Running Head: Repetition Priming

Lateralized Repetition Priming for Unfamiliar Faces

Douglas Martin, Louise, K. Nind and C. Neil Macrae

University of Aberdeen

Word count: 4427

Address Correspondence To:

Douglas Martin
School of Psychology
University of Aberdeen
King's College
Aberdeen AB24 2UB
Scotland, UK

Email: d.martin@abdn.ac.uk

Abstract

Repetition priming is the ability to recognize a stimulus more rapidly as a result of prior exposure to the item. Recent research examining the neuroanatomical basis of this effect has demonstrated repetition priming for familiar faces presented to the right but not the left cerebral hemisphere. Extending this line of inquiry, the current research considered whether similar effects emerge when unfamiliar faces are the stimuli of interest. Using a divided-visual-field methodology, repetition priming for unfamiliar faces in the left and right hemispheres was assessed. The results revealed that repetition priming: (i) only emerges in the right hemisphere; (ii) is evident regardless of whether the lateralized presentation of unfamiliar faces occurs at study or test; and (iii) occurs only when hair is cropped from the faces. The theoretical implications of these findings are considered.

It has frequently been demonstrated that repeated presentation of a stimulus can result in facilitated processing of the item, an effect termed *repetition priming* (RP, see A. W. Ellis, Flude, Young, & Burton, 1996; Jacoby & Dallas, 1981). RP is a robust and highly replicable phenomenon, with the effect emerging across multiple domains and a range of stimulus materials (see Schacter, 1994, for a review). Such is the diverse nature of RP, researchers have questioned whether the effect reflects the operation of a single process or the common product of divergent cognitive operations (Schacter, 1994). This debate is perhaps most prominent in discussions of the inconsistencies that emerge when RP is assessed using familiar and unfamiliar faces (e.g., Ellis, Young & Flude, 1990; Goshen-Gottstein & Ganel, 2000). Given recent work demonstrating the laterality of RP for familiar faces (Bourne & Hole, 2006), the current investigation explored whether comparable effects emerge when unfamiliar faces comprise the stimuli of interest.

Most of the available research on RP to date has focused on the processing of familiar rather than unfamiliar faces (see Bruce, Burton, Carson, Hanna, & Mason, 1994, for a review), a methodological preference that derives from the contention that, as they are processed by functionally distinct cognitive operations, unfamiliar faces may be unsuitable for the generation of RP effects (Burton, Bruce, & Johnson, 1990; Ellis et al., 1990). Based on work on implicit-memory, however, Goshen-Gottstein and Ganel (2000) have recently challenged this viewpoint. Noting that RP for objects demands stimuli be processed as perceptual wholes, Goshen-Gottstein and Ganel speculated that attempts to demonstrate RP with unfamiliar faces may have failed because one of the favoured tasks (e.g., sex categorization) does not require participants to direct attention to the internal features of a face. It is generally conceded that while a variety of facial features can be used to determine the sex of an individual (e.g., textural information, shape of eyebrows), by far the most useful and reliable cue is a person's hairstyle (Brown & Perrett, 1993; Burton, Bruce, & Dench, 1993; Macrae & Martin, 2007; Martin & Macrae, 2007). What this means, of course, is that in studies investigating RP using unfamiliar faces, participants can sex the stimuli simply by attending to available hair cues. The resulting failure to encode a structural representation of the face necessarily impedes the emergence of

RP when the stimulus is encountered on a subsequent occasion (Bruce & Young, 1986; Hay & Young, 1982; Schacter, 1994). To remedy this situation, Goshen-Gottstein and Ganel (2000) removed hair cues from their images, thus ensuring that participants processed the faces as perceptual wholes during the sex-categorization task. Under these conditions, RP was observed (see also Henson et al., 2003; Quinn & Macrae, 2005).

Extending this general line of inquiry, recent work has documented important cerebral asymmetries in the emergence of RP, at least for familiar faces. Bourne and Hole (2006), for example, have demonstrated a right hemisphere advantage for RP. Using a divided-visual-field methodology, participants were presented with images of familiar and unfamiliar faces unilaterally to either the right or left visual field (i.e., left hemisphere (LH) or right hemisphere (RH) respectively) and were asked to judge the familiarity of each face. Then, in a subsequent test phase, they were required to repeat the classification task on previously seen and unseen faces presented at fixation. Interestingly, Bourne and Hole (2006) reported a significant RP effect, but only when familiar faces were presented to the RH. Corroborating this result, a similar effect was observed in a second study in which faces were presented to either the right or left visual field at both study and test. These results, then, provide clear evidence for a RH advantage in the emergence of RP for familiar faces.

But what about unfamiliar faces, do they also elicit a RP advantage in the RH? While sex categorization and face identification have often been deemed to rely on parallel cognitive operations (Bruce & Young, 1986), recent behavioural and neuroimaging work points to the extraction of these classes of invariant person-related knowledge via a single processing route (Dubois et al., 1999; Ganel & Goshein-Gottstein, 2002; Haxby et al., 2000; Mason & Macrae, 2004; Rossion, 2002; Rossion et al., 1999; Sergent, Ohta, & MacDonald, 1992). This then would suggest that RP for unfamiliar faces may also be most pronounced in this hemisphere. Interestingly, Bourne and Hole (2006) observed no such effect. It is possible, however, that some methodological limitations may have undermined the emergence of RP. First, by only using a small number of critical faces (Expt 1: 5 unfamiliar faces were presented to each hemisphere) Bourne and Hole did not create the optimal conditions for

identifying hemispheric differences in RP. Second, because the task used by Bourne and Hole required participants to make familiarity judgments to known (i.e., famous) and unknown (i.e., previously unseen) faces at study, when the unfamiliar faces were re-presented at test they would have acquired a level of episodic familiarity, thereby contaminating the 'unfamiliar' response that participants were required to make (see also Dosher & Rosedale, 1991; Goshen-Gottstein & Moscovitch, 2005).

