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Is the Left Hemisphere Androcentric?

Evidence of the Learned Categorical Perception of Gender

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Abstract

Effects of language learning on categorical perception have been detected in multiple domains. We extended the methods of these studies to gender, and pitted the predictions of *androcentrism theory* and the *spatial agency bias* against each other. Androcentrism is the tendency to take men as the default gender and is socialized through language learning. The spatial agency bias is a tendency to imagine men before women in the left-right axis in the direction of one's written language. We examined how gender-ambiguous faces were categorized as female or male when presented in the left and right visual fields to 42 native speakers of English. When stimuli were presented in the right visual field rather than the left visual field, participants (1) applied a lower threshold to categorize stimuli as male and (2) categorized clearly male faces as male more quickly. Both findings support androcentrism theory suggesting that the left hemisphere, which is specialized for language, processes face stimuli as male-by-default more readily than the right hemisphere. Neither finding evidences an effect of writing direction predicted by the spatial agency bias on the categorization of gender-ambiguous faces.

Keywords: social categorization; gender categorization; androcentrism; spatial agency bias; face perception

Categorical perception occurs when perceptually different stimuli are processed as equivalent due to being members of the same conceptual category. In non-social domains such as color, number, and space, categorical perception is a well-documented phenomenon (Eimas, Siqueland, Jusczyk, & Vigorito, 1971; Franklin & Davies, 2004; Franklin, Pilling & Davies, 2005; Hespos, & Spelke, 2004; Wynn, 1992). But for social categories, such as gender, the mechanisms of categorical perception are less clear. In many domains categorical perception is determined by the features of objects and the characteristics of the human nervous system, but categorical perception can also be affected by cultural processes such as language learning (Davies, 1998; Roberson, Pak & Hanley, 2008). One revealing way to detect such linguistic influences is to examine the categorization of ambiguous stimuli presented in the right and left visual fields to the left and right hemispheres of the brain respectively. As the left hemisphere is specialized for language comprehension, effects of language on categorization can be inferred from the differential processing of ambiguous stimuli presented under such conditions. Past studies using this methodology have shown linguistic influences on categorical perception, particularly in the domain of color categories (Franklin, Drivonikou, Clifford, Kay, Regier & Davies, 2008; Gilbert, Regier, Kay & Ivry, 2006; Gilbert, Regier, Kay & Ivry, 2008; Roberson et al., 2008), but also in such domains as number (Saxton & Towse, 1998), animal (Gilbert et al., 2008) and spatial relations categories (Choi & Hattrup, 2012). In these studies, categorisation was faster when stimuli were presented to the right visual field (i.e. to the linguistic hemisphere). Additionally, infants with incomplete colour knowledge were found to shift from a reliance on the right hemisphere to a reliance on the left hemisphere when categorising colours, and this shift occurred at the time of language acquisition (Franklin et al., 2008). Thus it appears that language can influence categorical perception.

To date, however, these methods have not been applied in more social domains. In response, we extended research on categorical perception to *gender* for the first time. Whilst the attribution of gender to others has long been known to be highly automatic, the gender attribution process is also understood by social scientists to be a cultural process that can vary across both micro-social situational contexts and broader cultural contexts (Garfinkel, 1967; Kessler & McKenna, 1978; Morris, 1995). Two aspects of this cultural socialization process pertain particularly to the attribution of gender to stimuli presented in the left and right areas of the visual field, *androcentrism theory* and the s*patial agency bias*. Both theories make assumptions about the relationship between language learning and spatial imagery, and they yield competing predictions in some cultural contexts. We review the predictions of each theory below to introduce our experiment which is a critical test of these theories.

Androcentrism is a feminist concept that describes how people are designated to be men or male by default for cultural reasons, and that such default designations work to women's disadvantage (Bem, 1993; deBeauvoir, 1949; see Hegarty, Parslow, Ansara, & Quick, 2013 for a recent review). Androcentrism is socialized by the learning of languages that include masculine generic pronouns such as "he," and noun terms such as "man" that both prompt male imagery and are used as "defaults" to refer to individuals whose gender is not known (Hyde, 1984; Stout & Dasgupta, 2011). In addition, many social category labels prompt imagery of men more than imagery of women (Pratto, Korchmaros, & Hegarty, 2007). Such androcentric understandings of social category labels have clear effects. Because "voters" are imagined to be men, explanations of gender differences among voters focus on women's difference from men (Miller, Taylor, & Buck, 1991). For some category labels, such as "surgeon", androcentric understandings are so immediate that vexing riddles can be constructed that exploit the difficulty of calling to mind members of the social category who are women (Reynolds, Garnham, & Oakhill, 2006). As language comprehension occurs in the left hemisphere, effects of androcentrism on categorical perception of gender-ambiguous stimuli can be predicted to be lateralized. Androcentrism theory would be confirmed by evidence that gender-ambiguous stimuli are processed as male-by-default more readily when presented in the right visual field (RVF) than when presented in the left visual field (LVF).

