Understanding gender bias in face recognition: Effects of divided attention at encoding

Matthew A. Palmer *, Neil Brewer, Ruth Horry

Flinders University, Australia

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Prior research has demonstrated a female own-gender bias in face recognition, with females better at recognizing female faces than male faces. We explored the basis for this effect by examining the effect of divided attention during encoding on females’ and males’ recognition of female and male faces. For female participants, divided attention impaired recognition performance for female faces to a greater extent than male faces in a face recognition paradigm (Study 1; N = 113) and an eyewitness identification paradigm (Study 2; N = 502). Analysis of remember–know judgments (Study 2) indicated that divided attention at encoding selectively reduced female participants’ recollection of female faces at test. For male participants, divided attention selectively reduced recognition performance (and recollection) for male stimuli in Study 2, but had similar effects on recognition of male and female faces in Study 1. Overall, the results suggest that attention at encoding contributes to the female own-gender bias by facilitating the later recollection of female faces.

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1. Introduction

A substantial literature demonstrates own group biases in recognition memory tasks. For example, people are better at recognizing faces of their own race versus another race (i.e., the own-race bias; e.g., Hugenberg, Young, Bernstein, & Sacco, 2010; Malpass & Kravitz, 1969; Meissner & Brigham, 2001; Sporer, 2001), and their own age versus older or younger faces (i.e., the own-age bias; e.g., Anastasi & Rhodes, 2005; Perfect & Harris, 2003; Wright & Stroud, 2002). One variation of own group bias that has received relatively little attention is the own-gender bias. Prior research has demonstrated a female own-gender bias in face recognition, with females better at recognizing female faces than male faces (Cross et al., 1971; Ellis et al., 1973; Hugenberg et al., 2010; Meissner & Brigham, 2001; Sporer, 2001). Further, there is empirical evidence that own-group biases rely on encoding factors (e.g., Goldinger, He, & Papesch, 2009; Van Bavel, Packer, & Cunningham, 2008; Young, Bernstein, & Hugenberg, 2010). One idea central to several models (Hugenberg et al., 2010; Levin, 2000; Rodin, 1987; Sporer, 2001) is that people selectively attend to own-group faces at encoding. Although this idea has been discussed most often in the context of the own-race bias, some researchers have suggested that the female own-gender bias may arise because females pay more attention to female faces than to male faces (Cross et al., 1971; Ellis et al., 1973; Hugenberg et al., 2000; McKelevie, Standing, St. Jean, & Law, 1993; Rehnman & Herlitz, 2007). Why might females but not males attend more to faces of their own gender? Two types of explanations have been offered. The first is a developmental one, and rests on the notion that females and
males have different length histories of selectively attending to own-gender faces (Herlitz & Rehnman, 2008). Female and male infants show a preference for looking at female faces over male faces (Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002), perhaps because infants experience more social interaction with female adults than male adults (Ramsey, Langlois, & Marti, 2005). As a result, female and male infants are better at recognizing female faces than male faces (Quinn et al., 2002). Thus, if adult males do have an attentional preference for male faces, any advantage this affords for recognition may be undermined by an early history of selective attention for female faces. The second type of explanation is social, and holds that women are more attentive to female than male faces because they are more socially interested in other women than in men (Rehnman & Herlitz, 2007). This might reflect the fact that relationships between females tend to be of longer duration (Parker & de Vries, 1993) and involve a greater degree of intimacy (Davidson & Duberman, 1982) than relationships between males (for a review, see Sherman, De Vries, & Lansford, 2000). Other researchers have suggested that females may be more interested in female faces due to the high value placed by society on female attractiveness (Cross et al., 1971; Ellis et al., 1973). Note that, like the aforementioned developmental account, these social explanations do not suggest that males attend more to male faces than female faces.

1.2. Overview of studies

The attentional explanation of the female own-gender bias provides the basis for specific predictions about the effects of divided attention on female and male participants' recognition of female and male faces. If females selectively attend to female faces during encoding, a divided attention manipulation at encoding should impair females' later recognition to a greater extent for female faces than male faces. As a result, the magnitude of the female own-gender bias will be reduced. In contrast, assuming that males do not selectively attend to male faces during encoding, the effects of a divided attention manipulation on males' face recognition performance should be similar for male and female faces.