So under more favourable task conditions, would one expect to find a RH advantage in RP for unfamiliar faces? Several lines of evidence suggest that this may indeed be the case. First, an extensive behavioural literature has demonstrated that the RH commonly outperforms the LH on a variety of face processing tasks (e.g., Rhodes, 1985, 1993; Yin, 1969). These findings, moreover, are supported by neuroimaging research (e.g., fMRI) which has revealed that regions in the right ventral temporal cortex play a critical role in both the registration and construal of unfamiliar faces (e.g., Dubois et al., 1999; Haxby et al., 2000; Henson et al., 2003; Hoffman & Haxby, 2000; Rossion et al., 2001). Similarly, research using event-related potentials (ERPs) has demonstrated a right-lateralized response signal negativity (N170) following the presentation of facial stimuli (Bentin, Allison, Puce, & Perez, 1996; Eimer, 1998; George, Evans, Fiori, & Davidoff, 1996; Henson et al., 2003).

Supplementing the neuroimaging evidence, work on implicit memory is also suggestive of a RH bias in RP for unfamiliar faces. Memory systems accounts of implicit memory posit the existence of pre-semantic structural representations that can be formed following a single exposure to a stimulus. Importantly, these representations are reactivated on reappraisal of the stimulus resulting in the facilitated processing that is indicative of RP (e.g., Tulving & Schacter, 1990). Crucially, the RH seems to be particularly adept at creating and activating these structural representations (Marsolek, 1999; Marsolek, Kosslyn & Squire, 1992; Marsolek, Schacter, & Nicholas, 1996; Marsolek, Squire, Kosslyn, & Lulenski, 1994). Using divided-visual-field and dichotic listening methodologies, a RH implicit-memory advantage has been reported for visually presented words (Marsolek et al., 1992), aurally presented words (Schacter, 1994), meaningless 2-dimensional ideograms (Marsolek et al.,

1992) and objects (Marsolek, 1999). Models of implicit memory suggest that all of these effects are supported by domain specific perceptual representation systems (PRS; Tulving and Schacter, 1990) that are located in the RH.

It seems, therefore, that there are several reasons for suspecting that, like familiar faces (Bourne & Hole, 2006), unfamiliar faces should display a RP advantage in the RH. As such, the current investigation employed a sex categorization task to explore the emergence of RP across the hemispheres, at both encoding (Expt 1a) and test (Expt 1b), using intact and cropped (i.e., hair removed) unfamiliar faces (Goshen-Gottstein & Ganel, 2000).

Method

Participants and Design.

Forty-eight undergraduates (34 female) completed both Expt 1a and Expt 1b in return for course credit. Two participants were excluded from the final data analyses because of their excessive error rates (>10% error rate). Each experiment had a 2 (Face: intact or cropped) X 3 (Position: left visual field – LVF/RH or central or right visual field – RVF/LH) X 2 (Item Status: repeated or new) mixed design with repeated measures on the second and third factors. In Expt 1a, the factor *Position* referred to the location of the faces at study, in Expt 1b it referred to the location of the faces at test.

Materials and Procedure

Participants arrived at the laboratory individually, were greeted by a female experimenter, seated at a Viglen PC and asked to place their chin on a chin rest to ensure that their eyes were 57 cm from the fixation cross on the monitor during testing. Participants were informed that they would be taking part in an experiment exploring person perception. They were then randomly assigned to either the intact-face or cropped-face prime condition and informed that their task was to classify, as quickly and accurately as possible, faces according to their sex. They were also told that on some trials faces

would not appear at fixation, but that they should continue to fixate on the centre of the screen throughout the experiment.

The priming stimuli comprised greyscale digital headshots (each face subtended a visual angle of 5˚ vertically and 4.3˚ horizontally) of 288 unfamiliar people (144 men and 144 women) in frontal pose, displaying neutral facial expressions. These images served as stimuli in both the intact and cropped face conditions (see Figure 1). In the intact-face condition, the original stimuli were used (i.e., internal facial features and hair). In the cropped-face condition, the stimuli were digitally altered using a standard oval mask, available in Adobe Photoshop (version 8.0), to remove all hairstyle information from the images (i.e., only the internal facial features remained).

Each trial comprised the appearance of a central fixation cross which remained onscreen for 500 ms. In Expt 1a, this was then replaced by the presentation of a face, either centrally at fixation, to the LVF/RH (5˚ visual angle from fixation), or to the RVF/LH (5˚ visual angle from fixation), which remained onscreen for 125 ms. Participants were asked to make a response, using a key press, indicating the sex of the face. Each participant completed a total of 72 trials (36 men and 36 women). The order of trial presentation was randomized and the computer measured the accuracy and latency of each response. Following the study phase, participants performed the same sex-classification task on 144 unfamiliar faces (72 old faces & 72 new faces). On this occasion, however, the faces were presented centrally at fixation. The presentation position of the faces during the study phase (i.e., left, central, right) and the status of the items at test (i.e., repeated, new) were counterbalanced across participants.

Expt 1b was identical to Expt 1a with two exceptions. First, different faces were used. Second, the presentation order of the stimuli was reversed (i.e., central presentation at study, lateralized (and central) presentation at test). The order in which participants completed the experiments was counterbalanced. On completion of the task, participants were debriefed and dismissed.

Results

The dependent measure of interest in each experiment was the time taken by participants to classify the faces by sex. Trials on which errors were committed were excluded from the analyses (Expt 1a = 4% errors, Expt 1b = 6% errors). Median response times were calculated for each participant and separate 2 (Face: intact or cropped) X 3 (Position: left visual field – LVF/RH or central or right visual field – RVF/LH) X 2 (Item Status: repeated or new) mixed design analysis of variance (ANOVA) were undertaken on the data from each experiment, the results of which are summarized below.

