EXPLICIT CATEGORIZATION IN THE FACE OF AMBIGUITY

An ERP Study of Sexually Ambiguous Face Processing

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Abstract

The purpose of this study is to determine if and how sexually ambiguous faces are categorized differently than unambiguously male and female faces. The P3 event-related potential (ERP) component, a long, slow, positive-going wave, was quantified during an explicit categorization oddball task. Specifically examining the task-relevant P3b, we found both unambiguous faces and ambiguous faces elicited the P3 oddball response. A significantly larger mean amplitude and fractional area latency was observed for both unambiguous and ambiguous oddball faces compared to unambiguous context faces. There was no significant difference between unambiguous and ambiguous oddball responses. Reaction times for ambiguous oddball faces were significantly slower than both the unambiguous oddball and context faces. A significant difference was not found between ambiguous and unambiguous oddballs for P3 mean amplitude and fractional area latency. This may be attributed to immediate "other" categorization followed by conscious categorization, or real, undetected effects. Secondary analysis was conducted with the ambiguous oddball in a male context separated from ambiguous oddball in a female context. Remaining feminine attributes of ambiguous faces likely attenuated P3 amplitude and latency difference in the female compared to male context. These results support our hypothesis that ambiguous faces are processed differently than unambiguous faces.

Gender perception influences basic human interactions. Processing face gender has been shown to be an efficient and fast cognitive process that is developed early in life (Cellerino, Borghetti, & Sartucci, 2004). Previous research has found that working memory processes are sensitive to the explicit categorization of both race and gender, suggesting that psychological and neural mechanisms of categorization underlie this basic human behavior and that encoding is relatively automatic (Azizian, Freitas, Watson, & Squires, 2006; Ito & Urland, 2003; Baudouin & Tiberghien, 2002; Reddy, Wilken, & Koch, 2004). In the absence of gender-ambiguous faces, previous studies have concluded that adult subjects are able to correctly classify faces into male or female categories with 100% accuracy (Wild et al., 2000). Furthermore, even in the absence of social gender cues such as hairstyle, make-up, accessories, etc., gender classification is still accurate in almost all cases among adult subjects (Cellerino et al., 2004). To categorize faces based on gender, participants must rely on previously encoded information that distinguish male and female faces such as facial structure and texture. Previous studies have explored the relationship between cognitive responses and male and female gender categorization. However, cognitive responses to gender-ambiguous faces have not been investigated, thus, are not widely understood.

The purpose of the current work is to determine whether the categorization of gender ambiguous faces requires more cognitive processing and elicits a resulting increased latency in gender categorization compared to unambiguous stimuli. We focus on analyzing the P3 ERP component associated with working-memory operations. Characterized in terms of amplitude, latency and scalp location, the P3 is sensitive to task-relevant categorization decisions (Azizian et al., 2006; Ito & Urland, 2003). Consequently, the P3 amplitude increases in response to less frequent, target stimuli, in a task-relevant fashion (Ito & Urland, 2003). Furthermore, when an increased P3 is observed, it is generally maximal in parietal electrode sites (Duncan-Johnson & Donchin, 1977). In a classical oddball paradigm, Kutas et al. was one of the first to observe a P3 effect in an explicit categorization task. In this study subjects were instructed to count infrequent female names intermixed in a male-name dominated context. Kutas et al. observed a larger P3 component and increased latency for less frequent female names, in a male context (Kutas, McCarthy, & Donchin, 1977). The work done by Kutas et al., and subsequent studies, support interpreting the P3 as reflecting the neurophysiological mechanisms for categorical processing (Azizian et al., 2006). Of particular relevance to our investigation, is a study on the electrocortical measures of attention to the race and gender of multiple categorizable individuals, in which Ito et. al observed a significantly larger P3 elicited by target faces that differed from the context, gender, or race. Thus, the P3 indexes updates to an explicit mental model held in working-memory (Ito & Urland, 2003).

The purpose of this study was to address whether gender-ambiguous faces are categorized differently than unambiguous male and female faces; thus, requiring extra cognitive processing when presented in a classical oddball paradigm. In order to address this question we designed an oddball paradigm in which subjects were presented with target ambiguous faces in two separate contexts: 1) male context - frequent male faces and infrequent ambiguous faces; 2) female context - frequent female faces and infrequent ambiguous faces. We also included a male/female gendered oddball in which unambiguous female faces occurred infrequently in a male context or unambiguous male faces occurred infrequently in a female context. Given the reliability and reproducibility of the P3 in the oddball paradigm, we indexed this component in our investigation. We hypothesized that there would be relative latency and amplitude increases in the P3 component for the explicit categorization of ambiguous faces compared to the P3 in response to gendered context or gendered oddball faces. We also predicted that ambiguous faces would produce P3 like increases in amplitude, reflective of the extra cognition to process their categorization, with a pronounced effect over parietal areas, specifically the Pz electrode site, and others in that region. We anticipated behavior measures with reaction time (RT) would reflect the changes in P3 latency. Since the P3b component is task specific, the observed P3 would likely be the P3b (2003). Evidence supports that in response to the explicit categorization of stimulus, processing of such stimulus events produces P3b activity related to context-updating operations and subsequent memory storage (Polich 2007). The P3b component is active when participants are asked to perform a task with oddballs whereas the P3a component is active when the oddball is not relevant to a task (Luck 2012).

Methods

Participants

Nineteen right-handed college students and a single professor participated in the experiment. All subjects gave informed consent. Of the 20 subjects analyzed, seven were male and 13 were female, ranging in age from 20 to 34 years old (mean 21.6 years) and in good health at the time of testing, though one subject had received a head injury in the last five years. Three of the four authors of this piece participated in the study as well. Furthermore, all of the participants had a basic understanding of the experimental design and predicted results, as they were presented by the authors before testing. Lastly, several participants, including the authors, helped create some of the sexually ambiguous pictures.