Predictions derived from androcentrism theory sometimes contrast with the predictions of how categorical perception might be affected by the spatial agency bias (Maass, Suitner, Favaretto & Cignacchi, 2009). Languages that are written from left-to-right or from right-to-left prompt their users to: imagine action as unfolding in the left-right axis in the direction of their written language (Maass & Russo, 2003); scan visual space in this same direction (Chokron & Imbert, 1993; Spalek & Hammad, 2005); match sentences more quickly when action moves in the direction of written language (Chatterjee, 2001); and to regard such actions as more beautiful (Maass, Pagani & Berta, 2007). The spatial agency bias is the resulting tendency to also imagine social groups descending in agency and power in the direction of one's written language. For example, the tendency to depict men first and women second in accord with the direction of written language has been observed in art, cartoon images, experiments in which women and men are arranged in space, and in graphs of gender differences (Coslett, 1999; Coslett, Schwartz, Goldberg, Haas & Perkins, 1993; Hegarty, Lemieux, & McQueen, 2010; Maass et al., 2009; Suitner & McManus, 2011). In these studies participants fluent in languages written left-to-right positioned males on the left and females on the right. The opposite tendency was observed in participants fluent in languages written right-to-left. Effects of the spatial agency bias on the categorical perception of ambiguous stimuli should lead faces presented in the "first" position to be designated male more often and more readily, and faces presented in the "second" position to be designated female more often and more readily.

Androcentrism theory and the spatial agency bias lead to competing predictions in some linguistic contexts. Among people who use a right-to-left language such as Arabic, the spatial agency bias suggests that faces presented in the RVF should be categorized as male and faces presented in the LVF categorized as female more readily. However, among speakers of a left-to-right language such as English, the spatial agency bias suggests that faces presented in the LVF will be categorized as male and faces presented in the RVF categorized as female more readily. Consequently, androcentrism theory and the spatial agency bias make similar predictions about speakers of right-to-left languages, but competing predictions about speakers of left-to-right languages. We tested those competing predictions among speakers of English below.

Existing studies of the categorization of faces by gender do not provide a conclusive test of these two competing theories. One study found categorical perception for gender-ambiguous morphed faces, but only when participants had previously attached the faces to linguistic names or categorized the morphed faces along a male-female axis (Bülthoff & Newell, 2004). However, Bülthoff and Newell (2004) also always presented the crucial categorization task following a matching task that may have led participants to focus attention on specific features of target faces rather than on the overall gender of the face. Consequently, the categorical perception observed in this study occurred in a context where it competed with bottom-up perceptual cues which had been made salient. In other studies wherein participants categorized faces according to gender without a preceding matching task, no effect of familiarity on face processing has been observed (Quinn, Mason & Macrae, 2010; Tomelleri & Castelli, 2012; Wild, Barrett, Spence, O'Toole, Chang & Brooke, 2000). Similar to Bülthoff and Newell (2004), the current study used morphed female-male faces, but without any preceding familiarization or matching tasks.

Similarly, research into the influence of hemisphere on gender categorization has yielded complex results. Most studies (e.g. Burt & Perrett, 1997; Parente & Tommasi, 2008) have used chimeric faces with one half of a face being male and the other half being female. In these studies it is presumed that the left half of a face is processed in the LVF and the right half in the RVF, and that any bias in gender attribution results from hemispheric differences in gender categorization. Parente and Tommasi (2008) found that participants tended to categorize chimeric faces on the basis of the gender presented to the LVF, suggesting a right-hemisphere dominance for gender categorization; however, this effect was most pronounced for the categorization of female half-faces in the LVF. This latter finding is inconsistent with the spatial agency bias account, but it is also not fully consistent with the androcentrism hypothesis which would predict male half-faces presented to the RVF to be categorized as male. However, using chimeric faces to investigate gender categorization assumes that one hemisphere dominates the other in free-viewing conditions. In contrast, the androcentrism hypothesis assumes that gender attribution will tend towards a male default when gender attribution is made in the left hemisphere which processes language. Therefore, the current study presented whole faces, morphed on a continuum of female to male, to either the left or right visual field. Central fixation was controlled by inclusion of an attentional control task and a brief stimulus presentation time that limited the possibility that participants made saccades to either visual field. In contrast, the free viewing conditions used in previous research may have masked any effects of androcentrism by allowing participants to use a left-right pattern of eye movements, favoring the spatial agency bias account.