We tested these predictions in two studies involving different types of recognition decisions. In Study 1, female and male participants completed simple face recognition tests for female and male faces that had been studied under full or divided attention conditions. In Study 2, we re-analyzed data from an eyewitness memory experiment in which female and male participants attempted to identify a female and male culprit who had been viewed under full or divided attention conditions (Palmer, Brewer, McKinnon, et al., 2010). After reporting the results of these studies, we outline a potential mechanism for the effects of attention on females' recognition memory performance (based on dual process theories of recognition memory; Yonelinas, 2002) and explore the viability of this mechanism by re-analyzing additional data from Palmer, Brewer, McKinnon, et al. (2010). We then compare our results and methodology with those of recent research in this area (Lovén, Herlitz, & Rehnman, 2011).

2. Study 1: The own-gender bias in face recognition

2.1. Outline

In Study 1, male and female participants completed a face recognition experiment in which attention at encoding (full vs. divided) and gender of target face (female vs. male) were manipulated within-subjects. Male and female participants completed two blocks of face recognition trials. In one block, faces were studied under full attention conditions; in the other, participants performed a secondary tone-monitoring task (Parkin, Reid, & Russo, 1990) during study.

2.2. Method

2.2.1. Participants

Participants were 113 undergraduate students (68 females; aged 17 to 39 years, $M = 19.70, SD = 3.00$) with normal or corrected-to-normal vision who were paid an honorarium for their time. Four additional participants were excluded for failing to follow experimental instructions.

2.2.2. Procedure and materials

After being informed of their rights, participants were seated at an individual computer. All instructions were administered on screen and progress through the study was self-paced. Participants were told that there would be two blocks of face recognition questions; in each block, they would view some faces, complete a short visual memory task, and then make recognition judgments about a series of faces.

Face stimuli comprised head-and-neck color photographs of 80 individuals (40 female) obtained from the Face-Place Face Database Project (Tarr, 2011). These were randomly divided into four sets of 20 faces (10 females). For each recognition block, one set of faces served as targets and the other as foils. The use of faces was counterbalanced such that each face was used equally often (a) as a target and a foil, and (b) in the full and divided attention blocks.

During the study phase of each block, participants viewed a series of 20 target faces (10 females) in random order, each presented for 2 s with an inter-stimulus interval of 250 ms. Following the study phase in each block, participants completed a 3-minute distractor task. (On each trial of the distractor task, participants were presented with a pattern of black and white squares. After 3 s, the pattern would disappear, and then re-appear another 3 s later with one black square changed to white. Participants were asked to click on the square that had changed color.) Participants then completed the test phase for that block. Participants viewed a series of 40 faces (the 20 targets mixed with 20 foils). To minimize the chance that participants were recognizing pictures rather than faces (Bruce, 1982), the photos used at study and test were not identical. There were two photos of each stimulus face, one taken with the person looking straight at the camera (used during study phases) the other with the person looking slightly away from the camera (used during test phases). For each face in the test phase, participants indicated whether it had appeared during the study phase for that block and rated their confidence (from 50% to 100%) that their decision was correct. At the end of each block, participants were informed that they had now completed all questions for that set of faces, and that no more questions would be asked about the faces they had seen during that block. Participants then completed the study phase, distractor task, and test phase for the second block.

2.2.3. Divided attention manipulation

Each participant completed the study phase for one block under full attention conditions and the other under divided attention conditions (counterbalanced so that half of the participants studied faces under divided attention during their first block). The divided attention manipulation was based on a tone-monitoring task used by Palmer, Brewer, McKinnon, et al. (2010). In the divided attention condition, the study phase was accompanied by a pre-recorded soundtrack of tones randomized for pitch (high and low) and intervening interval (1 s or 2 s). Participants were asked to respond to low and high pitch tones by pressing keys marked low or high with their left or right index finger, respectively. In the full attention condition, the study phase was not accompanied by a soundtrack.

2.3. Results

Face recognition performance was indexed by $d'$ values, calculated from hit and false alarm rates. Cohen's $f$ was used to estimate effect
sized for interactions and main effects, and Cohen’s $d$ was used for pair-
wise comparisons of means in follow up tests (with $d$s corrected for corre-
lations between paired-samples means; Morris & DeShon, 2002).