Stimuli

We used the color FERET database containing colored neutral frontal view male and female faces as the source of the images for presentation as visual stimuli. Forty unfamiliar male faces and 40 unfamiliar female faces were selected and used from the database. Another 32 images (half male and half female) were selected from the same database and made “ambiguous” using the face merging/morphing software Java Psychomorph, such that male faces were feminized and female faces masculinized to the point where a face no longer clearly could be considered male or female (Tiddeman, 2011). Gender-ambiguous images were created by individual researchers and presented independently to each of the other three researchers conducting the study. Upon an unanimous agreement that the candidate image was gender-ambiguous, the image was selected for inclusion in the pool of ambiguous images. All images were color corrected so that they all had the same white balance. Images were cropped using an oval to only show the face, removing the neck, background, and most hair. Images were displayed on a computer monitor with a white background (see Figure 1). All of the faces chosen were racially homogenous to avoid any oddball effects of racial rather than sexual categorization.

Procedure

The experiment included four blocks, two experimental blocks and two control blocks. There were a total of 240 faces. The control blocks contained 40 faces per block. The experimental blocks contained 80 faces per block. The ratio of oddball to context faces was 1:4 in all blocks. Female faces were used as the oddballs with a male context in one control block and vice versa for the second control block. In the experimental blocks, sexually ambiguous faces were used as oddballs. One experimental block had a context of male faces while the other had a context of female faces. An ambiguous face was not shown within the first three images and ambiguous faces were not shown back to back. Participants were asked to determine the gender of the presented face as either male or female and register their judgement by pressing one of two assigned buttons. Participants were instructed to register a best-guess selection with the buttons if they could not decide after one second. After the button press, an interstimulus interval of 1000ms - 2000ms was triggered before the presentation of the next image. The variation in time was used to prevent anticipation of an image and response. A fixation cross (+) was displayed in the center of the screen between the presentation of stimulus images. The word, "*Pause*" was shown on the screen after the conclusion of each block until the participant pressed a button to initiate the next block of images. In all blocks, faces were presented for 1000ms consistent with what similar studies have done.

EEG/ERP Recording and Analysis

Scalp voltages were recorded with Brain Amp (Brain Products, Munich, Germany) for the fifteen minute duration of the experiment. Amplified analog voltages were sampled and digitized for 64 channels at 500 Hz to prevent aliasing. EEG signal was hardware high pass filtered at 0.1 Hz to remove slow oscillations generated by skin potentials and DC currents. A hardware low pass filter filtered below 100 Hz to ensure signals above 100 Hz would not interfere with the signals of interest. No reliable data can readily be obtained from signal above 100 Hz when recording from the scalp as the scalp attenuates most signal above 100 Hz. Individual electrodes were adjusted until impedances were below 25-kOhm to make sure accurate signal could be recorded and that electrodes had sufficient electrical connection to the scalp. Reference recording sites was Cz. The 1000 ms long EEG epochs were baseline-corrected to a 200 ms pre-stimulus recording interval (to correct for any differences that might have occurred before the stimulus was even shown) and digitally low-pass filtered at 10 Hz (to remove high frequency signal that is often artifactual and to maintain signal that is in the frequency range of brain activity). Filtering at 10 Hz was preferable to filtering at the default 40Hz because the P3 is a relatively large slow ERP and was better able to be extracted when more of the faster noise was removed (Ito & Urland, 2003). Individual channels were replaced on a trial-by-trial basis with a spherical spline algorithm if the channel had very large consistent noise (greater than channels containing alpha waves) or other artifacts (Srinivasan, Nunez, Tucker, Silberstein, & Cadusch, 1996).

ERPLab's artifact detection tools were used to identify and reject artifacts. Signal with amplitudes over 100 mV or below -100 mV were marked along with signals with amplitude differences between adjacent samples that exceeded 50 mV. These artifacts are often caused by non-brain sources (e.g. eye-blink, muscle movement, or electrical noise). EEG was measured with respect to a Cz reference but was re-referenced to an average reference over all the channels as this yields a better approximation for a neutral reference.

For ERP analysis, mean amplitudes were compared between averaged response epochs to gendered faces, gendered context faces, and ambiguous oddball faces in the P1, P2, CPz, Pz channels. Fifty percent area latencies were also compared for the same conditions. Previous work with the P3 shows that the ERP is most apparent in parietal vertex electrodes, specifically the Pz electrode region.

Results

ERP Results

Parietal regions of interest (ROIs) for the Sensor Net were chosen for analysis. Specifically, for the P3 effect, ROIs were the P1, P2, CPz, and Pz channels (shown in Fig. 2); mean amplitude and 50% area latency from 300 to 1000 msec was computed by averaging each channel for each of the three stimulus types. This time window was chosen based on prior literature that observed a P3 generally remaining within this range of time (Ito & Urland, 2003). Grand average waveforms are shown in Figure 3. Mean amplitudes were analyzed with a two-way repeated measures ANOVA; Stimulus Image (gendered oddball face, gendered context face, and ambiguous oddball face) × Electrode (P1, P2, CPz, Pz). The 50% area latency was analyzed independently in a separate ANOVA of similar setup. Secondary analysis used the same ANOVA setup but with the following conditions for Stimulus Image: (gendered oddball face in male context, gendered oddball face in female context,gendered context face, and ambiguous oddball face). Grand average waveforms for secondary analysis are shown in Figure 8. ANOVA results that were not reported were not statistically significant.

P3 Effects

For mean amplitude there was a main effect of Stimulus Image ($F(2,19) = 68.094$, $MSE = 68.094$, $p = .004$) and a main effect of electrode ($F(3,19) = 11.450$, $MSE = 37.198$, $p < .001$) (see Figure 4). There were no significant interactions in either ANOVA. In measuring 50% area latency there was a main effect of Stimulus Image ($F(2,19) = 7.476$, $MSE = 50232.467$, $p = .002$) and no main effect of electrode (see Figure 5).

