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Dissociating perceptual and representation-based contributions to priming of face recognition ☆

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Abstract

Repetition priming of object identification refers to the phenomenon whereby experience with an object induces systematic changes in subsequent processing of that same object. This data-driven form of priming is distinct from conceptually-driven priming. To date, considerable controversy exists about whether data-driven priming reflects facilitation in perceptual processing or mediation by preexisting object representations. The present study concerned priming of recognizing familiar and unfamiliar faces and how this priming is influenced by face inversion, which interferes with perceptual face processing. Perceptual and representation-based loci conjointly contributed to priming; the perceptual locus was operative similarly for familiar and unfamiliar faces, whereas the representation-based locus was only invoked for familiar faces and resulted in a response-time reduction triple the magnitude of that from the perceptual locus. The results constrain theoretical accounts of data-driven priming by indicating that improved identification can result from the combination of perceptual and representation-based facilitation.

Keywords: Implicit memory; Priming; Face priming; Face recognition; Stimulus identification; Familiar faces; Unfamiliar faces; Priming accounts; Memory systems

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1. Introduction

The identification of an object can be facilitated when that same object had been encountered recently. Such changes in the ability to identify an object develop quickly are long-lasting, and can occur even in the absence of explicit memory for the recent encounter (Roediger & McDermott, 1993; Schacter, 1992; Schacter, Chiu, & Ochsner, 1993). These processing changes are a prime example of implicit memory (for reviews, see Richardson-Klavehn & Bjork, 1988; Roediger & McDermott, 1993; Schacter, 1987).

It is important to distinguish this *data-driven* form of priming from *conceptually driven* forms of priming, which depend on conceptual knowledge spanning multiple modalities or domains. Conceptually-driven priming, for instance, appears as facilitation when objects are classified repeatedly according to such conceptual knowledge, for example, when famous persons are categorized by their nationality or occupation. Compared to conceptually driven priming, data-driven priming is disrupted to a relatively greater extent by perceptual transitions between initial and subsequent object encounter, such as a change of input modality from hearing to seeing[1] (Roediger & McDermott, 1993).

A variety of tasks have been employed to study data-driven priming. However, some tasks are more suitable than others. For example, tasks that require the naming of famous persons in response to their faces can be facilitated by both data-driven priming and conceptually driven priming from name processing. Whereas a domain shift will eliminate the data-driven part of priming, the conceptually driven part will remain unaffected (Ellis, Flude, Young, & Burton, 1996). On the other hand, other tasks have been demonstrated to selectively measure data-driven priming; such tasks include the name familiarity task and the face familiarity task that is used in the present study (Burton, Kelly, & Bruce, 1998; Ellis et al., 1996; for a review, see Burton, 1998). The face familiarity task can be administered without immediate face repetition, so as to avoid short-lived, so-called semantic or associative priming effects (Burton, Bruce, & Johnston, 1990; Calder & Young, 1996; Schweinberger, 1996); in this case, neither conceptual information that has been associated with a face (e.g., the name of the corresponding person) nor information that can be visually derived from any face (e.g., gender or age) is likely to contribute to priming. The face familiarity task is thus well suited for investigating data-driven priming.

Contemporary theoretical accounts of data-driven priming usually attribute it to either: (a) facilitation of perceptual processing or (b) mediation by abstract object representations that already exist in long-term memory (for example, see Bowers, 2000; Burton, 1998; Richardson-Klavehn & Bjork, 1988; Schacter, 1992; Tenpenny, 1995). Evidence taken to favor a perceptual locus includes reduced priming following various perceptual transformations of stimuli from first to second presentation. On the other hand, findings of reduced priming for unfamiliar compared to familiar stimuli favor a representation-based locus.

