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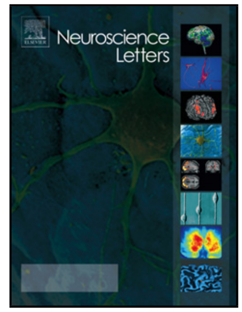

Title: First gender, then attractiveness: Indications of gender-specific attractiveness processing via ERP onsets

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Running head: Gender preceding face attractiveness

First gender, then attractiveness:
Indications of gender-specific attractiveness processing via ERP onsets

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Research Highlights

- Facial gender and attractiveness: Key features to study face processes
- Processing onsets estimated by LRP- and N200-effects
- Attractiveness follows gender in terms of underlying neural processes
- Early face attractiveness assessment seems to rely on gender-stereotypes
- Used paradigm is promising to further uncover the time course of face perception

Abstract (193 words)

We followed an ERP-based approach to gain knowledge on the dependence and temporal order of two essential processes of face perception: attractiveness and gender. By combining a dual-choice task with a go/nogo-paradigm focusing on the LRP and N200-effect, we could estimate the processing times and onsets of both types of face processing. The analyses of the LRP revealed that gender aspects were processed much earlier than attractiveness. Whereas gender was already analysed 243.9 ms post-stimulus onset, attractiveness came into play 58.6 ms later, i.e. after a post-stimulus onset delay of 302.5 ms. This resulting pattern was mirrored by the analyses of the N200-effect, an effect available mainly frontally which is supposed to correlate with the inhibition of inappropriate responses. Taking the onset of the N200 effect as an estimator for the moment at which information has been processed sufficiently for task decision, we could trace the N200 effect at 152.0 ms for go/nogo-decision on gender, while not as early as 206.7 ms on attractiveness. In sum, processing of facial attractiveness seems to be based on gender-specific aesthetic pre-processing, for instance via activating gender-specific attractiveness prototypes which show focused processing of certain facial aspects.

Keywords: face; attractiveness; gender; sex; EEG; ERP; microgenesis; LRP; N200; dual task; processing; time course

First gender, then attractiveness:

Indications of gender-specific attractiveness processing via ERP onsets

Introduction

Although it might be regarded as highly unfair from an ethical point of view, it is a common fact that facial attractiveness often is a door opener in everyday life. Starting quite innocently, “attractive babies” seem to “attract” more care and nurture [23]. Later on, attractive adults are perceived as more intelligent, more pro-social and even “better” romantic partners [14] and ultimately, physically attractive persons overall show a higher subjective well-being , e.g. satisfaction with life, global happiness and hedonic balance[12]. Facial attractiveness is operating as a “halo” [36], e.g., as the ultimate motive for finding a good mate, and has such an impact on the attitude and behavior of others that psychologists have long been attempting to reveal the processes underlying attractiveness judgments.

From cross-gender [e.g., 28], cross-group [e.g., 9] and cross-cultural [e.g., 4, 11, 13] research we know that assessing facial attractiveness is quite a universal process across individuals and cultures [3, 30]. This highly developed visual expertise is also very quick in its operation [57]: Judgments at presentation times of 100 ms have been shown to correlate with unlimited presentation with an R of .69. This is quite astonishing; particularly as the correlation of assessments under such restricted presentation times with assessments under unlimited presentation did not increase when the presentation time limit was massively extended by a factor of 10 (i.e., yielding a presentation time of 1,000 ms). Very similar results have been documented by Jander and Carbon [25] who could replicate a highly compatible correlation of attractiveness ratings for faces presented only for 100 ms with a presentation time of 3,000 ms: $R = .67$ ($k = 160$ stimuli; face stimuli were backward-masked by a random dotted pattern). Even a presentation time of only 14 ms resulted in mild correlation of $R = .42$ with that long presentation time of 3,000 ms in the very same study. Additional evidence on the speed of attractiveness processing comes from recent studies analysing event related potentials (ERPs). According to these studies attractiveness is processed very early, with first effects of attractiveness on ERP-components becoming evident from around 150 ms [34, 46]—it is important to note that "earliness" is defined and conceptualized very differently in the above studies: whereas behavioural studies focusing on presentation times strictly speaking refer to the minimal exposure times required for different face-related tasks (so having a kind of "first glance" processing in mind), ERP studies mostly refer to the duration of the related mental processes.

Research opinions differ on the extent to which attractiveness influences other aspects of face processing: While, e. g., according to Marzi and Viggiano [34] attractiveness modulates face processing at all stages, also affecting the highly face-relevant N170, Schacht et al. [46] claim that attractiveness processing is not mandatory. Rather, its effects may become obscured when people concentrate on another important task, such as gender classification.

Many researchers qualify facial attractiveness as an adaptive function used for sexual selection [19, 22]. Gangestad, Thornhill, and Yeo [21] argued that facial attractiveness predicts developmental success (via the criterion of stability) as it signals health status on the basis of genetic disposition. Thus, understanding the processing of facial attractiveness taps into very fundamental aspects of human co-existence and cognito-affective processing.

There are several streams of research proposing different predictors for facial attractiveness. Extensive meta-analyses and reviews on the different accounts are available but are not subject of deeper interest within the present study [32, 42]—just to briefly sum up, the major facial properties having an impact on facial attractiveness are: a) symmetry [but see 27, 35], b) averageness [but see 9, e.g., 31], c) skin "quality" [e.g., 16, 17], ,and d) sexual dimorphism (i.e., secondary sexual characteristics) [e.g., 40, 41]. Additionally, the visual perspective from which a facial depiction is assessed plays an eminent role [49, 50].