Lateralized Study Phase (Expt 1a). The analysis revealed main effects of Face [$F(1,44) = 6.73$, $p < .05$, $\eta^2 = .133$] and Item Status [$F(1,44) = 9.21$, $p < .01$, $\eta^2 = .173$] with participants responding faster to intact than cropped faces (*M*s: 360 ms vs. 401 ms) and to repeated than new items (*M*s: 377ms vs. 384 ms). A Face X Item Status interaction also emerged [$F(1, 44) = 22.36$, $p < .001$, $\eta^2 = .337$]. These effects, however, were subsumed within a Face X Position X Item Status interaction [$F(2, 88) = 3.26$, $p < .05$, $\eta^2 = .069$]. To explore the effects of theoretical interest, separate 2 (Position: LVF/RH or Central or RVF/LH) X 2 (Item Status: repeated or new) repeated measures ANOVAs were undertaken on the data obtained in each priming condition (see Figure 2).

Analysis of the cropped-face prime condition revealed a main effect of Item Status [$F(1, 22) = 27.37$, $p < .01$, $\eta^2 = .554$]. However, the analysis also yielded a Position X Item Status interaction. [$F(2, 44) = 3.25$, $p < .05$, $\eta^2 = .129$]. Simple effects analyses revealed that participants responded more quickly to repeated than new faces when the items were presented to the LVF/RH [$F(1,22) = 19.47$, $p < .0001$; *M*s: 382 ms vs. 411 ms] or Centrally [$F(1,22) = 12.69$, $p < .002$; *M*s: 386 ms vs. 413 ms]. No such effect emerged when the faces were presented to the RVF/LH [$F(1,22) < 1$, *ns*; *M*s: 407 ms vs. 409 ms; see Figure 2, top panel).

Analysis of the intact-face prime condition revealed only a marginally significant effect of Position [$F(2, 44) = 3.12$, $p = .054$, $\eta^2 = .124$], such that participants responded faster to faces that

were presented Centrally ($M = 351$ ms) than to faces presented either to the LVF/RH ($M = 367$ ms) or the RVF/LH ($M = 361$ ms) during the study phase (see Figure 2, bottom panel).

Lateralized Test Phase (Expt 1b). The analysis revealed main effects of Face [$F(1, 44) = 16.45, p < .001, \eta^2 = .272$] and Position [$F(2,44) = 62.74, p < .001, \eta^2 = .588$] with participants responding faster to intact than cropped faces (Ms: 423 ms vs. 499 ms) and to items presented Centrally ($M = 413$ ms) than to either the LVF/RH ($M = 483$ ms) or the RVF/LH ($M = 486$ ms). The analysis also yielded significant Face X Position [$F(2, 44) = 12.12, p < .001, \eta^2 = .216$], Face X Item Status [$F(1, 44) = 8.60, p < .01, \eta^2 = .164$], and Position X Item Status [$F(2, 44) = 5.23, p < .01, \eta^2 = .106$] interactions. These effects were subsumed, however, within a significant Face X Position X Item Status interaction [$F(2, 88) = 4.39, p < .05, \eta^2 = .091$]. To explore the effects of interest, separate 2 (Position: LVF/RH, Central, RVF/LH) X 2 (Item Status: repeated or new) repeated measures ANOVAs were undertaken on the data obtained from each priming condition.

Analysis of the cropped-face prime condition revealed main effects of Position [$F(1, 44) = 39.12, p < .001, \eta^2 = .640$] and Item status [$F(1, 22) = 7.77, p < .05, \eta^2 = .261$]. The analysis also yielded a Position X Item Status interaction. [$F(2, 44) = 6.94, p < .01, \eta^2 = .240$]. Simple effects analyses revealed that participants responded more quickly to repeated than new faces when the items were presented to the LVF/RH [$F(1,22) = 8.78, p < .007$; Ms: 513 ms vs. 547 ms] or Centrally [$F(1,22) = 16.86, p < .0001$; Ms: 412 ms vs. 448 ms] during the test phase. No such effect emerged when the faces were presented to the RVF/LH [$F(1,22) = 1.70, ns$; Ms: 545 ms vs. 528 ms; see Figure 3, top panel].

Analysis of the intact-face prime condition revealed an effect of Position [$F(2, 44) = 29.16, p = .001, \eta^2 = .570$], such that participants responded faster to faces presented Centrally ($M = 396$ ms) than to faces presented to the LVF/RH ($M = 436$ ms) or the RVF/LH ($M = 436$ ms) during the test phase (see Figure 3, bottom panel).

Error Rates. Mean error rates were calculated for each participant and separate 2 (Face: intact or cropped) X 3 (Position: left visual field – LVF/RH or central or right visual field – RVF/LH) X 2 (Item Status: repeated or new) mixed design ANOVAs were undertaken on the data from each experiment, the results of which are summarized below.

Lateralized Study Phase (Expt 1a). The analysis revealed main effects of Face [$F(1,44) = 30.94$, $p < .001$, $\eta^2 = .413$] and Position [$F(2,88) = 4.60$, $p < .05$, $\eta^2 = .095$], with participants making fewer errors to intact than cropped faces (*M*s: 2 % vs. 5 %) and to faces presented to the LVF/RH than either Centrally or to the RVF/LH (*M*s: LVF/RH = 3 %, Central = 4 %, RVF/LH = 4 %). There were also Position X Face [$F(2, 88) = 5.81$, $p < .01$, $\eta^2 = .117$] and Position X Item Status [$F(1, 88) = 4.42$, $p < .05$, $\eta^2 = .091$] interactions. These effects, however, were subsumed within a Face X Position X Item Status interaction [$F(2, 88) = 7.70$, $p < .01$, $\eta^2 = .149$]. To explore this effect further, separate 2 (Position: LVF/RH or Central or RVF/LH) X 2 (Item Status: repeated or new) repeated measures ANOVAs were undertaken on the error rates observed in each priming condition (see Table 1).