To disentangle the contributions of perceptual processing and preexisting representations to data-driven priming, we measured priming in a familiarity task for familiar and unfamiliar faces

[1] In keeping with this strong influence of perceptual transitions, the type of priming under investigation in the present study is frequently called "*perceptual priming*." Whereas this term has been associated with one theoretical account of priming (Tulving & Schacter, 1990), our emphasis on multiple accounts for this type of priming leads us to rely on the label "data-driven priming" here.

and we included a face-inversion manipulation (Yin, 1969). Priming in the familiarity task shows the typical features of data-driven priming. That is, it does not cross stimulus domains from names to faces or vice versa (Burton et al., 1998; Ellis et al., 1996), much as a modality change from hearing to reading reduces data-driven priming for words. Also, priming for unfamiliar faces is small or absent (Bentin & Moscovitch, 1988; Ellis, Young, & Flude, 1990; Goshen-Gottstein & Ganel, 2000), just as priming is often smaller for nonwords than words.

In order to produce priming conditions with and without preexisting representations, we used familiar and unfamiliar faces, respectively. For faces, the representations responsible for data-driven priming are usually considered to comprise: (a) representations of familiar faces, or *face recognition units* (Bruce & Young, 1986; Goshen-Gottstein & Ganel, 2000), or (b) face recognition units in combination with multimodal representations of familiar persons, or *person identity nodes* (Burton, 1998; Valentine, Brennen, & Bredart, 1996). Importantly, priming with familiar faces can arise from preexisting representations and/or from perceptual processing, commonly referred to as *structural encoding* (Bruce & Young, 1986; Burton, 1998). Priming with unfamiliar faces presumably reflects facilitation of structural encoding, given that specific representations of these faces have not been previously stored. A relatively pure measure of the perceptual contribution to data-driven priming of faces can thus be obtained with unfamiliar faces.

To verify this perceptual contribution to data-driven priming in the present experiment, we interfered with priming of perceptual processing. Whereas all repeated faces were presented upright, half of the initial face presentations were inverted. Theoretically, this inversion manipulation should prevent facilitation in perceptual processing (i.e., repeated faces previously presented inverted would not be subject to priming of structural encoding). To the extent that this manipulation is effective in interfering with priming of structural encoding, unfamiliar faces, which lack preexisting representations, should show no priming effect. For familiar faces, however, priming may still result from inverted face presentations to the extent that it is supported by processing beyond structural encoding, such as accessing preexisting representations.

This reasoning about priming that can occur when the initial face presentation is inverted is contingent upon some prerequisite perception of the inverted face. In some cases, for example, an inverted face can be accurately perceived such that the person's identity can be determined. Here, we used correct recognition responses as an indicator of adequate processing of inverted faces.

Interestingly, the inversion manipulation may involve important processing differences. Processing configural information in faces is thought to be critical for structural encoding of faces and to be disrupted by face inversion (Leder & Bruce, 2000; Leder, Candrian, Huber, & Bruce, 2001; Maurer, Le Grand, & Mondloch, 2002). Inverted faces may instead be processed to a relatively higher degree on the basis of their isolated features (Maurer et al., 2002), as indexed by increased activity in brain areas typically involved in processing other visual objects (Aguirre, Singh, & D'Esposito, 1999; Haxby et al., 1999). Importantly, it has been shown recently that configural processing plays a crucial role in data-driven face priming (Goshen-Gottstein & Ganel, 2000), suggesting that the face-inversion manipulation may indeed be a powerful tool to interrupt perceptually-based face priming.

We thus examined data-driven priming of faces as a function of whether the initial face presentation was inverted or upright and whether the face was familiar or unfamiliar. All repeated faces