Most of the research in this realm indicates that all of these variables might have an influence on facial attractiveness, but their specific roles and their degree of relevance for specific attractiveness tasks has not been systematically investigated so far. The face literature also lacks important knowledge on the processing of facial attractiveness in particular and the microgenesis of face perception in general [e.g., 8, 57], beside theoretical processing stage models [e.g., 5, 15] and the above-cited first evidence from ERP studies [34, e.g., 46, see for an overview 52].

Besides the variable sexual dimorphism which is by definition tightly linked with gender assessment, all predictor variables mentioned above, except for symmetry (which might be called a pure perceptual property) seem to be at least indirectly dependent on the antecedent processing of gender: averageness and skin, as well as cues associated with personality attribution, seem all to be based on gender-specific norms and distributions [see extensive statistics on this issue 45]; thus, a reliable judgment of such qualities requires the successful identification and processing of the respective gender. In contrast to these findings, Bachmann [2] revealed that attractive faces can be discriminated from unattractive faces already with very coarsely pixelated images where gender cues as well as information on skin quality might not play a role at all or are fully absent.

The present study aimed to shed light on the very early processing of facial attractiveness, particularly to gain knowledge on the timing of attractiveness and gender processing. For the sake of this research question, we employed a paradigm that is based on event-related potentials (ERPs). It has repeatedly been used in processing studies in the field of psycholinguistics [47, 55] and also more recently in empirical aesthetics [1]. The paradigm employs Lateralised Readiness Potentials (LRPs). LRPs are derived from the *Bereitschaftspotential* (readiness potential), brain responses that have been shown to correlate with voluntary movements of the (opposite) hand [26, 29]. LRPs represent the lateralized aspect of the readiness potential. They correlate with voluntary motor actions of a specific hand and thus allow to measure not only general but task-specific correlates of motor preparation [39]. Importantly, such LRPs cannot only be recorded during an actual hand movement, but also when the movement is prepared but not executed [39]. This characteristic of LRPs makes them an ideal tool to track the temporal relations of different processes. This can be achieved by combining two tasks: a dual choice task (where the person has to respond with either the right or the left hand) and a go/nogo task (where he or she is allowed to react or not). If LRPs can be seen even in nogo trials, one can assume that the information determining the hand movement is being processed earlier than the information determining go or nogo — since the person obviously already prepared a hand movement even though she was not supposed to react [39, 55].

Another important source of information regarding temporal aspects of processing is the so-called “N200-effect” — employed, e.g., by Thorpe, et al. [54] to examine the visual processing of natural scenes. The name N200 refers to the second negative peak in an ERP waveform [20]. This peak has been shown to be especially pronounced in conditions where participants withhold a response (nogo trials) as compared to go-trials [e.g., 20]. Subtracting activation in go-trials from that in nogo trials yields the N200-effect [e.g., 47], which has been discussed as a correlate of response inhibition [e.g., 54]. The onset of this effect has repeatedly been used as an indicator of processing time [1, 47, 54] — following the logic that in order to voluntarily inhibit a response, a person must have processed the response-relevant information to a sufficient amount. Combining the N200-effect and LRPs in one study allows to both derive estimates of processing times for two variables and to directly investigate their time course, i.e., independently from processing times themselves.

Following this line of argument, we explored the time course of the two main interesting variables for the respective research question: 1) attractiveness and 2) gender, both processed on the basis of mere presentation of frontal 2D faces. Our rationale was as follows: If gender is processed earlier than attractiveness, one cannot exclude the possibility that sexual markers are already taken into account early in the processing of attractiveness. In other words, attractiveness assessment at a very early stage is highly probably gender-specific. If, however, gender is processed later than attractiveness, we can logically exclude sexual dimorphism as playing an important role in "first glance" attractiveness, in contrast, factors such as symmetry or skin quality (e.g., skin homogeneity) might be predominantly effective.

Method

Participants

Twenty-five undergraduate students of psychology (11 male; M_{age} = 20.3 years, SD_{age} = 2.9, range 20-31) participated in this study for course credit. All except one participant were right-handed, as assured by the *Edinburgh Handedness Inventory* [37] and had normal or corrected-to-normal vision, as tested by the *Snellen Eye chart test.* Normal colour vision was shown by fully correct responses in a short self-fabricated version of the *Ishihara Colour test*.

Apparatus

Stimuli were presented with the experimental control software *Presentation* (Neurobehavioral Systems), version 10.3, running on a Microsoft Windows-PC; EEG data were recorded with the software *Portilab2* (TMS International), optimised for the EEG equipment we used. Participants could respond via a Logitech Precision USB Gamepad, while sitting at a distance of about 70 cm from a 19-inch CRT display Ilyama Vision Master Pro 454 at the native resolution of 1280 × 1024 pixels and a refresh rate of 60 Hz. We assessed data with a modular elastic cap (Easy Cap, Falk-Minow Systems, Germany) from five electrodes according to the International 10-20 system: *Fz*, *Cz*, *Pz*, *C3* and *C4* [see 1, 47, 48] which were recorded referentially against linked mastoids (as common reference); position *AFz* served as ground. Additionally, EOG was recorded bipolarly from the outer canthus of each eye as well as from above and below the right eye, respectively. We recorded the signals via a 32-channel EEG amplifier (Refa 32) by *TMS International,* using an online 0.01–40 Hz bandpass filter and a sample rate of 512 Hz. Impedances for scalp electrodes were kept below 5 kΩ. Reaction times were measured starting with picture onset. In line with Augustin and colleagues [1] continuous EEG data was segmented from 100 ms pre-stimulus onset to 1,000 ms post-stimulus, using the 100 ms pre-stimulus interval for baseline correction. All data were low-pass filtered at 30 Hz and segments corresponding to incorrect responses were removed from further analyses. The remaining data were visually inspected and trials with eye- or muscle artefacts eliminated on that basis. These two steps (elimination of incorrect and artefact-contaminated trials) preserved 90.19% (*SD* = 5.24) of the data.

