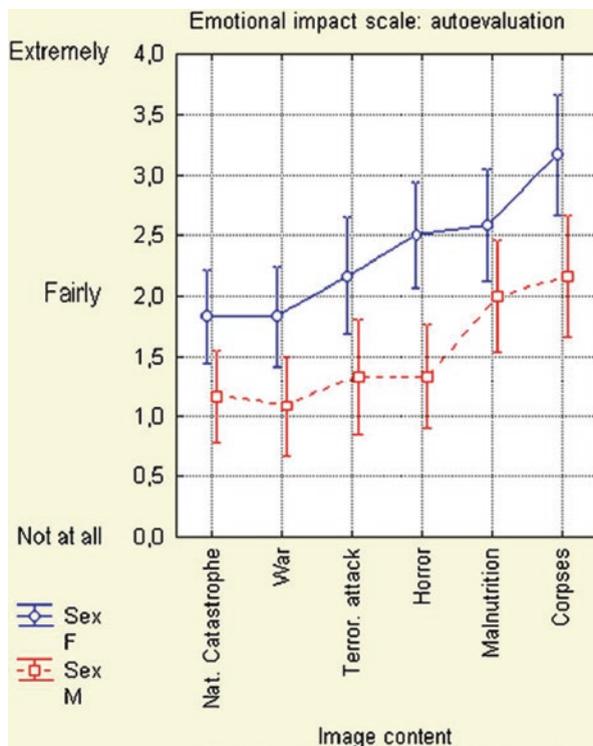


**Fig. 6.8** (Top) ERP waveforms recorded in women and men as a function of stimulus type. VPP was much larger to faces and faces-in-things than objects in women. (Bottom) Mean amplitude of the N170 response recorded as a function of stimulus type and relative scalp distribution

and 12 men). An emotional impact scale was administered to all participants prior to EEG recording, showing higher emotional psychological reactions in women than men to a variety of emotional stimuli (both animated and unanimated ones), as shown in Fig. 6.9.

Occipital P115 response of ERPs was greater in response to persons than to scenes and was affected by the emotional valence of the human pictures. A possible explanation for this piece of evidence is that the processing of biologically relevant stimuli was prioritized in both sexes. A late positivity to suffering humans (visible in Fig. 6.10, blue line) far exceeded the response to negative scenes in women but not in men. Increased right amygdala and right frontal area activities were observed only in women. These data possibly indicate a sex-related difference in the brain response to humans, possibly supporting human empathy.

Previous studies have demonstrated that females show greater responsiveness in various brain areas to generically negative pictures, but to date, none has investigated the specific role of the presence of humans in determining the brain emotional response in both sexes. For example, Hofer et al. (2007) found larger activation of the right superior temporal area, right insula, right putamen, and anterior cingulate cortices during the processing of positively valenced words versus non-words for

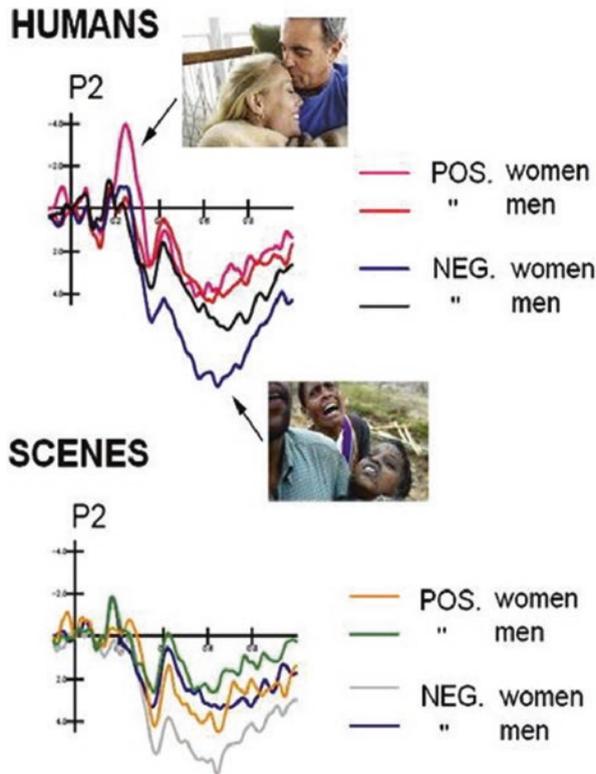


**Fig. 6.9** Data obtained from the emotional impact scale (self-reporting questionnaire) administered to the 24 persons participating in the ERP experiment, separately for each image type, and according to their sex. Key: 0 = not at all; 1 = a little; 2 = fairly; 3 = very much; 4 = extremely