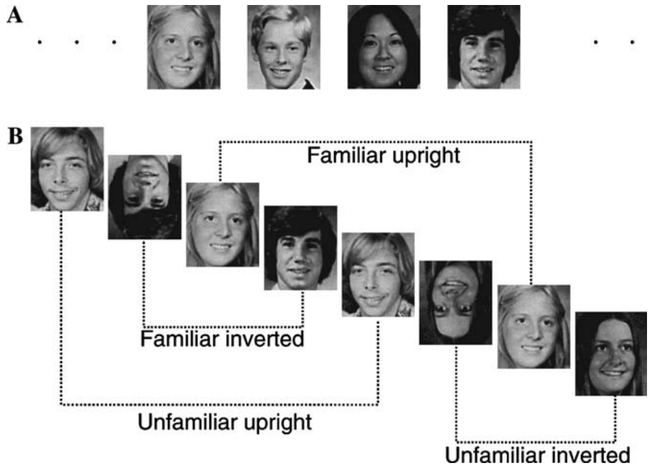

Fig. 1. Experimental paradigm. (A) Participants familiarized themselves with 50 new faces. (B) One to three days later, memory for these familiar faces was tested. In a continuous task, familiar and unfamiliar faces were presented consecutively and participants made a familiarity decision on each face. Each face was presented twice with one to three intervening faces. All repeated faces were presented upright; half of the familiar and half of the unfamiliar faces were initially presented inverted. (Faces shown here are not those used in the experiment.)

were presented upright; half of the familiar and half of the unfamiliar faces were initially presented inverted (see Fig. 1). The familiar faces were learned in an intensive learning session 1–3 days earlier, whereas none of the unfamiliar faces had been viewed before.

To illustrate the potential relevance of the results of our study for understanding data-driven priming, we formulate three alternative predictions. These predictions are based on strong forms of the chief theoretical accounts of priming so as to emphasize their differences; alternate views will also be considered when interpreting and discussing the results.[2]

(1) By a strong perceptual-processing account of data-driven priming, no differences would be expected in the amount of priming for familiar and unfamiliar faces in either condition, and significantly reduced priming would be expected in the inverted compared to the upright condition.
(2) By a strong representation-based account, in contrast, the same amount of priming would be predicted for familiar faces regardless of the initial face orientation, but no priming for unfamiliar faces in either condition.
(3) If a hybrid view applies and both perceptual processing and preexisting object representations contribute to priming, then the present procedure should reveal the relative contributions of the two components.

[2] Some of the accounts used to derive these predictions have typically been applied to stimuli other than faces. Although differences between stimulus domains should always be taken into account when interpreting priming findings, here we emphasize general aspects of data-driven priming and attempt to develop generalizations that may be independent of stimulus domain.

2. Method

Twenty-eight healthy adults (mean age 19 years, 17 female) participated for course credit. All but one were right-handed as assessed by a handedness questionnaire.

Because famous faces may be familiar to participants to a varying degree, we controlled face familiarity using a 1-h study session during which participants familiarized themselves with photographs of 50 preexperimentally unknown Caucasian faces of similar facial expression, physical properties like luminance and contrast, photographic style, and background. Faces were presented individually or in groups of 10 on a computer screen. This study session contained two short tests, using five new and five learned faces each, in order to provide feedback about learning. All faces in the experiment (those learned during the study session and unfamiliar faces presented only at the later test session) were taken from the same set of facial stimuli (Endl et al., 1998).

Memory for the newly learned faces was tested 1–3 days later (mean 2 days). Participants were asked to discriminate familiar (learned) from unfamiliar (new) faces by pressing buttons with their left or right index fingers. The assignment of hands to responses (familiar/unfamiliar) was counterbalanced across participants. Instructions emphasized both speed and accuracy.

The 50 familiar faces were presented together with 50 unfamiliar faces in a continuous task, which was interrupted by three short breaks. Each face was presented individually at the center of a computer screen for 600 ms (height 4.0°, width 2.8° visual angle). A 2800-ms fixation cross followed each face. All faces were presented twice. As shown schematically in Fig. 1, half of the familiar and half of the unfamiliar faces were initially presented inverted, whereas all repeated faces were presented upright. Repetition of faces occurred after one to three intervening faces. This short repetition lag of approximately 7–14 s was selected in an attempt to maximize priming effects. The existence of at least one intervening face and the lack of extended semantic knowledge about individual faces should be sufficient to prevent known short-lived effects of immediate face repetition that are not under consideration here (Burton et al., 1990; Calder & Young, 1996; Schweinberger, 1996). The order of conditions was unpredictable to the participants. Specific faces presented in the upright or inverted condition were counterbalanced across participants. Response-time relative to presentation onset and accuracy were subjected to repeated-measures analysis of variance (ANOVA). The level of significance was set to $\alpha = .05$ for all comparisons. Analysis of priming effects included only trials with repeated faces in which a correct response had been given at both presentations.