The present study therefore drew directly on studies of the categorical perception of color with the two aims of minimizing ambiguity about which hemisphere of the brain was processing the relevant stimuli, and of providing maximal opportunity to detect hemispheric effects on categorization. On successive trials, participants categorized gender-ambiguous faces presented in either the RVF or LVF as female or male. The faces were morphed and varied along a 7-point female-to-male continuum (Figure 1). Both response times and the proportion of faces categorized as male or as female were recorded for each point along the female-to-male continuum. These measures allowed a critical test of androcentrism theory and the spatial agency bias. If androcentrism affects categorical perception of gender-ambiguous faces, then we should observe a lower threshold for categorizing faces as male and lower reaction time in response to clearly male faces in the RVF. If the spatial agency bias affects categorical processing, then we should observe a lower threshold for categorizing faces as male for faces presented in the RVF and lower reaction time for clearly male faces presented in the LVF and clearly female faces presented in the RVF.

Alternatively, in participants for whom the direction of written language is left-to-right, it could be argued that the spatial agency bias would result in *increased* agency for faces presented in the RVF when participants are asked to fixate, as in the present study, compared to when free-viewing conditions are used, because the RVF is to the right of fixation (i.e. in the direction of written language). However, studies of the spatial agency bias using similar designs have shown that objects or actors to the right of fixation are considered to be 'non-agentic' (Suitner, 2009, Experiment 3a). This supports the characterisation of the spatial agency bias as producing opposing predictions to androcentrism theory in speakers of English, even when a task employing central fixation is used.

Finally, this method also allowed us to measure the slope of the categorization curve of each hemisphere, but we had no specific predictions as to whether the left or right hemisphere would categorize ambiguous faces more sharply as male and female.

Method

Participants

The initial opportunity sample consisted of 49 right-handed English-speaking student volunteers recruited on a British university campus. Handedness was assessed by self-report as this has been found not to differ significantly from the Edinburgh Handedness Inventory (Ransil & Schachter, 1994). Four participants were excluded due to chance performance on the attention task. Three participants were excluded due to outlying responses on the categorisation task resulting in PSE values below 0 or above 100, indicating random button pressing. Analysis was conducted on the remaining 28 women and 14 men participants aged between 17 and 28 (mean age = 20.29, SD = 2.70). A total of 28 psychology students volunteered as part of an undergraduate course credit scheme. The remaining participants were not reimbursed for their time.

Materials

Face stimuli were obtained from the Radboud Faces Database (Langner, Dotsch, Bijlstra, Wigboldus, Hawk & van Knippenberg, 2010). Neutral expression Caucasian faces were selected and morphed to create an average purely female face and an average purely male face which anchored the ends of a 7-point female-to-male continuum. The purely female and purely male faces were morphed to create ambiguous stimuli varying along a 7-point continuum with 0%, 16.7%, 33.3%, 50%, 66.7%, 83.3% and 100% male faces (Figure 1A). Below we refer to this scale in terms of "maleness" such that 0% refers to the purely female face and 100% refers to the purely male face.

Figure 1 about here

The categorization task (Figure 1B) consisted of 280 trials divided into four blocks. The task was presented using E-Prime version 2.0. Each block contained 70 trials and each face from the 7-point continuum was presented ten times in each block. On each trial, participants viewed a fixation cross for 1500, 1600, 1700, 1800 or 1900 ms, followed by an image of a face in either the LVF or RVF, at a visual angle of nine degrees from fixation to the centre of the face. This visual angle was chosen based on previous studies of categorical perception (Clifford, Franklin, Davies & Holmes, 2009; Liu, Li, Campos, Wag, Zhang, Qui, Zhang & Sun, 2009). Each face appeared on each side of the visual field an equal number of times, once for each fixation time.

The face stimuli were always presented for 250ms, to prevent participants from making a saccade toward a stimulus, and to ensure that each stimulus was processed by the expected hemisphere of the brain. Following each face image, participants were prompted with the question "female or male?" for 1750ms, and participants were given 2000ms to respond by using their right hand to press either the M or N keys on a QWERTY keyboard. The question prompt was always phrased in this order. The mappings of the responses "male" and "female" to the two keys were counterbalanced randomly between participants. The program moved on to the next trial either when the time had run out or an acceptable response was detected.

To ensure participants were looking at the fixation cross, an attentional control task was included. On 40% of trials, the fixation cross turned from black to red when the face was presented. On half of these trials, following the gender categorization prompt and response time, participants were prompted with the question "did the cross change color?" and were given 3000ms to respond with the Z key if it had and the X key if not. On 20% of the total trials, participants were prompted with this same question but the cross had not changed color. On the remaining 40% of trials the cross did not change color and participants were not prompted by the question. Order of appearance of trials within each block was random.