Guidelines for small, medium, and large effects, respectively, are 0.1, 0.25, and 0.4 for $f$, and 0.2, 0.5, and 0.8 for $d$.

2.3.1. The effects of divided attention on face recognition

For female participants, a $2 \times 2$ (attention $\times$ gender of target face) ANOVA on $d'$ values yielded a significant main effect of attention, $F(1, 67) = 21.09$, $p < .001$, $f = .35$. As expected, $d'$ was higher
for full attention ($M = .99$, $95\% CI = 0.84, 1.13$) than divided attention
($M = .57$, $95\% CI = 0.43, 0.71$). The main effect of gender of target face was also significant, $F(1, 67) = 15.31$, $p < .001$, $f = .27$. Consis-
tent with prior research demonstrating an own-gender bias for fe-
males, $d'$ was higher for female faces ($M = .93$, $95\% CI = 0.79, 1.07$)
than male faces ($M = .63$, $95\% CI = 0.50, 0.76$).

Of greatest interest was the significant Attention $\times$ Target interaction,
$F(1, 67) = 4.04$, $p = .049$, $f = .10$, which reflected the fact that di-
vided attention had a stronger effect on $d'$ for female faces than male
faces. As shown in Fig. 1, for female participants, divided attention reduced $d'$ for female faces and male faces. However, the effect of divided
attention on $d'$ was greater for female faces ($mean\ difference = 0.56$
$95\% CI = 0.33, 0.79$), $t(67) = 4.83$, $p < .001$, $d = 0.59$, than male faces ($mean\ difference = 0.27$, $95\% CI = 0.04, 0.50$), $t(67) = 2.34$, $p = .022$, $d = 0.28$.

For male participants, a $2 \times 2$ (attention $\times$ gender of target face) ANOVA on $d'$ values revealed a significant main effect of attention,
$F(1, 44) = 17.34$, $p < .001$, $f = .39$, with $d'$ higher for full attention ($M = .82$, $95\% CI = 0.65, 1.00$) than divided attention ($M = .39$, $95\% CI = 0.23$, $0.55$). The main effect of gender of target face and the Attention $\times$ Target interaction were non-significant, $F_s < 1$. Thus, for male participants, the effect of divided attention on $d'$ values did not vary significantly be-
tween female and male faces (see Fig. 1).

2.3.2. The effects of divided attention on the own-gender bias

This research focused primarily on the effects of divided attention on recog-
nition of female and male faces. However, we also examined the effects of divided attention on the female own-gender bias. This was done by using paired samples $t$-tests to compare female partici-
pants’ recognition performance for female versus male faces (under full and divided attention conditions separately). Note that these analy-
ses relate to the significant Attention $\times$ Target interaction described in Section 2.3.1.

The results showed that divided attention at encoding reduced the magnitude of female participants’ own-gender bias. Under full attention
conditions, $d'$ was higher for female faces than male faces ($mean\ difference = 0.45$, $95\% CI = 0.24, 0.66$), $t(67) = 4.29$, $p < .001$, $d = 0.52$. In con-
trast, under divided attention conditions, there was no significant difference in $d'$ between female and male faces ($mean\ difference = 0.16$, $95\% CI = 0.05, 0.38$), $t(67) = 1.50$, $p = .138$, $d = 0.18$. For male participants, there was no evidence of an own-gender bias: $d'$ did not significantly differ between female and male faces under either full attention or divided attention conditions, $t_s < 1$.

2.4. Discussion

Study 1 showed that divided attention at encoding had a greater
detrimental effect on females’ recognition of female faces than male
faces, and reduced the magnitude of the own-gender bias for females.
These findings are consistent with the idea that females selectively at-
tend to female faces during encoding. However, these results are

1 We conducted separate analyses of data for female and male participants because existing theory and data—described in the introduction—provided strong reason to expect different patterns between gender groups. The 3-way interaction (gender of participant $\times$ attention $\times$ gender of target face) did not reach significance, $F(1, 111) = 2.80$, $p = .097$.