Stimuli

The stimulus material consisted of 100 photographs (50 portraits of men and 50 of women) with a size of 346 × 550 pixels. Faces were retrieved from the extended DADA Faces Database established by the first author [6, 7]. The 50 male faces and the 50 female faces consisted of 25 attractive and 25 unattractive faces, as assured by a pre-study (see sub-section Pre-Study 1 and Pre-Study 2 for the stimulus material; below). Twenty additional faces (5 attractive and 5 unattractive for each gender) were used for practice trials. Both within the test picture sample and within the practice pictures attractiveness and gender were fully crossed.

Pre-study 1: Attractiveness ratings of stimuli

Aim of Pre-Study 1 was to select 100 stimuli (50 female, 50 male) from a larger face database clearly differing in respect of attractiveness. Ten participants (4 men and 6 women with an age range of 19-30 years) judged 141 photographs (70 portraits of men and 71 of women). Participants rated the portraits on attractiveness on a 7-point Likert scale (1 = *very unattractive*, 7 = *very attractive*) and estimated the age of each depicted person. According to these ratings "attractive" and "unattractive" faces were chosen on a relative basis — simply by using means and standard deviations of ratings: the distance of means for "attractive" vs. "unattractive" faces was maximized while faces where *SD* was minimal were preferred in order to obtain ratings as consistent as possible. Furthermore, the sets of "attractive" and "unattractive" faces were kept parallel with respect to their estimated age. The 50 face stimuli chosen as attractive received scores of $M= 5.07$ ($SD= 1.01$) for female and $M= 4.98$ ($SD= 1.36$) for male faces. The 50 face stimuli chosen as unattractive obtained mean attractiveness scores of $M= 1.87$ ($SD= 0.87$) for female and $M= 1.76$ ($SD= 0.74$) for male faces.

Pre-study 2: Reaction times for attractiveness ratings

Aim of Pre-Study 2 was to further validate the stimuli selected by Pre-Study 1 regarding response times to compare them with ERP onsets as indicators of the timing of processes. Twenty-four subjects (4 men and 20 women with a mean age of 21.7 years and a range of 19-29 years) participated in this pre-study. They performed a dual choice task with the 100 face stimuli chosen in Pre-study 1 and either had to categorise the stimuli on the basis of attractiveness (attractive or unattractive) or on the basis of gender (male or female). The order of the categorisation blocks "attractiveness" and "gender" was balanced across participants. Data with a ±3 *SD*s in RTs as well as false responses were excluded from further analyses. Results showed mean reaction times (RTs) of $M = 950$ ms ($SD = 88$ ms) for "attractive" faces and $M = 877$ ms ($SD = 101$ ms) for "unattractive" faces. RTs for the gender decision task were at $M = 726$ ms ($SD = 87$ ms) for female faces and at $M = 698$ ms ($SD = 69$ ms) for male faces. Mean RTs for attractiveness were 914 ms ($SD = 52$ms) and 712 ms ($SD = 59$ ms) for gender. *T*-tests resulted in significant differences in RTs for attractiveness task comparing male and female faces, $t(49) = 3.3$, $p = .002$, $d = 0.51$, and when comparing attractiveness and gender task, $t(49) = 20.0$, $p < .001$, $d = 3.63$, as well as a trend for gender task comparing female and male faces, $t(49) = 1.9$, $p = .062$, $d = 0.36$.

Procedure

The procedure comprised two phases: pre-testing and the EEG-experiment. After reading and signing the written consent form, the participants were pre-tested for handedness via the *Edinburgh Handedness Inventory* and for their vision abilities via the standard *Snellen Test*. The EEG-experiment included the aforementioned experimental design, which consisted of eight different blocks (2 [dimensions determining the go/nogo condition] × 2 [level signalling "Go"] × 2 [condition left or right hand]), see Figure 1.

[insert Figure 1 about here]

The order of these blocks was pseudo-randomised per participant, resulting in a different order of blocks for each participant. The blocks were separated by self-paced breaks. Each block started with a written instruction, which was followed by a visual illustration of the task. The latter included a picture of the gamepad with signs representing the go- and the nogo-conditions of the specific block and the meaning of the two buttons of the gamepad illustrated. Afterwards, the 20 practice pictures were presented in random order, followed immediately by the 100 test pictures, also in random order. The practice trials were not explicitly introduced as such and were excluded from analysis later on. Each trial started with a fixation cross, which appeared in the middle of the screen for 150 ms, followed by a blank screen for a randomised interval of 250–350 ms length. Then the stimulus appeared for 2,000 ms [cf. 1], followed by a screen indicating allowances for eye blinks. Figure 2 illustrates the time course of an experimental trial. As described in the introduction, the participants' task always required a combined reaction to the face's gender and its attractiveness, with the exact role of the two variables depending on condition/block. The variable relevant for the Dual Choice decision determined with which hand to respond (button press on gamepad), while the variable relevant for go/nogo signalled whether to respond at all or not. Participants were asked to give their answer as fast as possible. Every participant spent about 2.0 to 2.5 hours in the lab (mounting of electrodes, calibrations and experiment), with the EEG-experiment itself taking about 2–2.5 hours.