Procedure

Participants were tested individually. After signing consent forms participants were briefed to fixate on a cross in the center of the screen on each trial, to categorize faces presented as either female or male, and to detect the change in the cross' color. Participants were instructed to categorize the faces as quickly and accurately as possible. Before the start of the first block, 25 practice trials were presented (12 trials presented to the left visual field and 13 to the right). The number of attention task trials in the practice block was proportional to that of the main task. Following each block participants were given the opportunity to take a break and were instructed to press the spacebar when they were ready to continue. Upon completion participants were thanked and debriefed. The experimental procedures were approved by the University Ethics Committee.

Results

For each participant in each visual field, the proportion of faces at each point on the 7-point continuum that were categorized as male was calculated. These data were used to compute psychometric functions, yielding values for both the slope and the *point of subjective equivalence* or PSE for each visual field (Figure 2). Slope refers to the steepness of the categorization curve. The PSE is the point on the morph continuum where participants were equally likely to categorize the stimuli as female or male. A lower PSE indicates a lower threshold for categorizing faces as male. We used the Palamedes toolbox to calculate these functions (http://www.palamedestoolbox.org/). Recall that androcentrism theory predicts a lower PSE for stimuli presented in the RVF and the spatial agency bias predicts a lower PSE for stimuli presented in the LVF. Mean reaction times were also calculated for each of the seven points on the female-male continuum in each visual field. Androcentrism theory predicts a faster reaction time to categorize stimuli as male in the RVF. In contrast, the spatial agency bias predicts a faster reaction time to categorize stimuli in the right visual field as female and in the left visual field as male.

Figure 2 about here

Slope, PSE and reaction time yielded no significant gender differences (F (1, 40) = 1.09, *p* = .30, F (1, 40) = .85, p = .38, and F (1, 40) = 3.40, *p* = .073, respectively). Gender did not interact with any analyses of interest. Participants responded with a high level of accuracy to the attentional control question (M = 81%, SD = 10%). The presence of the attentional control question did not affect any of the dependent variables and did not interact with any analyses of interest.

Slope

The higher the slope, the steeper the categorization curve and consequently, the more categorical a participant's perception is in that visual field. Similar values for the slope of the psychometric function were found for stimuli presented in the right and left visual fields (right: M = 23.82, SD = 7.11; left: M = 24.96, SD = 7.60). A paired-samples t-test revealed no significant differences between the two visual fields, t (41) = 1.41, *p* = .17. Thus perception of gender was not more categorical in one visual field than the other.

Point of Subjective Equivalence (PSE)

Our PSE metric was calculated such that the higher the number, the greater the male content needed for the face stimuli to be equally likely to be categorized as female or male. PSE scores were slightly over 50% in both visual fields, likely due to an artifact of the degree to which the two ends of the morph continuum were perceived as purely female and purely male. A paired t-test indicated a lower PSE for stimuli presented in the RVF (M = 52.00%, SD = 11.35) than for stimuli presented in the LVF (M = 57.35%, SD = 10.62 respectively), t

(41) = 3.27, *p* =.002, d = .47 (Figure 3). This result supports androcentrism theory as it suggests a lower threshold for categorizing ambiguous faces as male in the RVF/left hemisphere which is specialized for language. The finding also goes against the predictions of spatial agency bias that faces in the LVF would be categorized as male and those in the RVF as female.

Figure 3 about here

Response Times

Figure 4 illustrates the response times for each level of morph in each visual field. To test for significant differences in reaction times, a 2 (Visual Field: Right vs. Left) x 7 (Morph: 0% vs. 16.7% vs. 33.3% vs. 50% vs. 67.7% vs. 83.3% vs. 100%) within-subjects ANOVA was conducted. A significant main effect revealed that participants reacted faster to stimuli presented in the right visual field (M = 970.97, SD = 153.02) than the left visual field (M = 988.93, SD = 151.67), F (1, 41) = 5.86, p = .02, η^2 = .13. In addition, there was a significant main effect of morph, F (6, 246) = 31.27, p < .001, η^2 = .43. Figure 4 illustrates that this result was due to the typical response time profile for a categorical judgment task. Response times were slower at the center of the female-to-male continuum where stimuli were most ambiguous.