The results of Study 1 by testing whether similar effects would be found
with a task that more closely approximated face recognition decisions
made in everyday life (i.e., involving more complex stimuli and a more
complex recognition decision than those used in Study 1). In terms of
stimulus complexity, the stimuli used in the face recognition test in
Study 1 were still photographs of faces presented on plain white back-
grounds. In contrast, the target stimuli used at encoding in Study 2 com-
prised videos of two target persons (one male, one female) performing
various everyday tasks (i.e., withdrawing money from an automatic
bank teller; drinking coffee at a café) in settings with rich contextual de-
tail (i.e., shop fronts, cars, street signs, incidental persons).

In terms of decision complexity, in each trial during the recognition
tests in Study 1, participants were shown a single stimulus and made a
yes/no decision about whether it was presented during the earlier
study phase. In the eyewitness identification task used in Study 2, par-
ticipants viewed an array of stimuli (eight lineup members) and made a
decision that reflected (a) whether the target was present in the
array, and (b) if so, which lineup member it was. In the context of signal
detection theory (SDT; Green & Swets, 1966; Macmillan & Creelman,
1991), this is a compound recognition decision (also termed simul-
taneous detection and identification or identification with uncertainty).
There is no a priori argument for expecting that the effects of divided
attention on females’ recognition of female and male faces will differ
depending on the complexity of the recognition decision. However,
the vast majority of recognition memory research has focused on simple
decisions (O’Connor, Guhl, Cox, & Dobkins, 2011); from that viewpoint,
any investigation of whether effects found with simple recognition deci-
sions also occur with compound decisions is of theoretical interest.
### 3.2. Method

#### 3.2.1. Participants

Participants were 502 undergraduate students (280 females; aged 17–56 years, $M = 22.37, SD = 7.20$) who received course credit or payment.

#### 3.2.2. Materials and procedure

We provide a summary of the methodology used to collect the data analyzed in Study 2; a detailed description can be found in Palmer, Brewer, McKinnon, et al. (2010). Participants viewed a stimulus video depicting five adults, each of different appearance (e.g., young female with straight blond hair and a white shirt; young female with wavy, dark-brown hair and a red top), performing different everyday activities (e.g., drinking coffee; reading a newspaper). One male and one female were chosen as targets. Eight-person target-present and target-absent lineups were constructed for each target. Target-present lineups comprised head-and-shoulders photographs of the target and seven match-to-description foils (i.e., selected because they matched the general description of the culprit as might be given to police by a witness). For target-absent lineups, the target was replaced with another match-description foil.

Participant’s attention during encoding was manipulated via a tone monitoring task (Parkin et al., 1990). The soundtrack to the stimulus video comprised a series of tones randomized for pitch (high or low) and intervening interval (1 or 2 s). Participants in the divided attention condition were asked to respond to tones of high and low pitch by pressing keys marked high and low, respectively. Participants in the full attention condition were told that the soundtrack was for another experiment and asked to ignore the tones. Data for 19 divided-attention participants who failed to signal at least 2/3 of the tones correctly were excluded.

Following an 8-minute interval, participants were asked to identify two targets (one male and one female from the video) from separate lineups. Each participant viewed either (a) a target-present lineup for the female and a target-absent lineup for the male, or (b) a target-absent lineup for the female and a target-present lineup for the male. The order of presentation of targets and lineup types was counterbalanced. For each lineup, participants were informed that the lineup may or may not contain a person who appeared in the video, and were asked to click on the photo of anyone they recognized from the video or click the not present button. Participants rated their confidence in the accuracy of their decision on an 11-point scale ranging from 0% (not at all confident) to 100% (completely confident).

#### 3.3. Results and discussion

##### 3.3.1. Description of analyses

The analyses for Study 2 must be prefaced by two points. First, the calculation of $d'$ is different for compound versus simple decisions. In Study 2, we re-analyzed the results of Palmer, Brewer, McKinnon, et al. (2010) using a model designed to estimate $d'$ for compound decisions: Signal detection theory-compound decision (SDT-CD; Duncan, 2006; see also Palmer & Brewer, 2012; Palmer, Brewer, & Weber, 2010; Starr, Metz, Lusted, & Goodenough, 1975). Appendix A contains a description of this model and an explanation of how it was used to calculate the $d'$ values reported in Study 2. Second, because each participant provided only two identification responses (one for the female culprit and one for the male), typical parametric analyses could not be performed on $d'$ values in Study 2. Following Palmer, Brewer, and Weber (2010), we analyzed $d'$ values by calculating an inferential confidence interval ($IC_{05}$) for each $d'$ value (Tryon, 2001; see Appendix A for a description of this procedure). These intervals enabled us to make pair wise inferential comparisons between full and divided attention conditions, with non-overlapping intervals indicating a significant difference at the alpha = .05 level.