Collapsing across all four electrodes, a paired-samples t-test indicated that the 50% area latency was significantly greater for response to ambiguous oddball faces ($M = 577.18$, $SD = 53.973$) than for response to gendered context faces ($M = 527.08$, $SD = 64.215$), $t(19) = 3.797$, $MSE= 13.20$, $p = .001$. Collapsing across all four electrodes, a paired-samples t-test indicated that the the 50% area latency was significantly greater for response to gendered oddball faces ($M = 551.03$, $SD = 75.24$) than for response to gendered context faces ($M = 527.08$, $SD = 64.215$), $t(19) = -2.884$, $MSE= 16.15$, $p = .009$. This test did not reveal a significant latency difference between response to gendered oddball faces and ambiguous oddball faces.

Collapsing across all four electrodes, a paired-samples t-test indicated that the mean amplitude was significantly greater for response to ambiguous oddball faces ($M = 4.49$, $SD = 2.87$) than for response to gendered context faces ($M = 2.68$, $SD = 1.58$), $t(19) = 3.39$, $MSE= 13.20$, $p = .003$. Collapsing across all four electrodes, a paired-samples t-test indicated that the mean amplitude was significantly greater for response to gendered oddball faces ($M = 3.89$, $SD = 2.32$) than for response to gendered context faces ($M = 2.68$, $SD = 1.58$), $t(19) = -3.41$, $MSE= 16.15$, $p = .003$. There was no significant mean amplitude difference between response to gendered oddball faces and ambiguous oddball faces.

Gender Differences in P3

Secondary analysis of the data was conducted in which ambiguous oddballs were separated by sex of the context. Grand average waveforms are shown in Figure 8. When ambiguous oddballs were separated, significant results were found in P3 latency. A one-way repeated measures ANOVA for latency found a main effect of condition ($F(3,19) = 7.419$, $MSE = 72353.246$, $p < .01$) (see Figure 7). There was not a main effect of electrode condition. There was no interaction between electrode location and condition. A paired-samples t-test run on latency collapsed by electrode location indicated that there was no significant difference between ambiguous oddballs in a male context ($M = 586.75$, $SD = 61.89$) and those in a female context ($M = 589.78$, $SD = 89.53$), $t(19) = -.17$, $MSE = 17.82$, $p = .867$. There was a significant difference between ambiguous oddballs in male context ($M = 586.75$, $SD = 61.89$) and control oddballs ($M = 551.03$, $SD = 75.24$), $t(19) = 2.847$, $MSE = 12.55$, $p = .01$. The difference between ambiguous oddballs in female context ($M = 589.78$, $SD = 75.24$) and control oddballs ($M = 551.03$, $SD = 75.24$), $t(19) = 1.94$, $MSE = 20.02$, $p = .068$ only approached significance. A one-way repeated measures ANOVA for mean amplitude found a main effect of condition ($F(3,19) = 4.845$, $MSE = 63.57$, $p < .01$) (see Figure 9). This ANOVA excluded P1 because it resulted in an interaction that would prevent us from collapsing across electrodes. This exclusion allows us to report our results more concisely (by reducing the number followup tests) and should not affect our results. A paired-samples t-test run on mean amplitude collapsed by electrode location indicated that the difference between ambiguous oddballs in a male context ($M = 5.30$, $SD = .825$) and ambiguous oddballs in a female context ($M = 3.99$, $SD = 3.22$), $t(19) = 1.83$, $MSE = .717$, $p = .08$ approaches significance. Similarly, there was no statistically significant difference between ambiguous oddballs in a female context ($M = 3.99$, $SD = 3.21$) and the control oddballs ($M = 4.05$, $SD = 2.34$), $t(19) = -.095$, $MSE = .633$, $p = .93$. Lastly, there was no statistically significant difference between ambiguous oddballs in a male context (M =

5.30, SD = 3.69) and the control oddballs (M = 4.05, SD = 2.34), $t(19) = 1.56$, MSE = .797, $p = .134$.

Behavioral Results

A one-way repeated measures ANOVA for reaction time found a main effect of Stimulus Image ($F(2,19) = 18.315$, MSE = 209191.539, $p < .001$) (see Figure 6). A paired-samples t-test run on RT indicated that the RTs were significantly slower for response to ambiguous oddball faces (M = 681.97, SD = 198.99) than for responses to gendered context faces (M = 553.25, SD = 92.81), $t(39,19) = 4.571$, MSE= 28.16, $p < .01$. A paired-samples t-test run on RT indicated that the RT were significantly slower for responses to ambiguous oddball faces (M = 681.97, SD = 198.99) than for response to gendered oddball faces (M = 567.24, SD = 92.65), $t(39,19) = 4.162$, MSE= 29.19, $p < .01$ (see Figure 6). A paired-samples t-test also indicated there was no difference in RT between gendered context faces and gendered oddball faces.

Gender Differences in Reaction Time

A secondary analysis of the behavioral data was conducted in which the ambiguous oddball faces were separated by gender of the context: ambiguous oddball in male context and ambiguous oddball in female context. The same statistical tests were conducted and results indicated that the two ambiguous oddball subcategories were not significantly different from each other (results not shown). Furthermore, the statistical relationship between either of the two subcategories with the other two stimulus image types (gendered context and gendered oddball) were consistent with that between the collapsed ambiguous oddball category and the other two stimulus image types (results not shown).