Figure 4 about here

Crucially, a significant interaction between visual field and morph was also found, suggesting a hemispheric difference in the speed of categorization which is relevant to our central hypotheses F (6, 246) = 4.15, p = .001, η^2 = .092. Post-hoc paired sample t-tests revealed this interaction to be driven by differences in the speed at which the most male stimuli (the 100% point) were processed in the two visual fields. Purely male stimuli (i.e., 100% male faces) were processed faster when presented in the RVF (M = 883.97, SD = 142.05) than in the LVF (M = 945.96, SD = 179.50), t (41) = 3.63, p =.001, d = .35. No other post-hoc comparisons survived Bonferroni correction. These results also support androcentrism theory but not the spatial agency bias; they suggest a tendency for the RVF/left hemisphere to categorize more male faces as male-by-default more quickly than the LVF/right hemisphere. They refute the hypothesis that speakers of English categorize images in the LVF as male by default and those in the RVF as female by default.

Discussion

Using morphed male-female faces, we demonstrated clear categorization effects. Faces at the two ends of the morph continuum were categorized significantly faster than more ambiguous faces, with a peak in response times around the center of the morph continuum. The slope of the categorization curve did not differ across hemispheres; both hemispheres categorized ambiguous faces as male and as female with equal consistency. However, participants responded to male faces more quickly when presented to the RVF/left hemisphere than to the LVF/right hemisphere. Also, stimuli were more likely to be perceived as male when presented in the RVF/left hemisphere, as demonstrated by the lower PSEs in this hemisphere. These results are not consistent with a spatial agency bias, which should predict faster response times and lower PSEs for male stimuli in the LVF/right hemisphere, and for female stimuli in the RVF/left hemisphere. Instead they provide support for the androcentrism hypothesis, whereby the androcentric nature of the English language leads to dominance for masculine stimuli in the linguistic hemisphere.

The present research differed from past studies in controlling for the hemisphere that processed each stimulus through exposure time and attentional tasks. One potential concern is that participants always responded to the face stimuli using their right hand. The generally faster responses to faces presented to the RVF/left hemisphere may have been due to this factor. However, we do not think that the use of the right hand competes with androcentrism theory in explaining why the RVF advantage is found only for the most clearly *male* stimuli, as actually occurred.

Research has revealed androcentric tendencies for people to bring to mind male exemplars more easily (Foster & Keating, 1992; Hyde, 1984). The English language is also characterized by of the use of males as prototypes and defaults (Bodine, 1975). Such research has often been troubled by an ambiguity. Participants who are presented with gender-neutral language (e.g., “he and she”) rather than masculine generics (“he”) are both affected by automatic processes prompted by the use of more inclusive language and with controlled processes prompted by the use of salient and less familiar language terms. The present study contributes to this literature, not only by suggesting that it is the left hemisphere that is particularly accountable for androcentric thinking, but also by showing how brain research can constrain explanations of hitherto ambiguous phenomena in research on gender and language.

Such an effect of language on social – in this case gender – categorization is consistent with research on linguistic relativity in other domains and it suggests two cross-cultural extensions of brain research on gender and language. First, as the hemisphere effect observed here is contrary to that predicted by the spatial agency bias, it is possible that the effect was dampened by a spatial agency bias among our English-speaking participants. Replication of this paradigm among people who speak right-to-left languages would inform this point because they might be expected to show even stronger effects if the spatial agency bias combines with the androcentrism bias in such participants. Second, whilst we did not observe differences in the slope of the categorization curve by hemisphere in our participants, our method could test for such differences. Ethnographic research into cultures such as the xanith of Oman (Wikan, 1977) or the travesty of Brazil (Kulick, 1998) demonstrates that the two-gender system is not a cross-cultural universal. Cross-cultural studies of the categorical perception of gender that include cultural groups that recognize more than two genders might provide a fertile ground for further exploration of the ways that language learning affects the categorical perception of gender by humans.

