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Why It's Easier to Remember Seeing a Face We Already Know Than One We Don't: Preexisting Memory Representations Facilitate Memory Formation

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Abstract

In two experiments, we provided support for the hypothesis that stimuli with preexisting memory representations (e.g., famous faces) are easier to associate to their encoding context than are stimuli that lack long-term memory representations (e.g., unknown faces). Subjects viewed faces superimposed on different backgrounds (e.g., the Eiffel Tower). Face recognition on a surprise memory test was better when the encoding background was reinstated than when it was swapped with a different background; however, the reinstatement advantage was modulated by how many faces had been seen with a given background, and reinstatement did not improve recognition for unknown faces. The follow-up experiment added a drug intervention that inhibited the ability to form new associations. Context reinstatement did not improve recognition for famous or unknown faces under the influence of the drug. The results suggest that it is easier to associate context to faces that have a preexisting long-term memory representation than to faces that do not.

Keywords

preexisting memory representations, face recognition, familiarity, amnesia, context associations, episodic memory, long-term memory, memory, face perception, eyewitness memory

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Recognition memory for familiar faces is better than for unfamiliar faces (e.g., Bruce & Young, 1986; Ellis, Shepherd, & Davies, 1979; Hancock, Bruce, & Burton, 2000; Johnston & Edmonds, 2009; Leveroni et al., 2000; Valentine & Bruce, 1986; Voss & Paller, 2006; Voss, Reber, Mesulam, Parrish, & Paller, 2008). It has been suggested that semantic knowledge of celebrities facilitates recognition by enhancing elaboration of the encoding episode using associated factual knowledge of famous individuals (Carbon, 2008; Jackson & Raymond, 2008; Voss & Paller, 2006; Zion-Golumbic, Kutas, & Bentin, 2010). Although there is no doubt that it is easier to elaborate an encoding episode that involves a stimulus about which more is known, the goal of the present research was to explore whether other factors moderate this effect.

In this study, we tested the hypothesis that the memory advantage of known faces over unknown faces results, in part, from the greater ease of associating known stimuli to their encoding context. It is known that reinstatement of context often helps memory (e.g., Godden & Baddeley, 1975; Smith, Glenberg, & Bjork, 1978), including memory for faces (Kerr & Winograd, 1982). However, the benefit of context reinstatement is modulated by the *fan* of the context (i.e., the number of memories associated with a given context; Diana, Peterson, & Reder, 2004; Park, Arndt, & Reder, 2006; Reder, Donavos, & Erickson, 2002). To test our hypothesis, we manipulated the fan of the background shown with known and unknown faces and whether the background was reinstated at the recognition

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test. We predicted that these manipulations would have greater impact on memory for famous than for unknown faces.

To further test our hypothesis, we included a drug intervention in Experiment 2 that disrupted the formation of new memories but left familiarity-based judgments unaffected. Finally, in both experiments, we included an additional test of the hypothesis that the memory advantage for known faces comes from the greater ease of associating context to stimuli that have preexisting representations in memory than to stimuli that do not: We asked subjects to give a phenomenological report of whether a given "old" response was based on retrieval of contextual information from the encoding episode or based on item familiarity.

Why Manipulate Background Fan?

The source-of-activation-confusion (SAC) model of memory (e.g., Reder et al., 2002; Diana, Reder, Arndt, & Park, 2006) posits that when an encoding context is associated with many study episodes, the benefit of reinstatement is diminished. This is because the amount of additional activation that is sent to any single episode node from the activation source of the test-probe context is shared or distributed among all the competing contextual associations. Therefore, manipulations of contextual fan (such as the number of faces associated with a background) should affect the success of recovering the memory trace associated with that context (Diana et al., 2004; Park et al., 2006; Reder et al., 2002; Rutherford, 2004; Smith & Manzano, 2010). Given the reasonable assumption that it is easier to elaborate the encoding for famous faces than for unknown faces (because more is known about the former), we wanted to make sure that any greater reinstatement advantage for famous faces was the result of greater ease of associating the famous person to the encoding context, rather than to elaboration. We predicted that memory for famous faces would be more affected than memory for unknown faces by background fan when context was reinstated because it is more likely in the former case that the face was successfully associated to the context in the first place. The elaboration explanation for a reinstatement advantage for famous faces should not predict that background fan would affect the reinstatement advantage. Likewise, an elaboration account cannot explain why the recognition benefit of reinstatement of an unusual font or voice used during word encoding is modulated by font or voice fan.

Why Introduce a Drug Intervention?

Midazolam, a benzodiazepine that produces temporary anterograde amnesia, has been shown to block the formation of new associations (e.g., Hirshman, Fisher, Henthorn, Arndt, & Passannante, 2003; Park, Quinlan, Thornton, & Reder, 2004; Reder et al., 2006; Reder, Oates, et al., 2007) and should affect only stimuli that could otherwise be associated with context. Midazolam is known to not affect retrieval of previously learned (i.e., semantic) knowledge (e.g., Ghoneim, 2004; Hirshman et al., 2003). If the advantage of famous faces over unfamiliar faces is due to a greater ability to bind the stimulus to context, the detriment due to midazolam should be greatest for famous faces that have a reinstated, low-fan background. Conversely, it should have the smallest effect for unknown faces regardless of background manipulation.

Why Include Remember/Know Judgments?