women versus men and interpreted these data in terms of the greater emotionality of the female sex. On the other hand, Klein et al. (2003) found increased activation of the amygdala and ACC in women in response to negative IAPS images. In our study, sex differences as a function of the affective valence of pictures were much greater for humans than scenes, thus indicating the special status of the visual image of humans for the female brain, especially in interaction with affective information. Our data are consistent with the more recent literature suggesting that women are more empathic than men are when viewing suffering humans (Han et al., 2008; Schulte-Rüther et al., 2008; Singer et al., 2004).

## Sexual Hormones and Oxytocin

The literature has shown that social processes, and in particular, the neural response to opposite-sex faces, may vary as a function of hormonal phase of women. Furthermore, oral contraceptive pill use can affect cognition and alter resting state



**Fig. 6.10** ERPs recorded at right parietal sites as a function of stimulus content and valence and viewer's sex. A large effect of both emotional content of the stimulus is visible (evidenced by comparing ERPs to negative vs. positive unanimated scenes) and an effect of empathy for pain, especially in women (evidenced by comparing ERPs to negative scenes vs. ERPs to pictures portraying humans)

functional connectivity. Indeed, women using oral contraceptives have been shown to differ from non-pill users in memory, mental rotation, and affective memory tasks (Nielsen et al., 2011, 2014). In conclusion, the hormonal control, or lack of it, represents an important variable in determining the neurofunctional behavior of the female brain, and it should be monitored in studies on sex differences.

Several authors (Alexander & Hines, 2002) pointed out the genetic/biological nature of female preference for social stimuli. For example, evidences of toy preference in nonhuman primates (*Cercopithecus aethiops sabaues*) have been provided, with male vervets preferring to play with unanimated fast-moving toys (e.g., cars or balls) and female vervets preferring the contact with dolls. These data suggest that sexually differentiated interest for infants/dolls arose early in human evolution, prior to the emergence of a distinct hominid lineage. Comparative studies are quite relevant at this regard since monkeys are not subject to the cultural influences proposed to explain human sex differences in social cognition.

Furthermore, other findings support the hypothesis of biological, predetermined sex differences in social interest, not dependent on cultural conditioning, but linked to the genetic role of women as primary offspring caregivers. One of the most important pieces of evidence is the observation of an early interest for infants traceable in all human cultures and historical periods in young females. Remarkably, the same phenomenon has been observed in monkeys (juvenile baboons, macaques, and rhesus monkeys: Herman et al., 2003; Maestripieri and Roney, 2006) as reflected by a higher rate of interaction with infants in females than males. The interaction includes behaviors like embracing, holding, carrying, playing, grooming, touching, staying close to, and it is unaffected by hormone manipulations. According to Maestripieri and Pelka (2002), sex differences in interest in infants across the lifespan should be interpreted as a biological adaptation for parenting. Neuro-hormonal studies carried out in humans have shown that the early interest for infants may be modulated by hormonal factors. For example, Leveroni and Berenbaum (1998) reported that girls precociously exposed to high levels of androgens (because of congenital adrenal hyperplasia) displayed less interest in infants than their normal sisters. Consistently, it has been shown in primates that maternal hormonal changes influence social interaction with unrelated infants (Ramirez et al., 2004), making adult females more empathic and receptive. In this regard, oxytocin has been shown to affect the empathic attitude in humans, by increasing social trust, and even improving the ability to infer affective mental states of others (Domes et al., 2007).

## Conclusion

On the basis of a review of the relevant literature, it is concluded that many of the sex differences in social cognition may be related to the (biologically determined) role of females as primary offspring caregivers (as opposed to fighters/hunters, e.g., Kuhn and Stiner, 2006). This distinction may be associated with females' greater empathic attitude, ability to understand body language and facial expressions, attachment and responsivity to infants (Oxytocin-mediated), early interest for infants, interest for social information, emotional responsivity, lesser incidence of autistic, psychopathic and sociopathic disorders. In this way, this chapter provides a unified framework for understanding the multifaceted consequences of a sexual dimorphism in human parental behavior.

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