Analysis of the cropped-face condition revealed a main effect of Position [$F(2, 44) = 5.67$, $p < .01$, $\eta^2 = .520$]. However, the analysis also yielded a Position X Item Status interaction. [$F(2, 44) = 10.65$, $p < .001$ $\eta^2 = .326$]. Simple effects analyses revealed that participants made fewer errors to repeated than new faces when the items were presented Centrally [$F(1,22) = 16.23$, $p < .01$; *M*s: 5 % vs. 8 %]. No such effect emerged when the faces were presented to the LVF/RH [$F(1,22) < 1$, *ns*; *M*s: 4 % vs. 5 %] and there was a marginal effect in the opposite direction for faces presented to the RVF/LH [$F(1,22) = 4.05$, $p = .057$; *M*s: 6 % vs. 4 %].

Analysis of the intact-face condition revealed only a significant effect of Position [$F(2, 44) = 4.23$, $p < .05$, $\eta^2 = .161$], such that participants made more errors to faces presented to the RVF/LH (*M* = 3 %) than to faces presented either to the LVF/RH (*M* = 2 %) or Centrally (*M* = 2 %) during the study phase (see Table 1).

Lateralized Test Phase (Expt 1b). The analysis revealed main effects of Face [$F(1,44) = 31.81$, $p < .001$, $\eta^2 = .420$] and Position [$F(2,88) = 27.09$, $p < .001$, $\eta^2 = .381$], with participants making fewer errors to intact than cropped faces (*M*s: 4 % vs. 9 %) and to faces presented Centrally than to either the LVF/RH or RVF/LH (*M*s: LVF/RH = 7 %, Central = 5 %, RVF/LH = 8 %). There were also Position X Face [$F(2, 88) = 3.45$, $p < .05$, $\eta^2 = .073$] and Position X Item Status [$F(1, 88) = 3.80$, $p < .05$, $\eta^2 = .079$] interactions. The 3-way Face X Position X Item Status interaction was not reliable. Simple effects analyses on the Position X Item Status interaction revealed that participants made fewer errors to repeated than new faces when the items were presented to the LVF/RH [$F(1,45) = 7.20$, $p < .05$; *M*s: 6 % vs. 8 %]. No such effect emerged when the faces were presented Centrally or to the RVF/LH [both Fs(1,45) < 1, *ns*; *M*s: 5 % vs. 4 %; *M*s: 8 % vs. 8 %].

General Discussion

Until quite recently, RP for unfamiliar faces has proved to be a rather illusive phenomenon (Bentin & Moscovitch, 1988; Campbell & De Haan, 1998; Ellis et al., 1990). At least in task contexts tapping the efficiency of sex categorization, face repetition has routinely failed to elicit facilitated processing, the cognitive signature of RP (Burton et al., 1990; Ellis et al., 1990). Noting potential procedural difficulties with the selection of triggering stimuli, however, Goshen-Gottstein and Ganel (2000) revealed that it is indeed possible to observe RP for unfamiliar faces. Specifically, the removal of hair cues prompts the structural encoding of internal facial features, hence the facilitated processing of repeated items. Not only did the current findings corroborate this finding, but they also demonstrated a reliable hemispheric asymmetry in the emergence of RP for unfamiliar faces (cf. Bourne & Hole, 2006). Only when cropped faces were presented to the RH was RP observed. Moreover, this was the case whether the lateralized presentation of faces occurred at study (Expt 1a) or test (Expt 1b).

While the current results represent the first empirical evidence of hemispheric differences in RP for unfamiliar faces, they are consistent with several other lines of inquiry. Most notably, the

findings sit nicely with Bourne and Hole's (2006) recent demonstration of a comparable RH

advantage in RP for familiar faces. Although it is probable that RP for familiar and unfamiliar faces

may be dissociable at some level (Bruce & Young, 1986), the current results suggest an important

functional overlap in the processes that support the emergence of these priming effects. The most

likely candidate for such an overlap lies in the basic visual processes which underpin the generation of

RP for each type of face (Ganel & Goshein-Gottstein, 2002; Haxby et al., 2000; Mason & Macrae,

2004; Rossion, 2002; Rossion et al., 1999). It would appear that, to trigger RP, perceivers must extract

basic structural information from faces, a task that is accomplished most effectively by visual

operations subserved by neuroanatomical structures in the RH (Haxby et al., 2000; Rhodes, 1985,

1993). Extracting such information allows the formation of pre-semantic perceptual records that are

fundamental to prevailing theoretical accounts of both face and object based RP (Burton et al., 1990;

Tulving & Schacter, 1990).

The current findings support the notion that structural representations of unfamiliar faces can

be created after a single, brief exposure to a 2-D image as suggested by the memory systems account

of RP (Goshen-Gottstein & Ganel, 2000; Tulving & Schacter, 1990). According to this viewpoint,

following the detection of an object, perceivers retain a perceptual record of the stimulus in one of a

number of domain-specific perceptual representation systems (PRS; Tulving & Schacter, 1990). It is

posited that these perceptual records, or *engrams* (Kirsner & Dunn, 1985), are pre-semantic structural

representations of an object and are dissociated from explicit or semantic memory. Every time an

object (including a person) is perceived, an engram specific to that processing encounter is created but

is functionally independent from other information that may be related to the stimulus. Thus, when the

sex of an unfamiliar face is probed twice, access to an existing perceptual representation facilitates

processing of the stimulus on the second occasion (Kirsner & Dunn, 1985). Crucially, it is proposed

that the processing involved in creating and accessing these specific perceptual records occurs

predominantly in the RH (Marsolek et al., 1992), thereby providing the basis of the observed

hemispheric asymmetry in RP for unfamiliar faces both at encoding (Expt 1a) and retrieval (Expt 1b).