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Figures

Figure 1

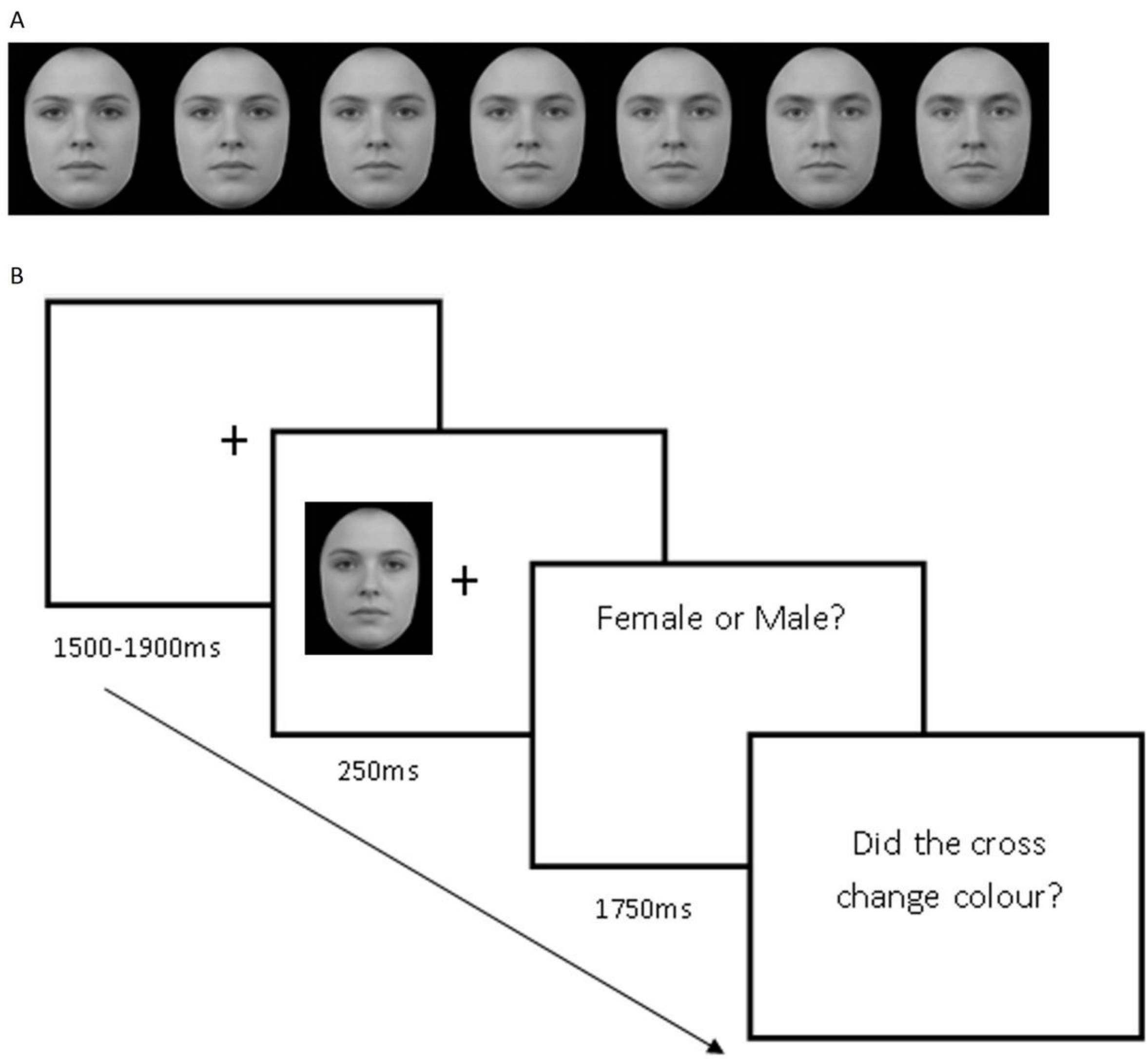

Figure 1. A. Face stimuli used in the categorization task in increasing levels of maleness ranging from 0% male to 100% male. B. Trial structure for the categorization task. On 40% of trials the fixation cross turned from black to red and on half of these trials, following the face decision, participants were asked if the cross had changed. On 20% of trials, participants were prompted to answer the question but the cross did not change color.