Discussion

The purpose of the present experiment was to determine whether gender-ambiguous faces are categorized differently than gendered faces during explicit visual gender discrimination and to observe any effects of gender ambiguous faces on the P3 component and categorization reaction time. We found that there is a P3 oddball effect for the gendered oddballs when embedded in the opposite gender context, which is consistent with previous literature (Ito & Urland, 2003). We also identified a delayed latency in the P3 for this condition, in line with what is expected from typical P3 oddball tasks (Polich 2007). This oddball effect is most reasonably elicited by the difference between the masculine and feminine facial features. One novel finding of this study is that ambiguous faces elicit an oddball response when embedded in both male and female contexts. This supports our hypothesis that ambiguous faces are categorized differently than gendered faces. Specifically, based on the observed P3 oddball effect, an ambiguous face is considered to be different from a male face and from a female face. It may be the lack of prominent gendered features that makes the face be considered a member of an “other” category. Thus, the difference between masculine and less masculine and between feminine and less feminine is enough to cause a P3 oddball effect. When ambiguous oddballs were not separated by the gender of the context, the P3 latency for the ambiguous oddballs was significantly delayed compared to gendered context faces, but not different from the gendered oddballs. These latency findings do not support our hypothesis of P3 demonstrating delayed initial categorization. Reaction time was not different between gendered context faces and gendered oddball faces, but was significantly longer (by an average of ~125 ms) for oddball ambiguous faces compared to the two other image types, as predicted. While the prolonged reaction time for ambiguous oddballs images seems contradictory to the lack of latency difference between the two types of oddballs, there may be several reasons for this apparent discrepancy.

One possible interpretation of the results of this study is that upon viewing a face, regardless of the apparent gender of this face, individuals categorize the face as either male, female, or other. Upon categorization of the face into male or female, the individual is immediately consciously aware and confident of the gender of the face and can quickly make a button selection. However, if a face is categorized as “other,” the individual may not be consciously aware of the gender, thus spending more cognitive resources and time to determine the best gender to categorize the face. This may be reflected in slower RTs for ambiguous oddball faces despite a lack of significant difference in P3 categorization latency.

On the other hand, there may truly be an amplitude and latency difference between the two types of ambiguous oddballs that remain undetected using current measures of amplitude, latency, and the statistical power. Considering the interesting effect visible between 600 -1000ms where the ambiguous oddballs seems to have a larger somewhat delayed amplitude, there may be evidence of a real, yet undetected, effect. This could be due to our ambiguous images being more feminine leaning than neutral as we would ideally liked to have had. To test if this could have biased our results we repeated the same statistical tests but with ambiguous oddball in a male context as a separate condition from ambiguous oddball in a female context. Based on the intuition that our ambiguous images may have been more feminine looking, we thought this could have attenuated a P3 amplitude and latency difference in the female context compared to in the male context; we found this to be the case. We found that the latency of the P3 for ambiguous oddballs in a male context was greater than that of control oddballs. The same trend for latency was found for ambiguous oddballs in female contexts, but this difference only approached statistical significance. The difference in mean amplitude was not significantly increased in these conditions. These results are consistent with the RT measures split into the same four conditions where RT for ambiguous oddballs in either context is greatly increased compared to the other two non ambiguous conditions. Had we had twice our sample size we may have found a significant increase in P3 latency and amplitude for ambiguous oddballs embedded in a female context compared to gendered oddballs in an opposite gendered context (despite the feminine leaning features of our ambiguous faces). We likely would have seen these same predicted results if we also had truly ambiguous faces even with our current sample size. These results thus support our hypothesis that ambiguous oddballs have a delayed gender categorization based on the P3 as a marker for explicit categorization.

Previous work on face categorization has demonstrated participant sex differences in the categorization of faces by gender (Cellerino et al., 2004). Therefore, it is possible that males are more efficient at categorizing male faces whereas females are more efficient at categorizing female faces (Cellerino et al., 2004). Since children tend to spend more time with individuals of the same sex, we may not have found a significant difference in P3 latency or amplitude for ambiguous oddballs and gendered oddballs because differences between male and female subjects exposed to same sex and ambiguous oddballs were not examined in much detail. More specifically, we may observe a significant difference in P3 latency between gendered oddballs and ambiguous oddballs if we analyzed differences between males exposed to a male gendered oddball compared to an ambiguous oddball, and females exposed to a female gendered oddball compared to an ambiguous oddball. A follow up study looking at gender differences in face categorization between males and females could confirm our hypothesis of the P3 effect, demonstrating a delayed initial categorization of ambiguous oddballs compared to gendered oddballs, that is sex specific.

We observed a difference between categorization of ambiguous oddballs in a male context and in a female context. One possibility is that the process of categorization may have been easier in a male context than a female context due to the presence of male faces with beards in the former. Male faces with beards are easily categorized as male, increasing the contrast between those faces and ambiguous faces (without beards). The increased contrast may have made it statistically easier for participants to categorize faces without beards as ambiguous or female. Ambiguous faces in the female context may have been more difficult to categorize as "other" because of the absence of beards in female context faces.

In a classical oddball paradigm, the current work established that ambiguous oddball faces elicit significant differences in P3 amplitude, fractional area latency and reaction time compared to gendered context faces. These findings extend the existing body of knowledge on face categorization. In addition, the results raise some interesting questions that could be addressed in follow up studies. As mentioned earlier, it was interesting that we did not observed a significant P3 latency difference between gendered oddball and ambiguous oddball faces (contexts combined); however, we did observe a significantly longer reaction time for oddball ambiguous faces compared to gendered oddball faces. It would be interesting to observe whether manipulations to the facial stimuli could produce significantly different results. Follow up studies looking at latency and reaction time differences between gender-ambiguous faces and gendered faces during explicit visual gender discrimination should utilize more consistent images in terms of lighting, attractiveness, ambiguity, and facial cropping. In addition, follow up studies should have a group of non-experimenters determine the ambiguity of images, which was not the case in the current study. These simple modifications may also address the discrepancy observed between P3 latency and reaction time. A similar study design could also be used to test ambiguity in race.