3. Results

Recognition accuracy was assessed by comparing hit rates for learned (familiar) faces to false alarm rates for new faces (see Table 1), using separate ANOVAs for upright and inverted faces. At initial presentation, high accuracy for upright faces signaled reliable memory for learned faces, $F(1,27) = 996.04$, $p < .0001$. Recognition accuracy for inverted faces was also well above chance, $F(1,27) = 71.57$, $p < .0001$.

The effect of face inversion was analyzed using separate ANOVAs for hit rates and false alarm rates. Accuracy was reduced for inverted faces compared to upright faces, as reflected by a lower hit rate, $F(1,27) = 87.67$, $p < .0001$, and a higher false alarm rate, $F(1,27) = 23.63$, $p < .0001$. Accordingly, recognition sensitivity (as measured with d-prime) was lower for inverted faces.

Table 1
Recognition accuracy across presentation conditions

Measure	Initial presentation				Repetition (upright)			
	Upright		Inverted		Initially upright		Initially inverted	
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Hit rate	.82	.02	.51	.04	.90	.02	.84	.03
False alarm rate	.06	.01	.18	.02	.06	.01	.05	.01
D-prime	2.47		.94		2.84		2.61	

Note. Hit rate (proportion of familiar faces correctly recognized); false alarm rate (proportion of unfamiliar faces incorrectly endorsed as familiar). A hit rate higher than the false alarm rate indicates above-chance recognition, as indicated by a positive value for d-prime, an index of recognition sensitivity. D-prime was derived from mean hit and false alarm rates.

These results demonstrate the well-known face inversion effect. An effect of face inversion was also found in response times; ANOVAs showed that responses were delayed to inverted in comparison to upright faces by 168 ms for familiar faces, $F(1,27) = 46.88$, $p < .0001$, and by 177 ms for unfamiliar faces, $F(1,27) = 50.56$, $p < .0001$. Response times for initial presentation of upright faces were longer for familiar faces than for unfamiliar faces, $F(1,27) = 13.96$, $p < .0009$.[3]

We assessed data-driven priming for upright faces within separate ANOVAs for familiar and unfamiliar faces by comparing reaction times for repeated faces against reaction times for initial upright presentations. Reaction times were analyzed only for correct trials and data from repeated faces were included only if they had also been recognized correctly on initial presentation. As shown in Fig. 2, in the upright condition a priming effect of 170 ms was observed for familiar faces, $F(1,27) = 130.27$, $p < .0001$, and of 48 ms for unfamiliar faces, $F(1,27) = 15.52$, $p < .001$. In a direct comparison of priming effects in these two conditions, priming was significantly smaller for unfamiliar than for familiar faces, $F(1,27) = 110.35$, $p < .0001$, replicating previous reports of reduced priming for unfamiliar faces.

We assessed the influence of the inversion manipulation on face priming with separate ANOVAs for familiar and unfamiliar faces by comparing the priming effects between upright and inverted conditions. Priming effects were smaller with inverted than with upright initial presentations for both familiar, $F(1,27) = 6.39$, $p < .05$, and unfamiliar faces, $F(1,27) = 12.37$, $p < .01$ (Fig. 2). These priming reductions due to stimulus inversion at initial presentation were directly compared between familiar and unfamiliar faces and found to be of comparable size, $F(1,27) = 0.57$. Priming in the inverted condition was analyzed with separate ANOVAs for familiar and unfamiliar faces by comparing reaction times to repeated faces initially presented inverted against reaction times to initial upright face presentations. The priming effect of 141 ms for familiar faces was significant, $F(1,27) = 91.16$, $p < .0001$, whereas the difference of 8 ms for unfamiliar faces was negligible, $F(1,27) = 0.53$.