[insert Figure 2 about here]

Written consent was obtained from each participant prior to the experimental session. After the experiment had ended participants were fully informed about the study and allowed to ask questions. Persons who did not consent were not included in the study—but this did not happen in the course of the study. All data was collected anonymously and no harming procedures were used. The Ethics committee of the University of Bamberg confirms that "for projects such as these, no approval by the Ethics committee is required according to our national standards" (Bamberg, November 23, 2014, signed by the chairman of the Ethics committee).

Results

Behavioral results

The mean RT for correct go responses was 1,007 ms (*SD* = 384 ms), with 993 ms (*SD* = 360 ms) in the *hand = gender* conditions and 1,022 ms (*SD* = 413 ms) in the *hand = attractiveness* conditions. The two response conditions did not differ significantly in response time, $t(24) = 1.59$, $p = .124$, *n.s*. The same was true with respect to percentage correct rates: mean percentage correct was 91.3 % (*SD* = 6.4 %), with 91.5 % (*SD* = 8.3 %) in the *hand = gender* conditions, and 91.1 % (*SD* = 7.8 %) in the *hand = attractiveness* conditions, $t(24) = 0.20$, $p = .846$, *n.s*.

LRP results

We calculated the LRP response from the mean amplitude relative to the pre-stimulus baseline of the electrodes *C3* and *C4* with the formula $(C3\text{-}C4)_{\text{right hand}} - (C3\text{-}C4)_{\text{left hand}}$ [56]. Four LRPs were calculated across participants: (1) *hand = gender*, *go = attractiveness*, (2) *hand = gender*, *nogo = attractiveness*, (3) *hand = attractiveness*, *go = gender* and (4) *hand = attractiveness*, *nogo = gender*, with 200 (2 × 100) trials entering into each average. Prior to the analyses of the LRP response, the response of LRP within both go-conditions was inspected visually on an individual basis. Seven participants were excluded from further analyses of the LRP, since they did not show a general go-LRP.

To test which of the two characteristics in question, attractiveness or gender, is processed faster we conducted one-tailed serial *t*-tests against zero in the time window 200–500 ms after stimulus onset, with a step size of 1.95 ms and a moving average window size of 39.08 ms (approx. ±20 ms around each time point; this was done to exclude temporary amplitudinal artefacts). We defined onset latency as the point from which eight consecutive *t*-tests' *p*-values were all below the significance level of 0.05 [see 1]. We found a significant nogo LRP for the condition *hand = gender* between 347.4 ms and 429.5 ms after stimulus onset (see Figure 3, note: given accuracy is beyond accuracy of measurement due to averaging), but no nogo-LRP for the condition *hand = attractiveness*. A direct comparison of the mean amplitudes of the nogo-conditions by a paired *t*-test between 200 and 500 ms post-stimulus also revealed a significant difference, $t(16) = 2.26$, $p = .0365$, $d = .518$. For the go LRPs the onset latencies were 236.1 ms for *hand = gender* and 253.6 ms for *hand = attractiveness*, respectively.

To derive an estimation of the time interval for which gender-related, but no attractiveness-related information was available, we applied van Turennout et al.’s [55] idea of comparing the go- and the nogo-LRPs for the condition where attractiveness determined the go/nogo-decision (*hand = gender*). Van Turennout et al.’s idea was that go- and nogo-LRPs should develop in a similar way, until the later processed information (here: the information on attractiveness) comes in for nogo-trials. Consequently, we compared both LRPs within the time window 200-500 ms after stimulus onset by one-tailed serial *t*-tests, again employing a moving time window of approx. ±20 ms. Significant differences emerged from 302.5 ms stimulus onset on. As the respective start of differences between go- and nogo-LRPs for condition *hand = attractiveness* in the given design lay 243.9 ms, the time interval in which gender-related (but not attractiveness-related) information was available was 58.6 ms. Figure 3 shows the averaged go- and nogo-LRP for the condition *hand = gender*.

[insert Figure 3 about here]

N200 results

The N200 (N2) effect was tested by analysing the *Fz*, *Cz* and *Pz*, with the main focus on *Fz*, as the N200 for phenomena of cognitive control is mostly localised at frontal brain areas [see 20]. For both response conditions, *hand = gender* and *hand = attractiveness*, we calculated the grand average ERPs — corrected in relation to pre-stimulus baseline (see details above) — for the go- and the nogo- trials separately. Additionally, we calculated the difference curves of nogo- minus go-trials. In Figure 4, the grand average ERPs plus the respective difference curves are shown for all response conditions and electrode sites.