When meeting a person for the first time, whether for a job interview or first date, physical appearance, including gender perception and physical attractiveness, are noticed, and influence subsequent interactions (Watkins & Johnson, 2000). Most notably, Dion, Berscheid, and Walster (1972) found that attractive people are perceived to be happier and more successful than less attractive people. Following Dion, Berscheid, and Walster's finding, employment studies have also revealed that attractiveness is an advantage during the job application process, and attractiveness is positively associated with perceptions of personal efficacy (Watkins & Johnson, 2000). In society, individuals who are gender ambiguous may be deemed as less attractive compared to unambiguous gender individuals. Specifically, less feminized, and more masculinized females may be viewed as less attractive than their clearly feminine counterparts, and less masculinized, and more feminized males may be viewed as less attractive than their clearly masculine counterparts. As a result, gender ambiguity could negatively impact how individuals are perceived in the real world setting. In this study we have shown that gender ambiguous faces take longer to process and likely require more cognitive resources to do so, possibly affecting subsequent actions.

Figure. 1 Example Male, Female and Ambiguous Stimulus (from left to right).

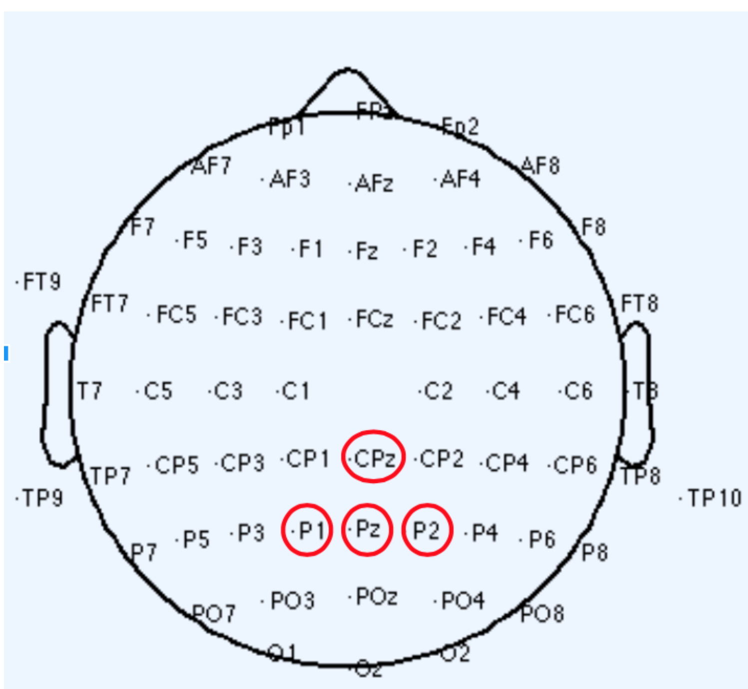

Figure 2. Sensor net layout. Electrode sites are labeled. Circled electrodes were analyzed.

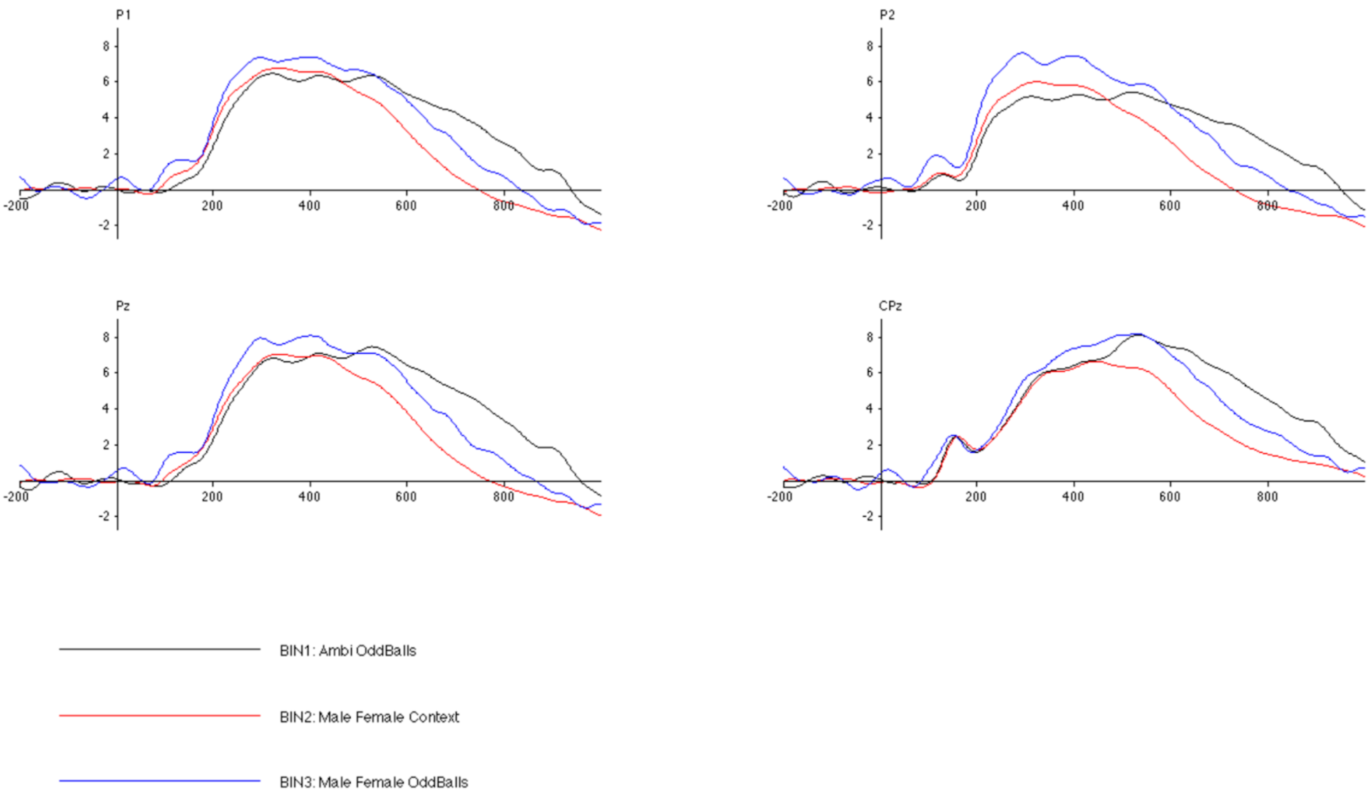

Figure 3. Grand Average ERP waveforms for gendered oddball faces, gendered context faces, and ambiguous oddball face response for the P3 (P1, P2, Pz, CPz at 300 - 1000 msec).