#### 3.3.2. The effects of divided attention on eyewitness identification decisions

Fig. 2 depicts the effects of the divided attention manipulation on female and male participants’ responses to lineups for the female and male culprits. It is clear that overall recognition performance was better for the female stimuli than the male stimuli. Palmer, Brewer, McKinnon, et al. (2010) speculated that this may have been due to differences between the female and male stimuli in terms of factors such as the degree of similarity between targets and distractors in the lineup, or the degree of change in appearance between study and test.

In terms of the effect of divided attention on female participants’ recognition performance, the results aligned with those of Study 1. Identification performance for the female culprit was poorer under divided attention ($d' = 2.43, IC_{05} = 2.11, 2.75$) than full attention conditions ($d' = 3.44, IC_{05} = 3.13, 3.75$). In contrast, females’ identification performance for the male culprit did not differ significantly between the divided ($d' = 1.14, IC_{05} = 0.76, 1.52$) and full attention conditions ($d' = 1.55, IC_{05} = 1.13, 1.97$). Thus, divided attention had a greater detrimental effect on females’ identification of the female culprit than the male culprit.

For male participants, the results did not align with those of Study 1; instead, they mirrored those found for female participants. Identification performance for the female culprit did not differ significantly between the divided attention ($d' = 2.17, IC_{05} = 1.80, 2.54$) and full attention conditions ($d' = 2.73, IC_{05} = 2.26, 3.20$). However, identification performance for the male culprit was poorer under divided attention ($d' = 0.37, IC_{05} = 0.17, 0.91$) than full attention conditions ($d' = 1.68, IC_{05} = 1.68, 2.64$). Thus, for male participants, divided attention impaired later identification of the male culprit but not the female culprit. This result was not anticipated, and it is not clear why divided attention selectively impaired males’ recognition of male faces in Study 2 but not Study 1. One possibility is that the difficulty of the face recognition task in Study 1 (evidenced by relatively low $d'$ values) may have produced a floor effect. In other words, male participants’ poor recognition of male faces in the full attention condition may have limited the potential for divided attention to further reduce performance. This issue warrants further investigation.

#### 3.3.3. The effects of divided attention on the own-gender bias

For female participants, there was evidence that divided attention reduced the magnitude of the own-gender bias in Study 2. Female participants performed better for the female culprit than the male culprit under full attention (female: $d' = 3.44, IC_{05} = 3.13, 3.75$ vs. male: $d' = 1.55, IC_{05} = 1.13, 1.97$) and divided attention conditions (female: $d' = 2.43, IC_{05} = 2.11, 2.75$ vs. male: $d' = 1.14, IC_{05} = 0.76, 1.52$). However, the corresponding effect sizes estimates suggest that the difference in performance between the female and male culprit was greater...
for full attention (Cohen’s $d = 0.64$) than divided attention (Cohen’s $d = 0.46$). Note that this comparison of effect sizes must be interpreted with caution because it is not accompanied by an inferential test of the Attention × Culprit interaction (which was not possible because analyses were conducted via inferential Cs, owing to the collection of a single data point per participant for each culprit).

Male participants did not display an own-gender bias; in fact, there was evidence of an opposite-gender bias. Male participants recognized the female culprit better than the male culprit under divided attention conditions (female: $d = 2.17$, $CI_{95\%} = 1.80$, 2.54 vs. male: $d = 0.37$, $CI_{95\%} = 0.17$, 0.91), and there was a non-significant trend toward better recognition of the female culprit than the male culprit under full attention (female: $d = 2.73$, $CI_{95\%} = 2.26$, 3.20 vs. male: $d = 2.16$, $CI_{95\%} = 1.68$, 2.64). As noted in the Introduction, an opposite-gender bias for males has been reported in some prior studies (e.g., McKelvie et al., 1993; Rehman & Herlitz, 2007). In Study 2, the relevant effect size estimates suggested that the divided attention manipulation increased the magnitude of the other-gender bias for male participants. That is, that the difference between male participants’ recognition of the female and male culprit appears to be greater under divided attention (Cohen’s $d = 0.53$) than full attention (Cohen’s $d = 0.17$). Again, note that this comparison of effect sizes must be interpreted with caution due to the absence of an inferential test of the Attention × Culprit interaction.