[insert Figure 4 about here]

We traced the onset of the N200-effect for each grand average ERP by analysing the amplitudes via serial *t*-tests against zero from 100 ms post-stimulus onwards. In parallel to the LRP analyses we used moving time windows of approx. ±20 ms. Significant deviations from zero were only then qualified as the onset of the N200 effect, if 8 consecutive *t*-tests were significant [i.e., $p < .05$, cf. 54]. For the condition *hand = gender* (i.e., when a reaction to *attractiveness* had to be held back), the onset of the N200 effect was detected at *Fz* from 152.0 ms onwards, whereas the onset for the *hand = attractiveness* (i.e., when a reaction to *gender* had to be held back) did not occur before 206.7 ms. The respective onsets for *Cz* and *Pz* for the condition *hand = gender* lay at 179.4 ms and 195.0 ms respectively, while for the condition *hand = attractiveness* they were found to be 197.0 ms and 208.7 ms, respectively.

Discussion

The aim of the present study was to shed light on the very early processing of facial attractiveness, specifically whether the assessment of gender is processed before attractiveness. This was done by employing a paradigm that has frequently been used to test neural time courses in the field of psycholinguistics [48, 55, 58] and also recently in the field of empirical aesthetics [1]. By combining a dual choice task with a go/nogo paradigm and focusing on the LRP and N200 effect, one can estimate processing times and onsets of specific processes [see 54] independently of motor execution timing—and thus much more precise than through simple reaction times in traditional behavioural experiments.

The analyses of the LRP suggests that gender processing starts earlier than the assessment of attractiveness. This indicates that gender information is at least available for such very early and preliminary attractiveness assessments—so potentially even such early attractiveness judgements already take gender aspects into account. In fact, male and female faces show very different morphological outward appearances [18, 24], so specific attractiveness norms might be triggered by precedent gender processing. For instance, whereas feminine faces show cheekbone prominence, male faces benefit from jaw and mouth width [22]. Red lip colour is specifically attractive in women [53], which is inter-culturally documented—it also let a face appear more female [43, 44]. Also, fine skin structure is strongly appreciated in women's faces [17], but does not seemingly have such an indicative value for men's attractiveness. It seems very clear that in everyday life we base many attractiveness assessments on sexual dimorphic properties, i.e. we evaluate aspects of attractiveness on specific sexual prototypes.

Certainly, with the present methodology we can only make statements on the onset and temporal relation of processing, but not on any causal relations. Nevertheless, our results show that gender information is at least available for very early attractiveness ratings – be it used or not. This also does not preclude that early attractiveness assessment is also, at least partly, based on gender-independent properties which might be called "direct visual properties" [see 5]: among them symmetry or skin quality in a very general sense. For example, skin homogeneity might be an important factor, recently demonstrated by a high impact of skin homogeneity on attractiveness for African female faces [10]. Although it seems quite implausible that the full range of attractiveness is just based on such rudimentary qualities, they may yet play an important role in early attractiveness processing, also given that their judgment does not require any norms or exemplars. This may be particularly relevant for all stimuli with which the beholder is not very familiar. Although we are obviously not able to assess some properties, e.g., the weight or height, from faces originated from other cultures [51], we are indeed quite good in reliably assessing the attractiveness of such faces — and, most importantly, our evaluations converge very much with the that of local inhabitants [3, 30]. In line with these findings, Carbon et al. [9] showed that people who have severe deficits in face recognition from birth onwards, people with so called congenital prosopagnosia, can still perfectly assess facial attractiveness although they lack the recognition faculties as well as the ability to judge how distinctive these faces are. These results demonstrate that typical findings on attractiveness evaluations proposing fast, reliable and even universal processing might actually be based on very perceptual and not evidently on expertise-based processing.

In addition to generally showing gender to be processed faster than attractiveness, the specific neural timing technique employed here allowed us to estimate the onset of gender- vs. attractiveness-related processing. Employing the LRP effect, which refers to the question of when information is used to prepare motor (re-)actions, we revealed that gender aspects were already analysed by approximately 244 ms post-stimulus onset, attractiveness came into play approximately 59 ms later, i.e. after a post-stimulus onset delay of about 303 ms. With one word: gender-related aspects had already been processed about 1/20 s before attractiveness was started to be processed. This pattern was mirrored by the N200 analyses, which refers to an effect that is available mainly frontally [20] and that correlates with the inhibition of inappropriate responses [e.g., 54]. As it is assumed that successful inhibition inevitably requires the sufficient processing of information relevant for the inhibitory decision, Schmitt et al. [47] proposed to take the onset of the N200 effect as an estimator for the moment at which the respective information is processed sufficiently for task decision. In the present study, we could trace the N200 effect at 152.0 ms for go/nogo decision on gender, while not before 206.7 ms for attractiveness. It is important to note that the result of gender-processing being faster than attractiveness-processing was reflected neither in the behavioural results (i. e., response times) of the pre-study nor of the EEG experiment. This is in line with other studies employing the same paradigm [e.g., 1] and further illustrates the paradigm's strength mentioned above — namely to allow to study "pure" processing times, irrespective of motor execution. In addition, it is further evidence that "behavioural measures alone might not always be sufficient to unravel the details of the time course of processing" [1, p. 2077].