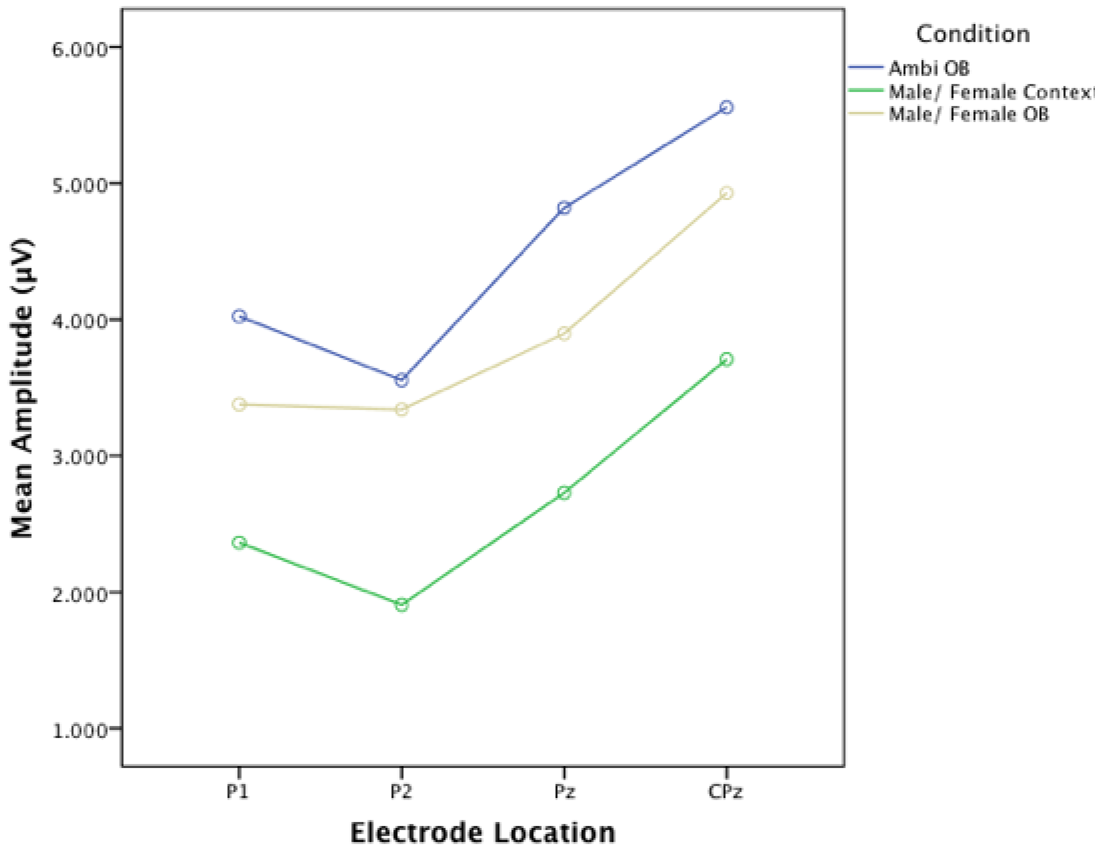

Figure 4. ANOVA of P3 ERP Mean Amplitude for gendered oddball faces, gendered context faces, and ambiguous oddball faces for each electrode (300 - 1000 msec). Main effect of electrode and stimulus image.

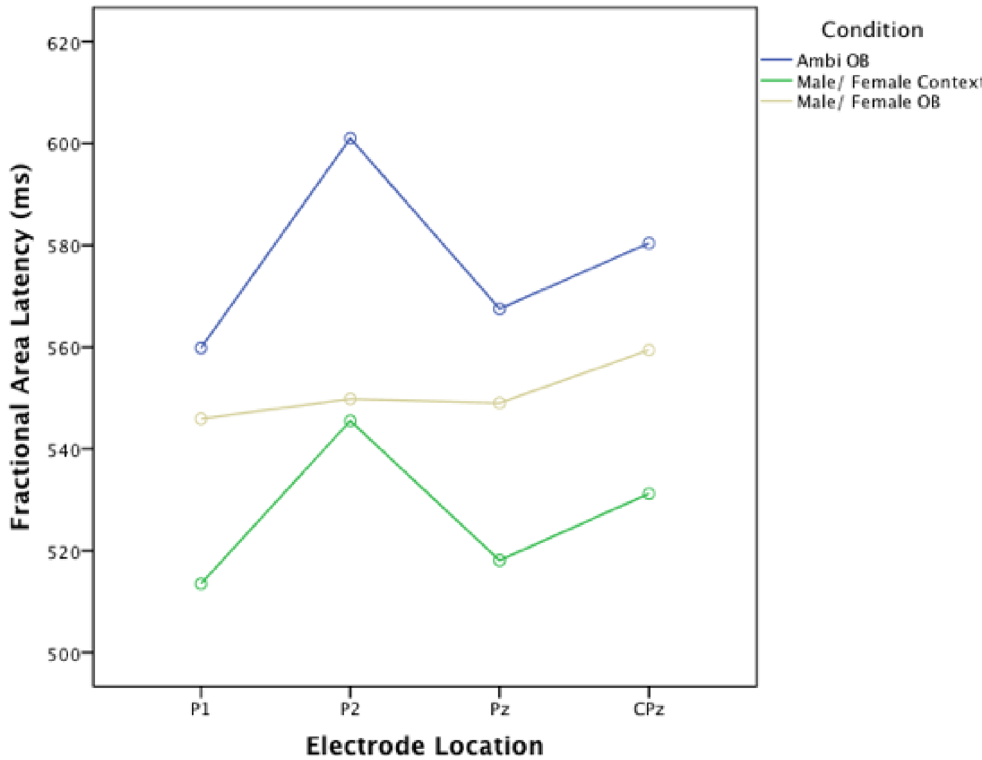

Figure 5. ANOVA of P3 ERP 50% area latency for gendered oddball faces, gendered context faces, and ambiguous oddball faces for Each Electrode (300-1000 msec). Main effect of stimulus image.