[3] This result contrasts to findings from two prior studies, showing faster responses to familiar than unfamiliar faces (Ellis et al., 1990; Pfuetze, Sommer, & Schweinberger, 2002) and may reflect a bias to respond "unfamiliar" in the present experiment (see Table 1). Importantly, the other patterns of priming and effects of inversion appear to be independent of these baseline differences in reaction time, given that a follow-up experiment with a similar behavioral design yielded the same pattern of priming, whereas responses to initially presented faces were found to be faster for familiar upright than for unfamiliar upright faces (Boehm, Klostermann, & Paller, 2005).

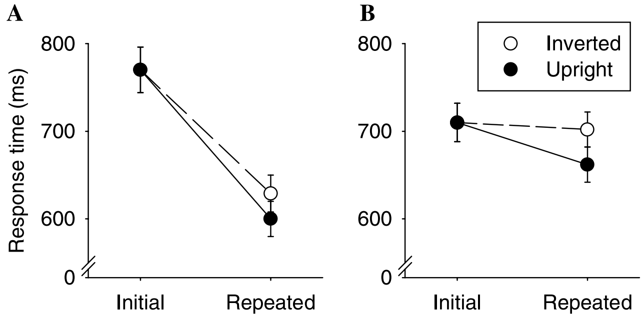

Fig. 2. Mean response times with standard errors for (A) familiar faces and (B) unfamiliar faces. The given stimulus orientation refers to initial stimulus presentation; all repeated stimuli were presented upright. To assess priming, reaction times of repeated faces were compared to the reaction times of initial presentations of upright faces. Response times were greatly slowed for inverted faces (938 ms, $SE = 36$, for familiar faces and 887 ms, $SE = 37$, for unfamiliar faces).

4. Discussion

The present results demonstrated data-driven priming in a face familiarity task for familiar as well as for unfamiliar faces. In our novel paradigm for studying face priming, each face was repeated after a delay of 7–14 s filled with one to three different faces. The combination of a face-inversion manipulation and the inclusion of familiar and unfamiliar faces made it possible to estimate the contribution of two types of processing to data-driven priming in these circumstances: (1) facilitated perceptual processing that is independent of preexisting representations and (2) mediation by preexisting representations of the specific face or person in question. The results suggest that both components contribute to data-driven priming. In particular, the results argue against a recently suggested model for data-driven priming of faces that postulates the representation-based component as the common priming locus for both familiar and unfamiliar faces (Goshen-Gottstein & Ganel, 2000).

A perceptual contribution to data-driven face priming was measured by the difference in priming between faces initially presented upright and faces initially presented inverted. Results showed clear perceptual contributions to priming for both familiar and unfamiliar faces. Importantly, in line with a perceptual-processing account, the magnitude of priming at the perceptual locus was independent of face familiarity. Moreover, there was no priming from inverted unfamiliar faces, implying that priming at this locus was eliminated when a face was inverted on initial presentation. The differences in perceptual processing of upright and inverted faces suggest that this priming component may depend critically on configural processing.[4] We interpret this component as priming of *structural encoding* of faces.

[4] The change from upright to inverted format involves a change in the specific angle from which a face is viewed (i.e., a change in viewpoint). Faces are often viewed from different angles and the generation of a viewpoint-independent description of a face is considered important for face identification. It could be argued that priming at the perceptual locus may result from facilitation of this processing and therefore may be dependent of the repetition of the same viewpoint. This possibility could be tested, for example, by presenting prime and test faces that differ in their specific viewpoint. Configural processing, however, may provide a better explanation for priming at the perceptual locus. The generation of viewpoint-independent descriptions of faces can be considered part of configural processing; most importantly, configural processing has been shown to be a prerequisite for data-driven priming to occur (Goshen-Gottstein & Ganel, 2000).