Although the presence of an opposite-gender bias for males and an own-gender bias for females complicates the interpretation of these results, it is important to note that all of the results described in this section reflect the same underlying effect. That is, divided attention at encoding impaired females’ recognition of female faces to a greater extent than other-race faces. Although some researchers have argued that R and K judgments do not reflect recollection and familiarity, respectively (Yonelinas, 2002), this results obtained with RK judgments (Tulving, 1985) are a widely-used method for classifying recognition decisions as subjectively based on recollection or familiarity (e.g., Bodner & Lindsay, 2003; Donaldson, 1996; Dunn, 2004, 2008), results obtained with RK judgments have been shown to converge with those obtained via other methods of indexing recollection and familiarity (Marcon et al., 2009; McCabe, Roediger, & Karpicke, 2011; Yonelinas, 2001; Yonelinas, Kroll, Dobbins, Lazzara, & Knight, 1998).

If divided attention at encoding selectively reduces females’ later recall of a female culprit, divided (cf. full) attention will be associated with a lower rate of recollection-based responses for the female culprit. This would be evidenced by a lower rate of correct R judgments ($R_{hit}$), but not lower rates of incorrect R judgments ($R_{fa}$) or familiarity-based judgments. Note that familiarity-based judgments were defined as K responses given that an R response was not made (i.e., [K−1-R]; Yonelinas & Jacoby, 1996).

3.4.2. The effects of divided attention on RK judgments

Table 1 shows the effects of the divided attention manipulation on rates of $R_{hit}$, $R_{fa}$, and K/[1-R]. These effects were examined via chi-square tests, and Cohen’s $w$ was used to estimate effect sizes (guidelines for small, medium, and large effects are 0.1, 0.3, and 0.5, respectively).

The results for female participants were consistent with the notion that divided attention impaired female participants’ later recollection of the female culprit but not the male culprit. For female participants, divided attention reduced the $R_{hit}$ rate for the female culprit, $\chi^2(1, n = 254) = 4.70, p = .030$, $w = 0.14$, but did not reduce the $R_{fa}$ or K/[1−R] rates, $\chi^2 < 1$. For females’ responses for the male culprit, divided attention had no significant effect on the rates of $R_{hit}$, $R_{fa}$, or K/[1−R]. $\chi^2 < 1$.

The results for male participants suggested that divided attention selectively impaired recollection for the male culprit. For the male culprit, divided attention reduced the $R_{hit}$ rate, $\chi^2(1, n = 205) = 5.34, p = .021$, $w = 0.16$, but did not reduce the rate of K/[1−R], $\chi^2 < 1$, or $R_{fa}$, $\chi^2(1, n = 205) = 2.38, p = .123$, $w = 0.11$. (Note that the latter non-significant trend was toward a higher, not lower, rate of $R_{fa}$ for divided versus full attention.) For male participants’ responses to the own-race and own-gender biases share similar underlying mechanisms—as several researchers have suggested (Hugenberg et al., 2010; Sporer, 2001)—then we would expect recollection to make a greater contribution to females’ recognition of female faces than male faces.
female culprit, divided attention did not significantly reduce the $R_{UIT}$ rate, although the effect size for this comparison exceeded the cutoff for a small effect, $\chi^2(1, n = 198) = 2.70, p = .101, \omega = 0.12$. The divided attention manipulation did not affect the rate of $R_{UP}$ or $K/[1-R]$, $\chi^2<1$ for the female culprit.