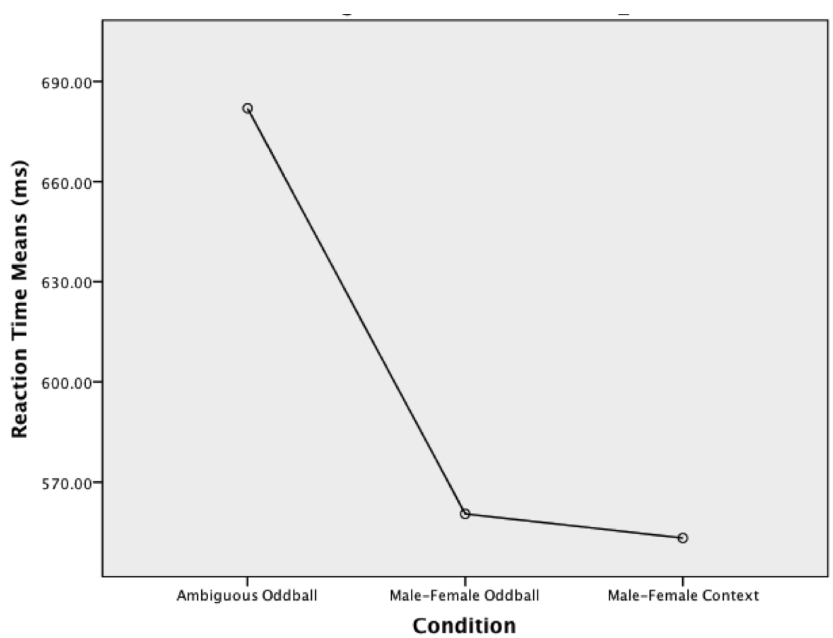

Figure 6. Reaction Time ANOVA for gendered oddball faces, gendered context faces, and ambiguous oddball faces. Main effect of stimulus image.

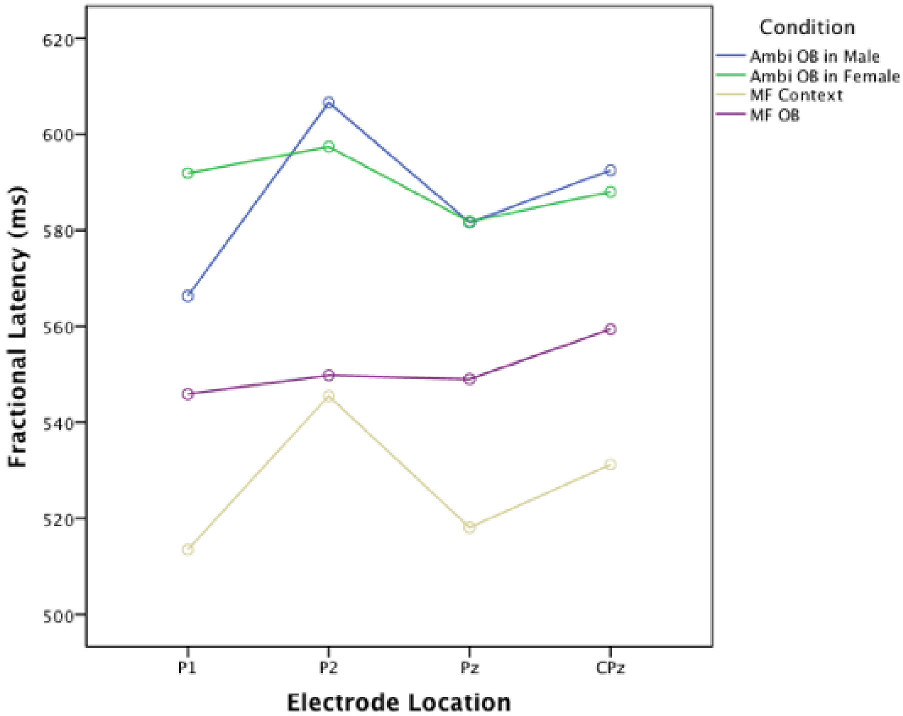

Figure 7. ANOVA of P3 ERP 50% area latency for gendered oddball faces, gendered context faces, and ambiguous oddball faces in either male or female context for each electrode (300 - 1000 msec). Main effect of stimulus image.