Figure 2

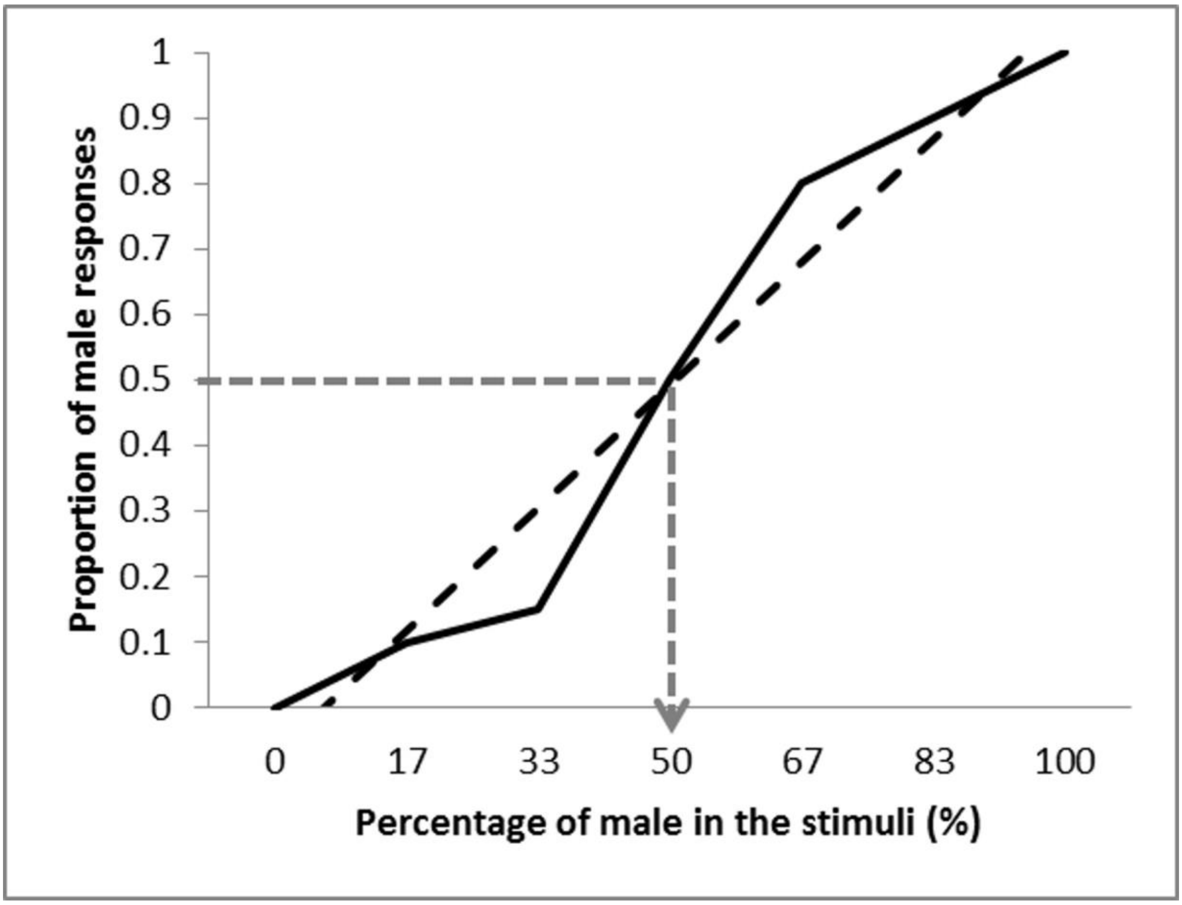

Figure 2. Example of a typical categorization curve. The solid line indicates responses made by the participant. The PSE, as indicated by the dotted line, refers to the point on the curve that participants are equally likely to respond with male or female. The dashed line indicates the slope of the categorization curve.