While the memory systems account provides a cogent explanation of lateralized RP for unfamiliar faces, how does this structural account fit with models of RP for familiar faces? Familiar face RP has often been explained within the Interactivity Activation and Competition (IAC) model of person recognition (Burton et al., 1990). Like the memory systems account, the IAC model posits that perceivers store structural representations of faces in Face Recognition Units (FRUs). Any positive identification of a face by a FRU leads to subsequent activation of a related Person Identity Node (PIN) that contains domain-general semantic information specific to the recognized person. Repeated exposure to a face is believed to strengthen the associations between FRUs and PINs, making the stored information highly accessible (Burton, Bruce, & Hancock, 1999; Burton, Kelly, & Bruce, 1998; Young & Burton, 1999). When this model is applied to RP for familiar faces, strengthening the association between the structural representation and semantic knowledge is reflected in facilitated responding to previously encountered faces (Burton et al., 1990). Importantly, this model is not well suited to account for RP for unfamiliar faces because although seeing a novel face may result in the creation of a FRU, the novelty of the face means there will be no associated PIN, hence no FRU/PIN relationship to strengthen (Bourne & Hole, 2006).

When considered in the context of previous research, the current results support the possibility of a single processing route for face perception (Ganel & Goshen-Gottstein, 2002; Goshen-Gottstein & Ganel, 2000). There is considerable scope for the suggesting that FRUs may actually be face-specific engrams (Bruce & Young, 1986; Burton et al., 1990; Goshen-Gottstein & Ganel, 2000), that is, pre-semantic structural representations of objects, but objects that just happen to be faces. Once such structural representations have been formed, RP may occur via two routes; reactivation of the structural representation (e.g., words, objects, sounds, faces) and strengthening of the relationship between FRUs and PINS (i.e., familiar faces). Such a model of RP accounts for the demonstrated persistence of different RP effects. As RP for unfamiliar faces relies on the reactivation of a pre-semantic perceptual representation, this effect is eliminated if a face is changed in any way (e.g., orientation) between study and test (Tulving & Schacter, 1990). This, of course, is not the case for

familiar faces. Guided by the accessibility of person-specific information contained within PINs, RP for familiar faces is largely unconstrained by the structural representation of a face (e.g., Bruce & Valentine, 1985). Thus, while RP for familiar and unfamiliar faces may display important functional differences, it is likely that in both cases RP emerges from the creation of structural representations in the RH.

In conclusion, the current the findings highlight hemispheric asymmetries in RP for unfamiliar faces similar to those observed for familiar targets – a RH advantage. In the context of extant work in RP, it is possible that this overlap in hemispheric specialization reflects reliance on structural encoding operations residing in the RH. Just as words, objects and ideograms display a RH advantage in RP (Marsolek, 1999; Marsolek et al., 1992), so too do unfamiliar faces.

References

Bentin, S., Allison, T., Puce, A., & Perez, E. (1996). Electrophysiological studies of face perception in humans. *Journal of Cognitive Neuroscience, 8*, 551-565.

Bentin, S., & Moscovitch, M. (1988). The time course of repetition effects for words and unfamiliar faces. *Journal of Experimental Psychology: General, 117*, 148-160.

Bourne, V. J., & Hole, G. J. (2006). Lateralized repetition priming for familiar faces: Evidence for asymmetric interhemispheric cooperation. *Quarterly Journal of Experimental Psychology, 59*, 1117-1133.

Brown, E., & Perrett, D. I. (1993). What gives a face its gender? *Perception, 22*, 829-840.

Bruce, V., & Young, A. W. (1986). Understanding face recognition. *British Journal of Psychology, 77*, 305-327.

Bruce, V., Burton, M., Carson, D., Hanna, E., & Mason, O. (1994). Repetition priming of face recognition. In C. Umiltà, & M. Moscovitch (Eds.), *Attention and performance 15: Conscious and nonconscious information processing.* (pp. 179-201). Cambridge: MIT Press.

Bruce, V., & Valentine, T. (1985). Identity priming in the recognition of familiar faces. *British Journal of Psychology, 76*, 373-383.

Burton, A. M., Bruce, V., & Dench, N. (1993). What's the difference between men and women?: Evidence from facial measurement. *Perception, 22*, 153-176.

Burton, A. M., Bruce, V., & Johnson, R. A. (1990). Understanding face recognition with an interactive activation and competition model. *British Journal of Psychology, 81*, 361-380.

Burton, A. M., Bruce, V., & Hancock, P. J. B. (1999). From pixels to people: A model of familiar face recognition. *Cognitive Science: A Multidisciplinary Journal, 23*, 1-31.

Burton, A. M., Kelly, S. W., & Bruce, V. (1998). Cross-domain repetition priming in person recognition. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 51*, 515-529.

Campbell, R., & De Haan, E. H. F. (1998). Repetition priming for face speech images: Speech-reading primes face identification. *British Journal of Psychology, 89*, 309-323.

Dosher, B. A., & Rosedale, G. (1991). Judgments of semantic and episodic relatedness: Common time-course and failure of segregation. *Journal of Memory and Language, 30*, 125-160.

Dubois, S., Rossion, B., Schiltz, C., Bodart, J. M., Michel, C., Bruyer, R., et al. (1999). Effect of familiarity on the processing of human faces. *Neuroimage, 9*, 278–289.

Eimer, M. (1998). Does the face-specific N170 component reflect the activity of a specialized eye processor? *Neuroreport: An International Journal for the Rapid Communication of Research in Neuroscience, 9*, 2945-2948.

Ellis, A. W., Flude, B. M., Young, A. W., & Burton, A. M. (1996). Two loci of repetition priming in the recognition of familiar faces. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 22*, 295-308.

Ellis, A. W., Young, A. W., & Flude, B. M. (1990). Repetition priming and face processing: Priming occurs within the system that responds to the identity of a face. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology, 42*, 495-512.

Ganel, T., & Goshen-Gottstein, Y. (2002). Perceptual integrality of sex and identity of faces: Further evidence for the single-route hypothesis. *Journal of Experimental Psychology: Human Perception and Performance, 28*, 854-867.