The resulting pattern of attractiveness information being processed later than gender information was consistently found across both measures used here — the LRP and the N200 effect. Nevertheless, results certainly have to be judged within the limits of the paradigms used. First of all, all numbers on time points and delays remain, despite their numerical precision, only rough estimates of the underlying processes. Like in other research domains, measurement techniques in neuroscience rely on indirect effects. With regard to LRP, we can only assess activations related to motor preparation. Still, motor preparation requires that the respective decision has been made, and thus we would regard the LRP as a measure of relatively "progressed" processing. Furthermore, the number of used electrodes was optimised in accord with the literature, but was still very limited. Additionally, we would like to stress that the revealed results are based on 2D-images of static and frontally depicted persons with neutral expression, and a task where speed of reaction was an important factor. The attractiveness categorisation asked for in that task was indeed very simple in its response format and accordingly simple regarding the degree of the elaboration of the underlying processes: "is the shown face attractive or not?" It is obvious that such a kind of processing is not comparable with any kind of more elaborated, deeply appraising and socially balancing assessment of attractiveness which we might ask for, or indeed use, in typical socially sensitive contexts—therefore, we have termed this kind of assessment “early, preliminary attractiveness assessments” within the text.

Notwithstanding these limitations, we can straightforwardly infer that facial attractiveness at (very first) glance is processed after gender processing has already been started. This might indicate that attractiveness assessment already refers to gender-specific or gender-relevant attractiveness cues. It was multiply shown that attractiveness is processed very early [33]—early, but still late enough to be potentially influenced by preceding information on gender aspects. As we already know from the literature that attractiveness factors are very hard to ignore [38] and because attractiveness has such an extensive impact on further affective and cognitive processing [14], our study would like to initiate more research on the neural timing of face processing. Here it might be especially interesting to ask: which information besides gender might potentially modulate or bias fast and preliminary attractiveness assessments?

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Figure captions

Figure 1. Illustration of the response logic for an experimental trial with gender as the go/nogo decision (go: “female” vs. nogo: “male”), where the specific hand indicates attractiveness (left hand: “attractive” vs. right hand = “unattractive”). Note: For privacy reasons, the faces were schematized in this figure (actually, we generated a generic facial outline on basis of many faces morphed together) to prevent individuation, objectivation and humiliation of the depicted persons—this was only done for this publication, not for the original study where high resolution, high quality pictures with full coverage of texture were employed (a high level of attractiveness is indicated by 5 stars, a low level by 1 star following the commonly used rating systems). The typical facial quality can be retrieved from the exemplary picture in the scheme of the time course illustrated by Figure 2.

Figure 2. Time course of an experimental trial within the EEG experiment.

Figure 3: (a) Grand average LRPs (n = 18) in the two dual choice conditions, *hand = gender* and *hand = attractiveness* for go- and nogo trials, respectively. LRPs were calculated from the mean amplitude relative to pre stimulus baseline at positions C3 and C4. X-axes represent the time (in ms) relative to picture onset; y-axes inversely plot activation in μV. The dashed line above the nogo LRPs in the bottom (nogo) diagram indicates the period within the first 500 ms for which the nogo LRP in the condition *hand = gender* diverges from the baseline. (b) Grand averages from graphs of the previous diagram exclusively comparing go- versus nogo LRPs for the condition *hand = gender*. The dashed horizontal line in the graph indicates the period during which the two LRPs differ significantly from each other.

Figure 4: Grand average ERPs (*n* = 25) for go and nogo trials for the two dual choice conditions (a) *hand = gender*, go/nogo = *attractiveness* and (b) *hand = attractiveness, go/nogo = gender* at the three electrode sites *Fz*, *Cz* and *Pz*. Column (c) illustrates the results regarding the N200 effect: Each graph plots the difference waves nogo–go for the two dual choice conditions. The x-axes represent the time (in ms) relative to picture onset; the y-axes inversely plot activation in μV.