3.5. Summary of results for Study 2

For female participants, the results of Study 2 converged with and extended the findings of Study 1. As per Study 1, divided attention at encoding was associated with female participants’ poorer recognition performance for female stimuli but not male stimuli. These results indicate that the relationship between attention at encoding and the female own-gender bias applies not only to simple recognition tasks, but also extends to compound recognition decisions involving relatively complex stimuli. In addition, the RK data for Study 2 provided evidence that divided attention at encoding affected female participants’ recognition performance by selectively impairing the recollection of female faces.

The results for male participants (unlike Study 1) also showed evidence that divided attention selectively reduced recognition performance for own-gender faces; divided attention was associated with poorer recognition performance for the male culprit but not the female culprit. Further, analysis of the RK data suggested that divided attention impaired male participants’ later recollection of the male culprit. These results raise the possibility that, when a male own-gender bias does emerge (as in Ellis et al., 1973; Wright & Sladden, 2003), it may be underpinned by the same mechanism that we propose is responsible for the female own-gender bias. That is, under some circumstances, males pay more attention to male faces than female faces and, in turn, better recollect male faces during a later recognition test.

4. General discussion

The aim of this research was to explore the role of effortful attention in the female own-gender bias in face recognition. The results advance knowledge of this issue in two main ways. First, by showing that divided attention at encoding reduced females’ recognition of female faces to a greater extent than male faces, these studies provide evidence that the female own-gender bias relies—at least in part—on attention at encoding. This notion is consistent with several theoretical accounts of the etiology of the female own-gender bias, which suggest that females pay more attention to female faces than male faces for social or developmental reasons (e.g., Herlitz & Rehnman, 2008; Rehnman & Herlitz, 2007).

Second, the results inform understanding of the cognitive processes that underpin the role of attention at encoding in the female own-gender bias. Specifically, analyses of RK judgments from Palmer, Brewer, McKinnon, et al. (2010) indicated that for female participants, divided attention at encoding reduces females’ recognition performance by selectively impairing females’ later recollection of female faces. Put another way, the reason why attention during encoding is important is because it facilitates the later recollection of female faces.

As noted briefly in Section 2.4, our results partly contradict those of a recent study conducted by Lovén et al. (2011). As in our research, Lovén et al. found a robust female own-gender bias, and debilitating effects of divided attention on face recognition. However, in contrast to our findings, divided attention did not reduce the magnitude of the female own-gender bias, suggesting that attention at encoding does not play a pivotal role in the female own-gender bias. At present these two studies are the only ones to examine this issue directly, and additional research may resolve this discrepancy in results. In the meantime, we offer one possible explanation: the discrepancy may have been due to differences in the strength of the divided attention manipulations used. We suggest that the manipulations used in Lovén et al.’s Experiments 1 and 2 (which involved monitoring a series of aurally-presented digits for two consecutive odd numbers) were likely stronger than those used in our research (monitoring a series of high and low-pitch tones). Although divided attention at encoding typically reduces recollection to a greater extent than familiarity (Yonelinas, 2002), strong divided attention manipulations can disrupt not only recollection, but familiarity as well (Kinoshita, 1995; Mulligan, 1997). If the manipulations used in Lovén et al.’s Experiments 1 and 2 were sufficiently strong to impair both recollection and familiarity, they would not be expected to reduce the magnitude of the female own-gender bias (an effect that relies on the selective impairment of recollection, as evidenced by the patterns of RK judgments in Study 2). This explanation gains traction when we consider the pattern of results found in Lovén et al.’s Experiment 3, which used a milder divided attention task (monitoring aurally-presented series of digits for the digits one or five instead of two consecutive odd digits) designed “…to reduce the attentional load in the divided attention condition” (p. 337). With this less demanding task, there was a non-significant trend toward divided attention reducing the own-gender bias for females (see the last panel of Fig. 1 in Lovén et al., p. 336). In sum, we suggest that divided attention conditions at encoding selectively impair females’ recognition of female faces to the extent that they selectively impair recollection. This explanation requires further testing, but can potentially account for all of Lovén et al.’s and our data.