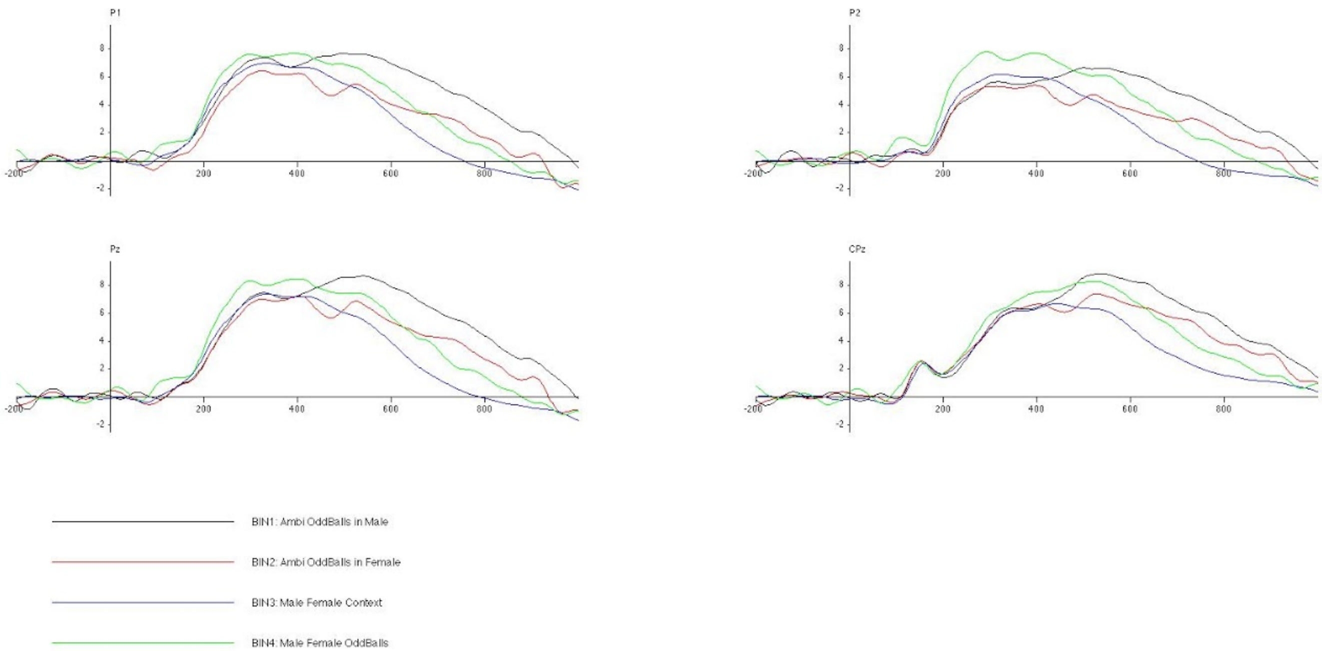

Figure 8. Grand Average ERP waveforms for gendered oddball faces, gendered context faces, and ambiguous oddball face response in male or female context for the P3 (P1, P2, Pz, CPz at 300 - 1000 msec).

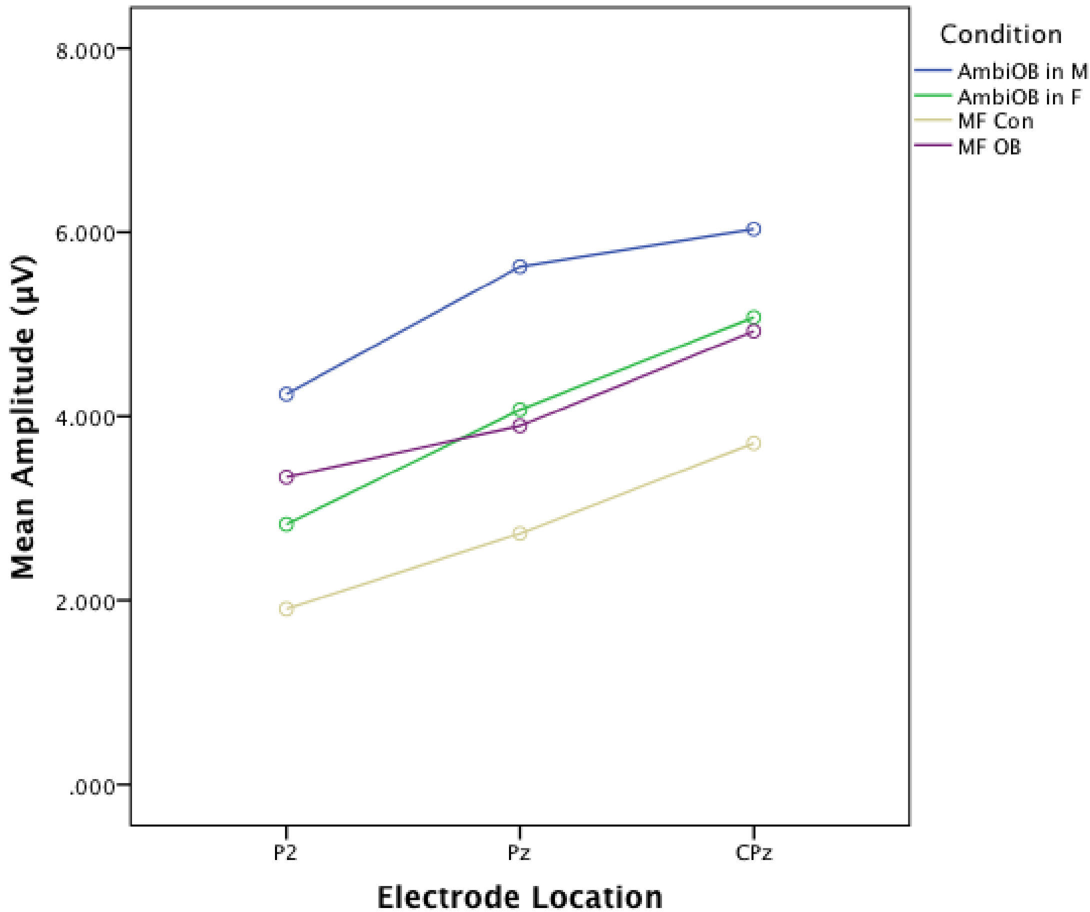

Figure 9. ANOVA of P3 ERP mean amplitude for gendered oddball faces, gendered context faces, and ambiguous oddball faces in either male or female context for each electrode excluding the P1 electrode (300 - 1000 msec). Main effect of stimulus image. Main effect of electrode. No interaction.

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