Figure 1

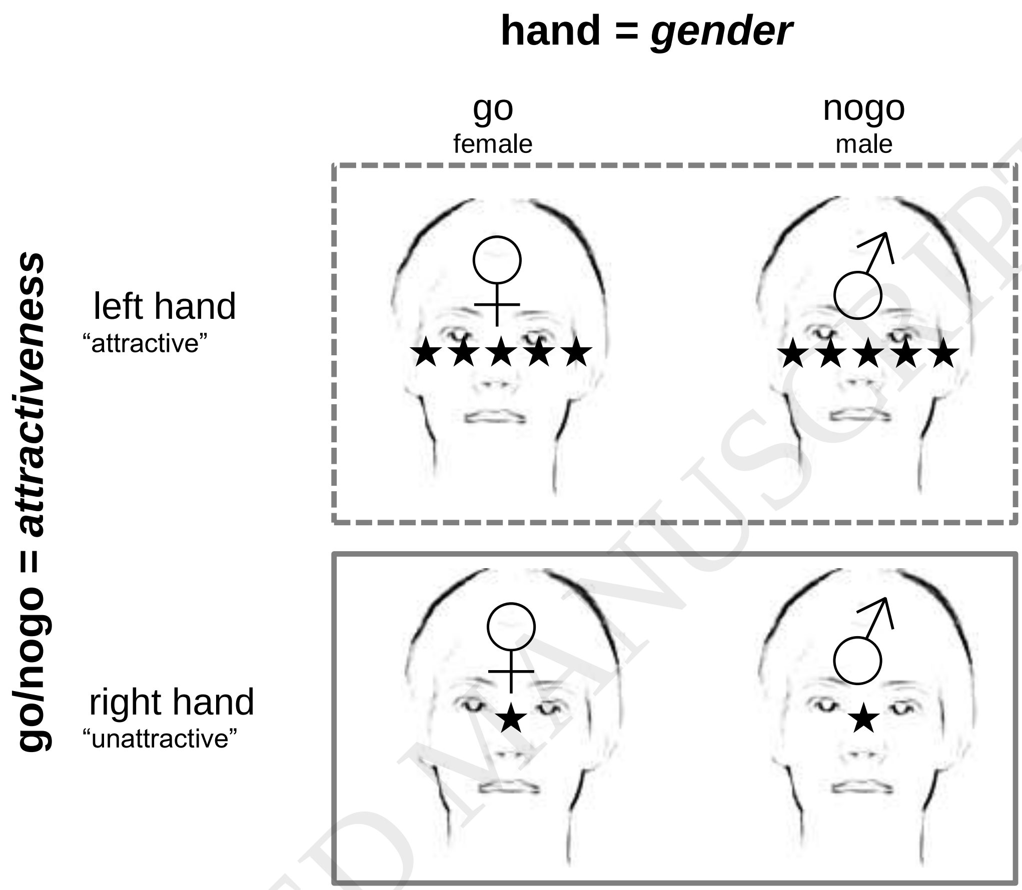

hand = gender
go
female
nogo
male
go/nogo = attractiveness
left hand
“attractive”
right hand
“unattractive”

Figure 2

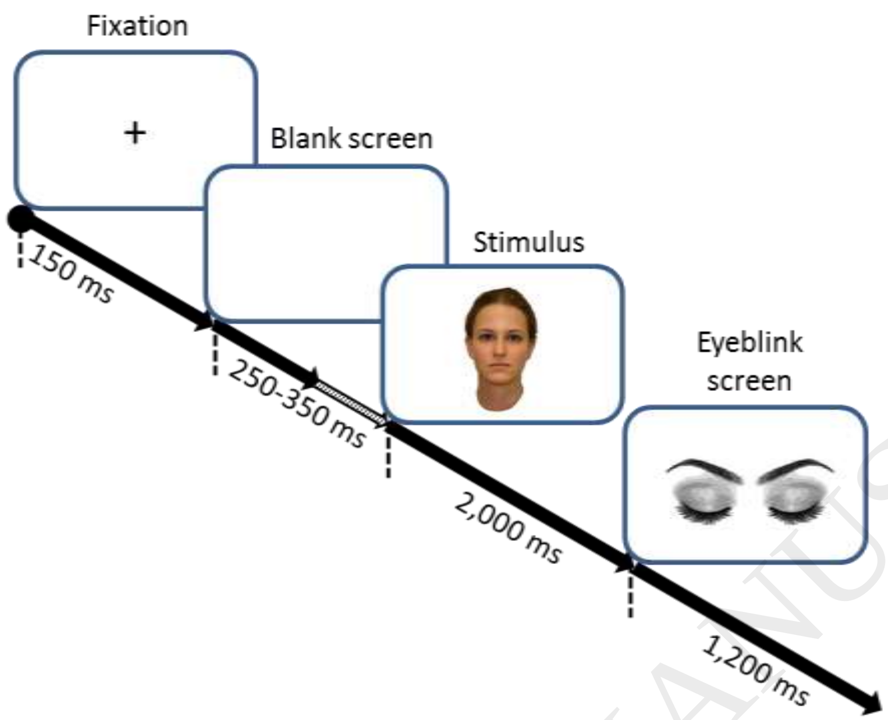

Fixation
+
Blank screen
Stimulus
Eyeblink
screen
150 ms
250-350 ms
2,000 ms
1,200 ms