Our results also point to some other potentially interesting issues for further investigation. One such issue concerns the nature of the contextual information that accompanies females’ recollection of female faces. The subjective experience of recollecting can be accompanied by a wide range of contextual detail (Yonelinas & Jacoby, 1996), including information about the spatial and temporal context that the recognized item appeared in (e.g., “I remember seeing that face as the very first one on the study list”, or the internal cognitive processes that accompanied recognition (e.g., “I remember thinking that that face looked friendly when I saw it on the study list”). It could be that females’ recollection of female faces is accompanied by the recall of a particular type of contextual detail. For example, if females perceive female faces as more relevant to themselves than male faces (cf. He, Ebner, & Johnson, 2011), they may encode female faces in a more self-referent manner (i.e., focusing on information that is relevant to the self; e.g., Symons & Johnson, 1997). In turn, females’ recognition decisions for female faces may be characterized by a relatively high proportion of self-relevant contextual information (e.g., “I remember that her eyes were a different color to mine”) as opposed to non-self-relevant information (e.g., “I remember that her eyes were blue”). Future research might examine whether this is the case.

Another topic for future research concerns the conditions under which an own-gender bias emerges for males. The results of Study 2 suggest that under at least some conditions, males selectively attend to male faces, facilitating later recollection. This raises the possibility that there may be factors that promote or deter the selective direction of attention to male faces by male perceivers. Although there do not appear to be any obvious methodological differences between studies that have found an own-gender bias for males and those that have not, a systematic investigation of this issue may prove fruitful.

4.1. Conclusion

Two studies present evidence that divided attention at encoding impairs females’ recognition of female face to a greater extent than male faces, suggesting that attention during encoding is important for the female own gender-bias. Patterns of remember–know responses suggest that attention during encoding facilitates females’ subsequent recollection of female faces.

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The calculation of $d'$ is different for compound versus simple decisions. For simple decisions, only four types of responses are possible (hits and misses for target trials; false alarms and correct rejections for lure trials), and $d'$ can be calculated from hit and false alarm rates. However, for compound decisions, a fifth type of response is possible: a foil can be chosen from a target-present array. Because such responses could be classified as false alarms (because a foil was chosen) or misses (because the target was present and not chosen), $d'$ cannot be calculated in the same way as for simple decisions. In Study 2, we used an integration model of SDT-CD (Duncan, 2006; Macmillan & Creelman, 1991; Palmer & Brewer, 2012; Palmer, Brewer, & Weber, 2010; see also Starr et al., 1975) which is designed to estimate $d'$ for compound decisions. SDT-CD produces model-generated response probabilities (i.e., foil identifications and correct lineup rejections for culprit-absent lineups, and correct identifications, foil identifications, and incorrect lineup rejections for culprit-present lineups) for a wide range of possible combinations of $d'$ and response criterion. These model-generated probabilities were compared against the observed response probabilities in each cell of the Palmer, Brewer, McKinnon et al. data to find the best-fitting combination of $d'$ and response criterion for that cell. This comparison was made via, three separate likelihood-ratio G-tests (Sokal & Rohlf, 1981) which compared observed and model-generated frequencies of false alarms, hits, and correct identifications. (Model-generated frequencies were calculated by multiplying model-generated response probabilities by the number of culprit-absent and culprit-present trials for false alarms and hits, respectively, and by the number of observed hits in the case of correct identifications). A $G_{\text{total}}$ statistic was calculated by summing $G$ for the three tests. The smallest total $G_{\text{total}}$ value indicated the best-fitting combination of $d'$ and $c$ estimates for that condition.

Further, because each participant provided only two identification responses (one for the female culprit and one for the male), typical parametric analyses could not be performed on $d'$ values in Study 2. Instead, we analyzed $d'$ values following the steps used by Palmer, Brewer, and Weber (2010). First, we used a modified jackknife procedure (Koriat, Lichtenstein, & Fischhoff, 1980; Mosteller & Tukey, 1968; Weber & Brewer, 2006) to estimate the variance for each $d'$ value. For each cell, $d'$ was calculated as many times as there were participants, with a different participant omitted each time (e.g., in a cell with 100 participants, $d'$ would be calculated 100 times, each time based on data from 99 participants). This procedure produced a distribution of $d'$ values from which a jackknife estimate of variance was derived. These estimates of variance were then used to calculate inferential 95% confidence intervals for each $d'$ value (Tryon, 2001), which enabled us to make pair wise comparisons between full and divided attention conditions. Non-overlapping intervals indicate a significant difference at the alpha = .05 level.