Figure 3

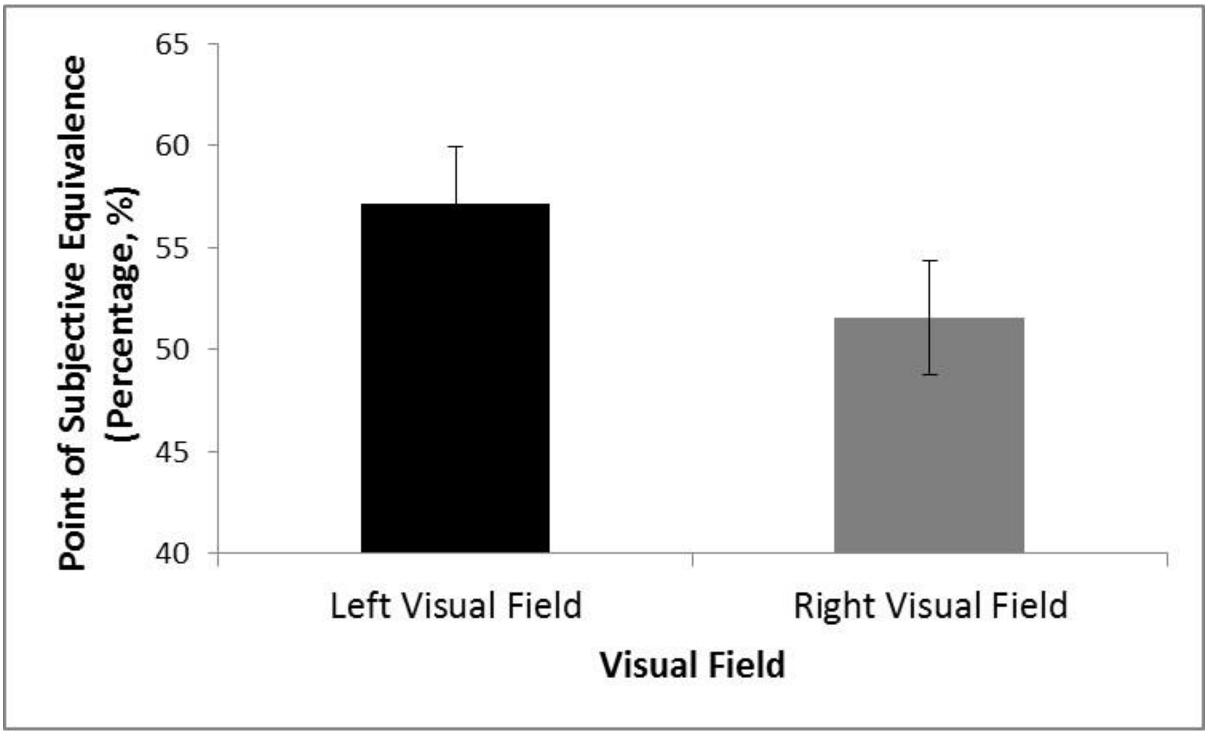

Figure 3. Mean ± standard error of the mean (SEM) PSE for both right and left visual fields. The lower PSE value in RVF suggests that less percentage of male is needed in a stimulus in order for it to be judged as male.

Figure 4

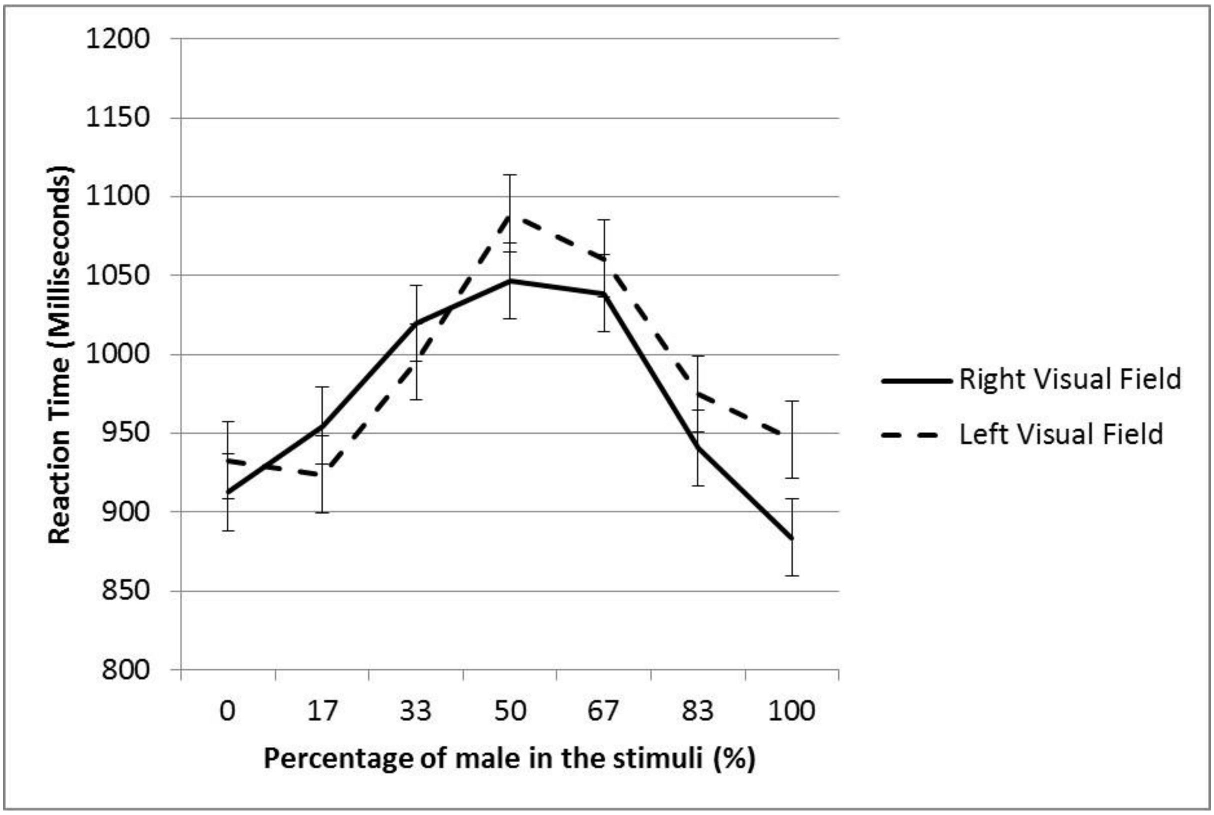

Figure 4. Mean ± SEM response times for both right and left visual fields. This clearly demonstrates the slower response times around the female/male category boundary, which is a typical response time profile for a categorical judgment task. The response times for the most male stimuli were significantly faster in the RVF than the LVF.