A representation-based contribution to data-driven face priming was measured as priming from inverted faces. In accordance with a representation-based account, priming at this second locus was present only for familiar faces. Moreover, this experiment is based on the premise that representation-based priming does not vary with perceptual transitions between initial and repeated presentation. If this premise had been violated, then the effect of inversion would have been greater for familiar than for unfamiliar faces. The finding that the effect of the inversion manipulation was no larger for familiar faces than unfamiliar faces is in keeping with the idea that priming at the second locus was unaffected by the orientation of the initial face presentation. This evidence supporting a representation-based contribution to data-driven priming is also remarkable considering that the same images for initial and repeated face presentations were used; under such circumstances, it could be argued that any performance gain may result simply from image-specific processing. Therefore, the presence of clear priming from inverted familiar faces in view of the absence of priming from inverted unfamiliar faces is compelling evidence for a representation-based locus of priming. The mediation of this priming effect by preexisting representations suggests that this priming component concerns processing pertaining to *person identity* (Bruce & Valentine, 1985). Representation-based face priming was described in the influential cognitive model of face recognition put forward by Bruce and Young (1986). Recent versions of this model propose that such priming reflects a Hebbian-like strengthening of the connections between face recognition units and person identity nodes (Burton, Bruce, & Hancock, 1999; Burton et al., 1990).

According to the classical view of semantic memory as long-term storage of all factual knowledge (Tulving, 1983), these representations supporting data-driven priming are considered part of semantic memory. Whereas the representation-based locus of priming is mediated by meaningful and well-established representations within semantic memory, we emphasize that it is data-driven and not conceptually driven. That is, when immediate stimulus repetitions are excluded, as in the current experiment, priming in the familiarity task does not cross domains (Burton et al., 1998; Ellis et al., 1996). This representation-based locus of data-driven priming is thus distinct from amodal forms of priming (e.g., conceptually-driven priming).[5]

The perceptual and representation-based loci conjointly facilitate person identification, but the amount of priming they contribute differs. These differences in priming amount and the different invocation of these loci for familiar and unfamiliar faces explain reduced priming effects commonly found with unfamiliar faces (Goshen-Gottstein & Ganel, 2000). That is, unfamiliar faces showed priming of the perceptual locus (indexed by upright-to-upright priming) and no priming from the representation-based locus (indexed by inverted-to-upright priming, which was negligible). This result confirms one important assumption of our approach, namely that unfamiliar faces show no priming from processing of person identity. Interestingly, the perceptual locus of data-driven priming may be operative only when participants engage in sufficient face processing that includes configural processing. Indeed, Goshen-Gottstein and Ganel (2000) suggested that priming effects in the gender discrimination task are absent when participants apply heuristics that focus on superficial features and therefore do not require configural face processing.

[5] We consider face recognition units and person identity nodes as part of semantic memory, but this should not be confused with *semantic information units* in face recognition models (Burton, 1998) as a label for person-related knowledge. Priming that arises at this level of multimodal semantic information is conceptually driven.

We found significantly more priming for familiar than unfamiliar faces, and we interpret this as evidence for a representation-based priming locus. This interpretation is not only based on the design and experimental findings in the current study. The importance of representations for data-driven face priming has commonly been accepted in the face recognition literature (Bruce & Young, 1986; Burton, 1998; Goshen-Gottstein & Ganel, 2000; Valentine et al., 1996). However, the finding that priming effects are smaller for unfamiliar than for familiar faces deserves further discussion with respect to task differences and the possibility of other factors influencing task performance.

The initial presentation of unfamiliar faces might be sufficient for creating new representations of those faces (Goshen-Gottstein & Ganel, 2000; Henson, Shallice, & Dolan, 2000; Schweinberger, Pfuetze, & Sommer, 1995). When unfamiliar faces are repeated, these new representations could signal that the faces are not totally unfamiliar. It could be argued that this would cause some interference, slowing down the "unfamiliar" response to repeated unfamiliar faces and thus counteracting and obscuring priming effects. For such interference to occur, however, two competing sources of information are required, but here there is only a single source of information—the strength of representations. Because these new representations of unfamiliar faces would arguably be weaker than previously established representations of familiar faces, participants could reasonably accommodate this situation by selecting a response criterion conservative enough to discriminate between the strength of familiar faces and the much lower strength of unfamiliar faces. Hence, conceding that the process of establishing a lasting representation of a face can start with the first exposure to an unfamiliar face, this appears unlikely to cause prolonged response times upon repetition. Instead it could be argued that the "unfamiliar" response to unfamiliar faces could show some representation-based priming, but this idea was not supported by our findings, which showed no priming for unfamiliar faces that were initially inverted.