George, N., Evans, J., Fiori, N., & Davidoff, J. (1996). Brain events related to normal and moderately scrambled faces. *Cognitive Brain Research, 4*, 65-76.

Goshen-Gottstein, Y., & Ganel, T. (2000). Repetition priming for familiar and unfamiliar faces in a sex-judgment task: Evidence for a common route for the processing of sex and identity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 1198-1214.

Goshen-Gottstein, Y., & Moscovitch, M. (1995). Repetition priming for newly formed and preexisting associations: Perceptual and conceptual influences. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 1229-1248.

Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Science, 4*, 223.

Hay, D. C., & Young, A. W. (1982). The human face. In A. W. Ellis (Ed.), *Normality and pathology in cognitive functions* (pp. 173-202). London: Academic Press.

Henson, R. N., Goshen-Gottstein, Y., Ganel, T., Otten, L. J., Quayle, A., & Rugg, M. D. (2003). Electrophysiological and haemodynamic correlates of face perception, recognition and priming. *Cerebral Cortex, 13*, 793-805.

Hoffman, E. A., & Haxby, J. V. (2000). Distinct representation of eye gaze and identity in the distributed human neural system for face perception. *Nature Neuroscience, 3*, 80-84.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110*, 306-340.

Kirsner, K., & Dunn, J. C. (1985). The perceptual record: A common factor in repetition priming and attribute retention. In M. I. Posner, & Marin, O. S. M. (Eds.), *Attention and performance* (pp. 547-565). Hillsdale, NJ: Erlbaum.

Macrae, C. N., & Martin, D. (2007). A boy primed sue: Feature-based processing and person construal. *European Journal of Social Psychology, 37*, 793-805.

Marsolek, C. J. (1999). Dissociable neural subsystems underlie abstract and specific object recognition. *Psychological Science, 10*, 111-118.

Marsolek, C. J., Kosslyn, S. M., & Squire, L. R. (1992). Form-specific visual priming in the right cerebral hemisphere. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 492-508.

Marsolek, C. J., Schacter, D. L., & Nicholas, C. D. (1996). Form-specific visual priming for new associations in the right cerebral hemisphere. *Memory & Cognition, 24*, 539-556.

Marsolek, C. J., Squire, L. R., Kosslyn, S. M., & Lulenski, M. E. (1994). Form-specific explicit and implicit memory in the right cerebral hemisphere. *Neuropsychology, 8*, 588-597.

Martin, D., & Macrae, C. N. (2007). A face with a cue: Exploring the inevitability of person categorization. *European Journal of Social Psychology, 37*, 806-816.

Mason, M. F., & Macrae, C. N. (2004). Categorizing and individuating others: The neural substrates of person perception. *Journal of Cognitive Neuroscience, 16*, 1785-1795.

Quinn, K. A., & MacCrae, C. N. (2005). Categorizing others: The dynamics of person construal. *Journal of Personality and Social Psychology, 88*, 467-479.

Rhodes, G. (1993). Configurational coding, expertise, and the right hemisphere advantage for face recognition. *Brain and Cognition, 22*, 19-41.

Rhodes, G. (1985). Lateralized processes in face recognition. *British Journal of Psychology, 76*, 249-271.

Rossion, B., Schiltz, C., Robaye, L., Pirenne, D., & Crommelinck, M. (2001). How does the brain discriminate familiar and unfamiliar faces? A PET study of face categorical perception. *Journal of Cognitive Neuroscience, 13*, 1019-1034.

Rossion, B. (2002). Is sex categorization from faces really parallel to face recognition? *Visual Cognition, 9*, 1003-1020.

Rossion, B., Campanella, S., Gomez, C. M., Delinte, A., Debatisse, D., Liard, L., et al. (1999). Task modulation of brain activity related to familiar and unfamiliar face processing: An ERP study. *Clinical Neurophysiology, 110*, 449-462.

Schacter, D. L. (1994). Priming and multiple memory systems: Perceptual mechanisms of implicit memory. In D. L. Schacter, & E. Tulving (Eds.), *Memory systems* (pp. 233-268). Cambridge: MIT Press.

Sergent, J., Ohta, S., & MacDonald, B. (1992). Functiona neuroanatomy of face and object processing. A positron emission tomography study. *Brain, 115*, 15-36.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247*, 301-306.

Yin, R. (1969). Looking at upside-down faces. *Journal of Experimental Psychology, 81*, 141-145.

Young, A. W., & Burton, A. M. (1999). Simulating face recognition: Implications for modelling cognition. *Cognitive Neuropsychology, 16*, 1-48.