Figure 3

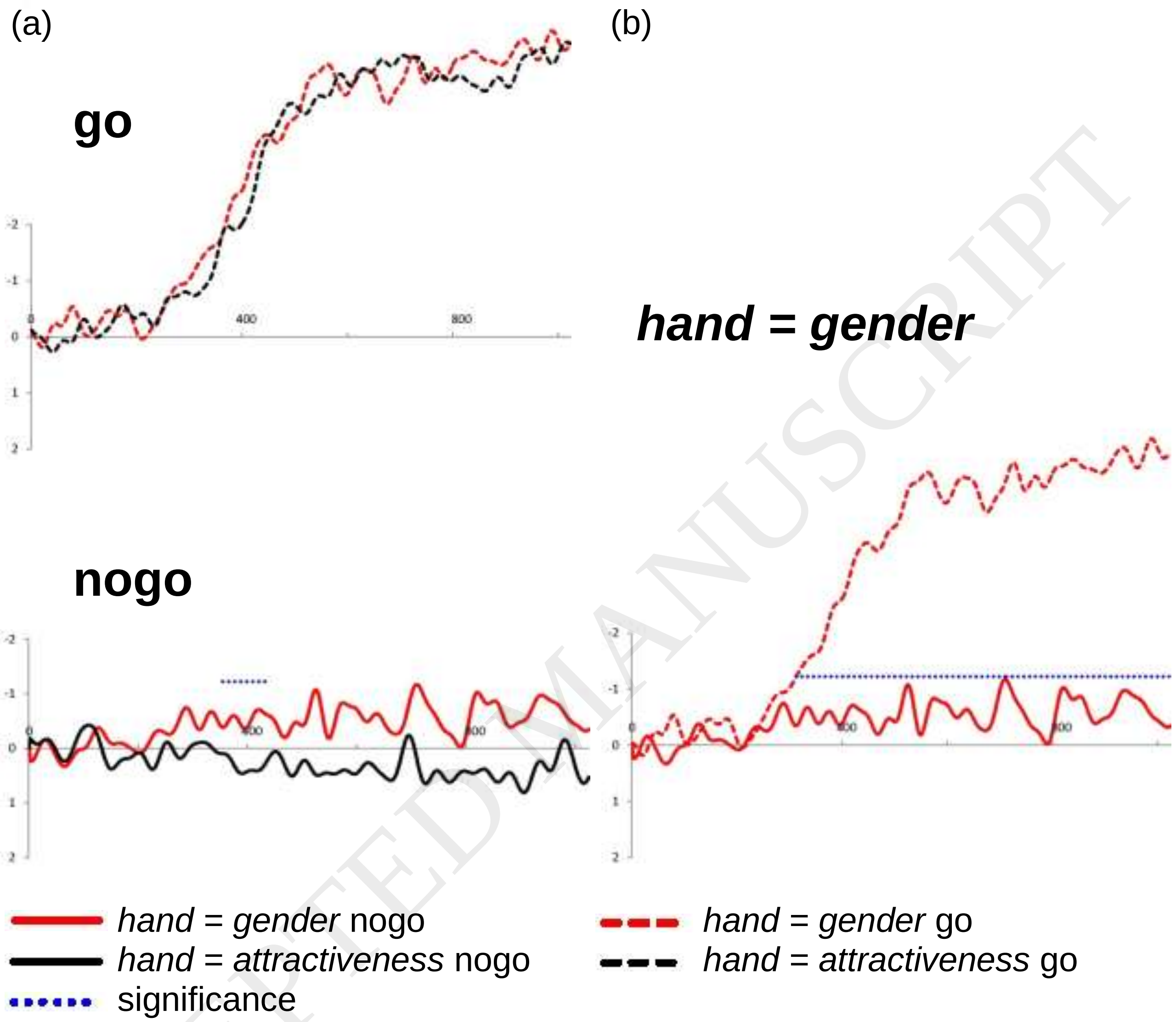
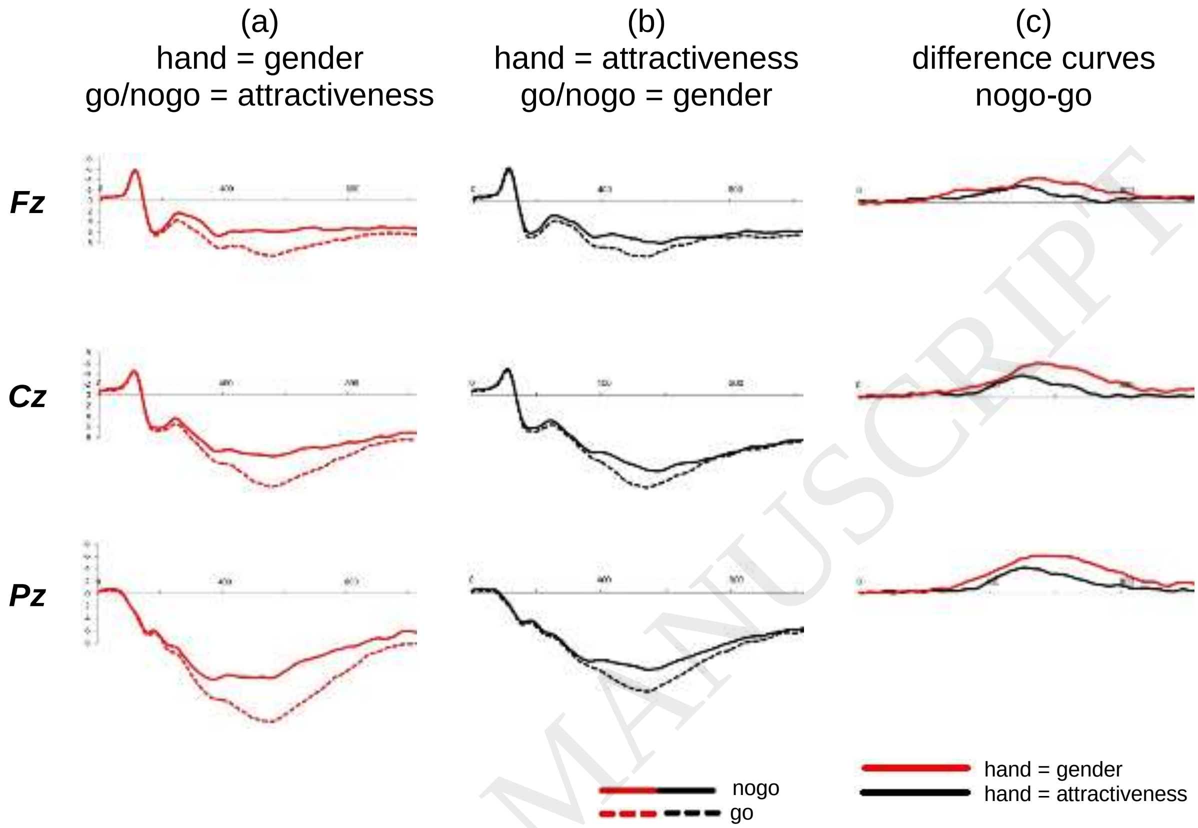

(a)
(b)
go
nogo
hand = gender
-2
-1
0
1
2
400
800
hand = gender nogo
hand = attractiveness nogo
significance
hand = gender go
hand = attractiveness go

Figure 4


(a)
hand = gender
go/nogo = attractiveness
(b)
hand = attractiveness
go/nogo = gender
(c)
difference curves
nogo-go
Fz
Cz
Pz
nogo
go
hand = gender
hand = attractiveness