In our experiment, participants judged each face as familiar or unfamiliar based on a study phase 2 days earlier. The within-session repetition of unfamiliar faces in this task likely resulted in episodic memory for those faces, signaling that a repeated unfamiliar face is not totally new. Arguably, this could have artificially reduced priming effects for unfamiliar faces. However, some empirical evidence argues against the relevance of such repetition-based bias. Consider a situation similar to our experiment where fame judgments are made to a series of famous and nonfamous faces or to a series of famous and nonfamous names. When nonfamous faces or names were repeated, increased fame ratings have been observed under certain circumstances (Bartlett, Strater, & Fulton, 1991; Jacoby, Kelley, Brown, & Jasechko, 1989; Squire & McKee, 1993). When the effect of episodic memory on fame judgments was investigated, episodic memory was found, however, to inhibit false fame judgments to both unfamiliar faces and names (Bartlett et al., 1991; Squire & McKee, 1993). A similar result can be found in our data in that the rates of false alarms for unfamiliar faces were virtually the same for upright new and repeated faces (see Table 1). Importantly, the effect of episodic memory on accuracy was not obtained through a slowing of responses (Squire & McKee, 1993). Based on these findings, a bias by episodic memory for unfamiliar faces seems unlikely to have offset priming effects here.

Recently, it has been noted that the comparison between priming of familiar faces and priming of unfamiliar faces is typically complicated by task differences (Goshen-Gottstein & Ganel, 2000). That is, only tasks commonly used to study data-driven priming of familiar faces concern configural processing and require the identification of the faces as belonging to individual persons.

During this identification, representations of familiar faces are accessed. Because these representations play such a crucial role in face priming, smaller priming effects for unfamiliar faces may reflect, in most cases, the use of tasks that do not involve identification. When task confounds are excluded, however, the finding of smaller priming for unfamiliar faces persisted (Goshen-Gottstein & Ganel, 2000). Notably, this finding was obtained while participants made gender judgments and thus familiarity of faces was irrelevant to the task. In the present study, confounding task differences were also excluded; a strength of our study is that the familiarity task used here required the accurate processing of each face's individuality. Still, smaller priming for unfamiliar faces was found. Together these studies suggest that priming for unfamiliar faces is reduced independent of task differences and of whether the task requires judgments concerning the familiarity of faces.

Summarizing our data and related findings in the literature, data-driven face priming appears to comprise two components, a perceptual locus and a representation-based locus. These loci are differently involved for familiar and unfamiliar faces. That is, familiar faces show priming of the perceptual and the representation-based locus, whereas unfamiliar faces only show priming of the perceptual locus.

Our results constrain theoretical models of data-driven priming by demonstrating that this form of priming is neither solely perceptual and presemantic nor solely mediated by preexisting object representations in memory. Data-driven priming is thus not a unitary process. The perceptual processes and the organization of preexisting object representations may vary with stimulus classes and input modalities, and, accordingly, so may the degree to which perceptual and representation-based processes contribute to priming. Here, the magnitude of priming from the representation-based locus was three times the magnitude of priming from the perceptual locus.

Data-driven priming should not be conceived of as the product of a brain system dedicated to producing priming. Instead, it reflects experience-induced adaptation in the perceptual and cognitive processes engaged by a stimulus. We conclude that theories of priming should consider it to be an emergent feature within the brain networks for perceptual processing of objects and for semantic memories of object identity. The study of repetition priming can thus provide insights into memory functions of the brain and also advance the understanding of how objects are perceived and identified.

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