Acknowledgements

Figure 1. Examples of Intact and Cropped-Face Stimuli (top panel); Examples of Trial Conditions (bottom panel; Expt 1a, left panel; Expt 1b, right panel).
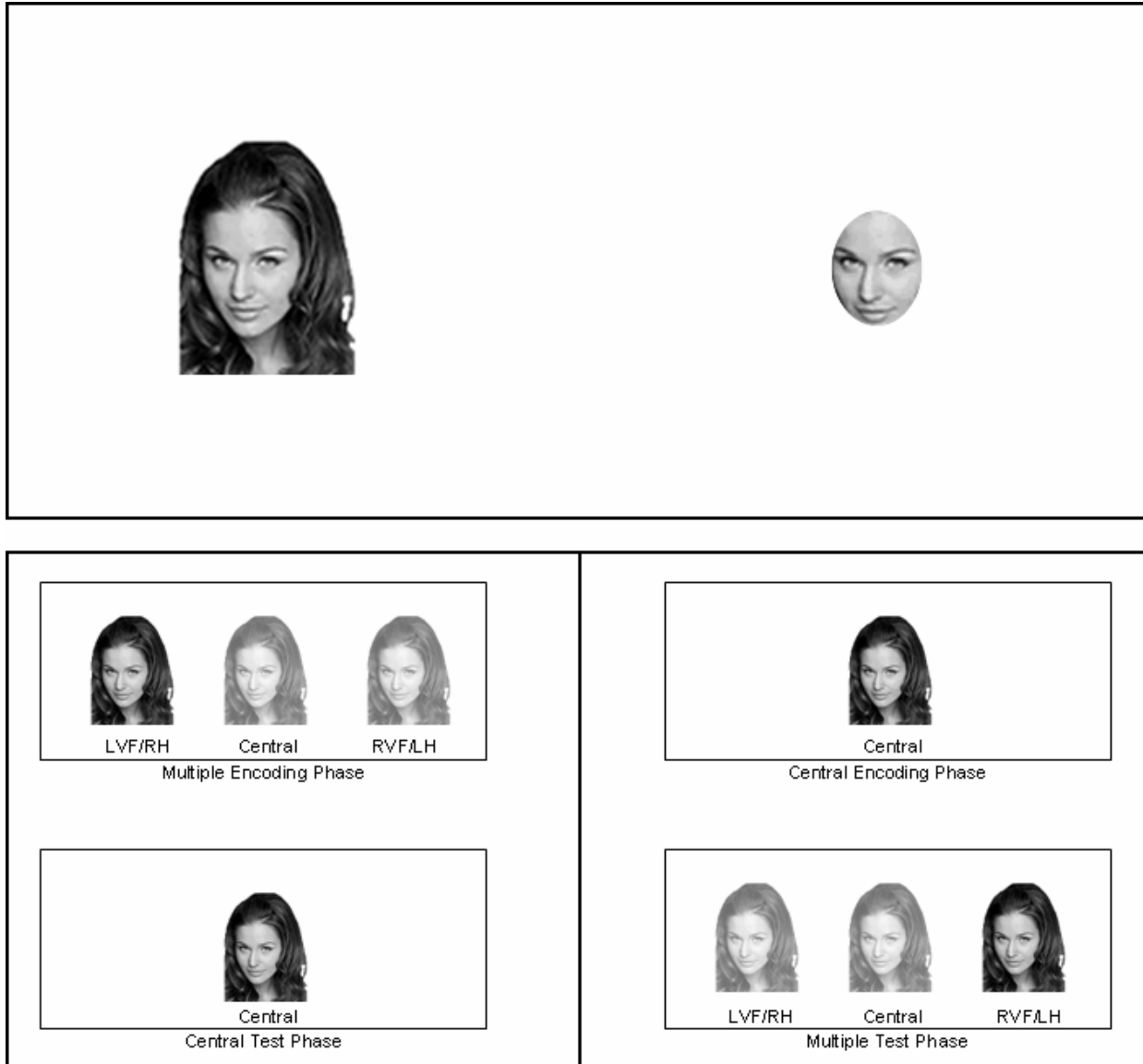
Figure 2. Task Performance as a Function of Study Position and Item Status (Expt 1a: Cropped Faces, top panel; Intact Faces, bottom panel).
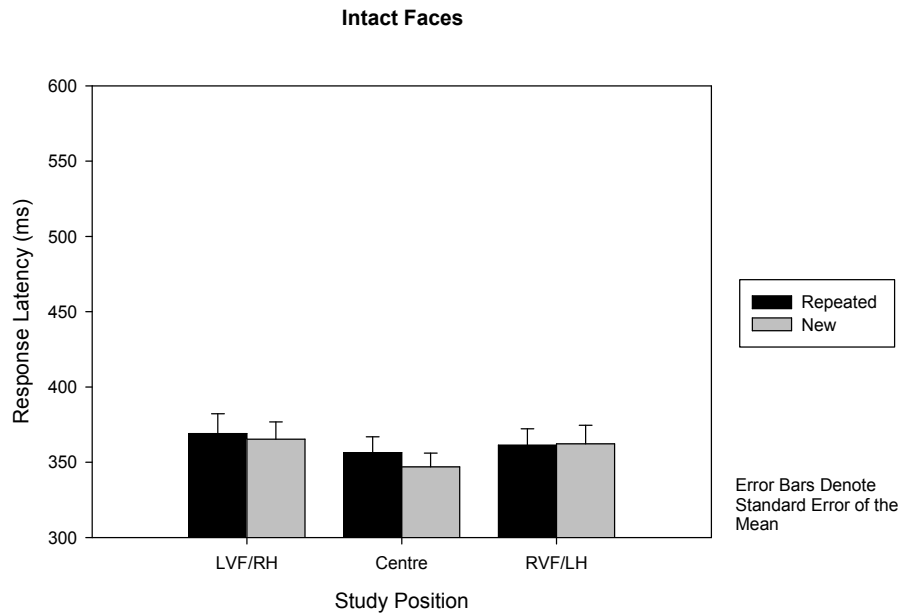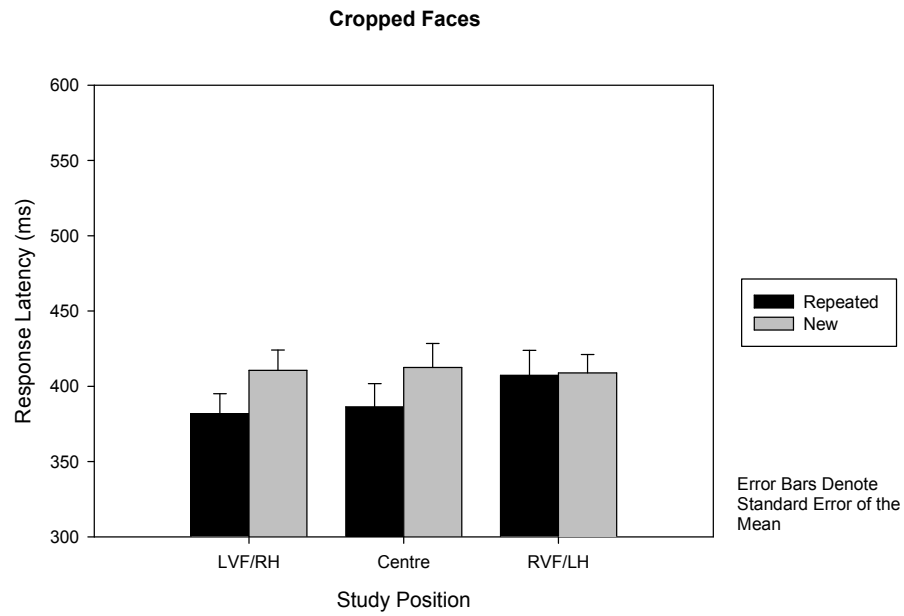
Cropped Faces

Intact Faces

Figure 3. Task Performance as a Function of Test Position and Item Staus (Expt 1b: Cropped Faces, top panel; Intact Faces, bottom panel).

Cropped Faces
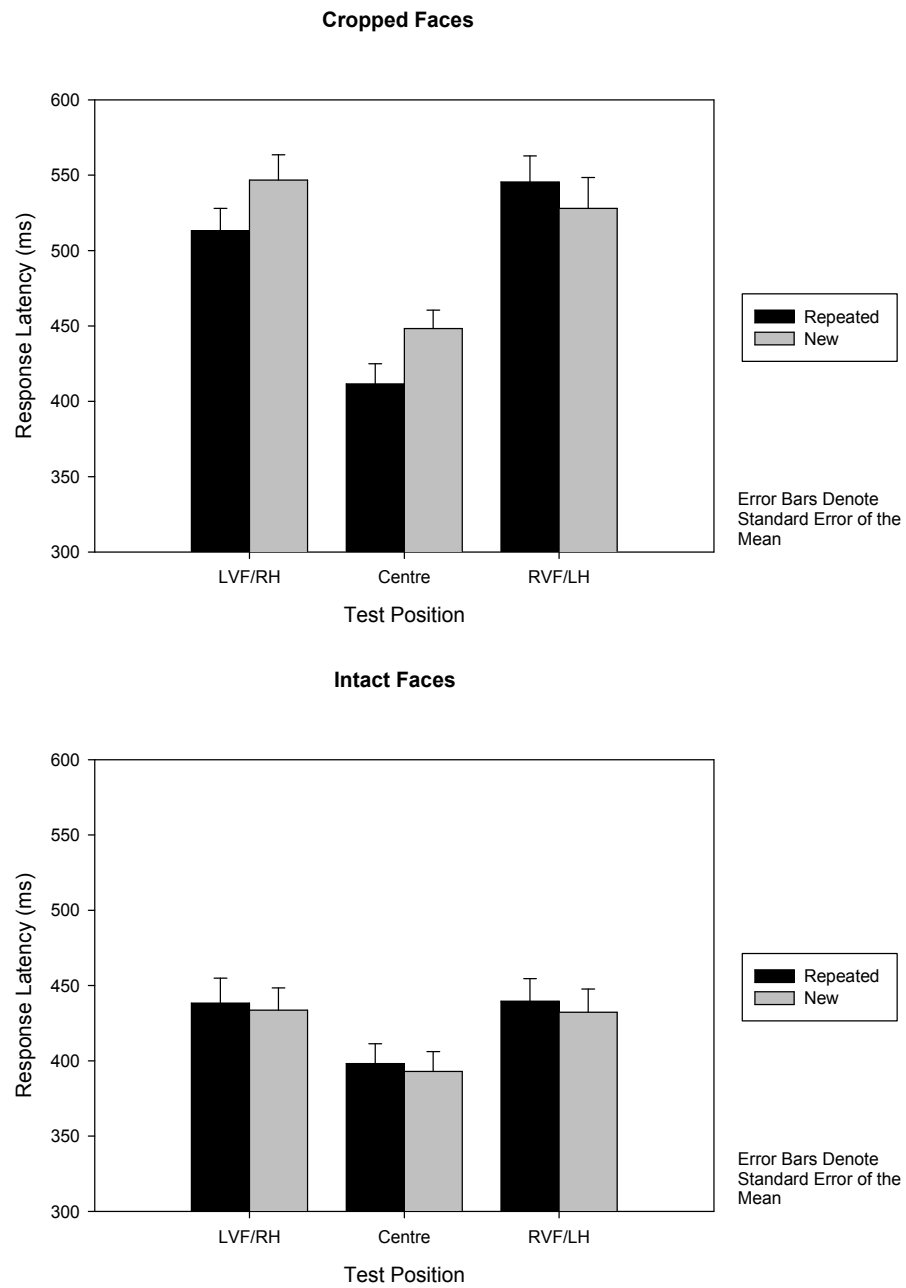

Intact Faces

Table 1. Mean Percentage Errors (Expts 1a and 1b)

Stimulus Type	Cropped Faces					Intact Faces			
Position of Stimulus	**LVF/RH**	**Centre**	**RVF/LH**	**Overall**		**LVF/RH**	**Centre**	**RVF/LH**	**Overall**
Expt 1a (Faces presented at multiple positions during encoding and centrally during test)									
Repeated	4.5	4.9	6.2	5.2		2.5	2	2.5	2.3
SE	0.6	0.6	0.7	0.6		0.6	0.4	0.4	0.5
New	5	7.5	4.4	5.6		1.2	1.7	2.8	1.9
SE	0.5	0.7	0.7	0.6		0.3	0.4	0.5	0.4
Expt 1b (Faces presented centrally during encoding and at multiple positions during test)									
Repeated	8	8.3	10.4	8.9		4	1.8	5	3.6
SE	1.2	1.0	1.1	1.1		0.6	0.4	0.8	0.6
New	10	6.8	11.6	9.5		5.3	1.7	3.8	3.6
SE	1.3	1.3	1.3	1.3		0.6	0.4	0.5	0.5