Although not all memory theorists agree that recognition judgments can be based on either a recollective or familiarity process (see Diana et al., 2006, for a review), many recognition-memory paradigms have employed the remember/know procedure developed by Tulving (1985) to measure the contributions of recollection and familiarity processes to recognition judgments (e.g., Dudukovic & Knowlton, 2006; Horry, Wright, & Tredoux, 2010; Joordens & Hockley, 2000; Reder et al., 2000; Yonelinas, 2002). In previous research (Reder et al., 2000; Reder et al., 2002), it has been proposed that recollection depends on the ability to access an encoding episode that links the stimulus to the encoding context. From that perspective, if it is difficult to form associations between the stimulus and the encoding context, "old" judgments should be based on familiarity rather than on recollection, which would yield few "remember" responses. If the episodic trace linking a stimulus to its associated context can be retrieved at test, we predicted that there should be more recollection-based responding than knowledge-based responding. Therefore, we predicted that famous faces with low-fan, reinstated backgrounds would generate the most "remember" responses, provided that the subject's ability to form associations was not impaired by the drug. The SAC model of memory posits that recollection ("remember" judgments) involves retrieval of the memory trace involving the encoding context and that the fan of the context (e.g., the number of other faces associated with a background) affects the ease of retrieval of any one of the associated encoding episodes (Reder et al., 2002).

Experiment 1

Subjects

Thirty-eight undergraduates from Carnegie Mellon University (ages 18–25) participated for partial course credit or $10.

Materials, design, and procedure

Stimuli were images collected from the Internet. Each stimulus was composed of a famous or an unknown face superimposed onto the bottom left side of a background (Fig. 1). There were two different photographs of each face, for a total of 384 face pictures. One photograph of a face was used during the encoding phase, and the other was used during the test phase. The backgrounds were photographs of 20 well-known locations (e.g., the Grand Canyon, the Statue of Liberty, the Eiffel Tower).

Fig. 1. Examples of the type of stimuli used at encoding (top row) and during the recognition test (bottom row). Each stimulus showed either a famous or an unknown face in front of a background. Some backgrounds were used on 12 study trials (high fan), and others were used on 3 study trials (low fan). At test, some faces were shown against the same background used during encoding (reinstatement condition; examples in the middle and on the right), and other faces were shown against a different background than during encoding (swapped condition; example on the left). See the text for more details about stimulus creation. The backgrounds shown here and the top left photograph of Natalie Portman are in the public domain. The photographs of Nicole Kidman in the middle top and bottom are by Michael Albov and Keith Hinkle, respectively, and the photograph of Natalie Portman on the bottom left is by gdcgraphics; these photos are licensed under the Creative Commons Attribution 2.0 License. The nonfamous person shown on the right gave the authors permission to use her photographs.

During the encoding phase, subjects viewed 96 faces superimposed on backgrounds and rated how likely it was that the person depicted would visit that location (from 1, *very unlikely*, to 5, *very likely*). After rating all 96 faces, there was a surprise recognition test in which subjects were shown 192 faces, half old and half new, and asked to judge whether the person depicted had been rated during encoding, irrespective of whether the background was the same one shown earlier. After all target and foil faces had been judged, there was a posttest in which subjects were asked to indicate whether the face was of someone they could identify as famous.

High-fan backgrounds appeared with 12 faces, and low-fan backgrounds appeared with 3 faces. We chose to swap backgrounds rather than replace them with new ones (Murnane & Phelps, 1993, 1994) when the context was not reinstated so that global familiarity was independent of contextual reinstatement. We chose to always replace the photo of the person whether in the swapped or reinstated condition so that the added value of reinstatement could not be attributed to an advantage due to an identical image. The factors (old/new stimulus, famous/unknown face, reinstated/swapped background, high/low background fan) did not comprise a full factorial design because the reinstated/swapped variable was only defined for the old faces, but all factors were balanced and randomly combined for each subject (e.g., for each subject, a given background was randomly assigned to be high or low fan, assigned to a famous or unknown face, and reinstated or swapped for the faces presented at encoding and test). Whether a face was a target or foil was also randomly determined for each subject.

During the encoding phase, the stimuli were displayed for 2 s each, followed by a prompt for subjects to rate the likelihood using the keyboard that the person depicted would visit that location.[1] During the test phase, half of the faces had not been rated previously. All of the backgrounds seen during the test phase had been part of the rating task in the first phase, but they were shown with different people half of the time. When the original background for a face was not reinstated at test, a different background of the same fan level was substituted (e.g., if the encoding background was high fan, the test background was also high fan). Although backgrounds were randomly assigned to famous or unknown faces for each subject, when a background was high fan, all associated faces would be of the same fame status (i.e., famous or unknown).

Subjects were further instructed that when they thought they recognized the face from the previous rating task (irrespective of whether the background matched), they were to indicate the nature of their recognition; we constructed this procedure following the remember/know method developed by Tulving (1985). Subjects were told to respond "remember" when they could retrieve details regarding the experience of judging the previously viewed face and "know" when the face seemed so familiar that it must have been viewed previously but no encoding details came to mind.[2] The keys "S," "G," and "K" were covered with stickers labeled with "R," "K," and "N" to indicate "remember," "know," and "new" responses, respectively.

In the face-identification posttest, subjects were shown faces without backgrounds, and they were required to indicate whether or not a face was famous. For famous judgments, subjects were asked to give some sort of identifying information, such as name, political office held, or movie in which the person appeared.

Results and discussion

Trials involving famous faces that were not identified as famous on the posttest were excluded from analysis. On average, subjects correctly identified 90% of the famous faces and were very accurate at rejecting unknown faces.

The proportion of hits and false alarms are presented in Table 1 as a function of whether the background was reinstated or swapped at test (for targets), whether the background was high or low fan, and whether the face was famous or unknown. These results are presented both as "old" responses that reflect the sum of "remember" and "know" responses and separately for "remember" responses, thought to reflect a recollection-based recognition judgment. The results of the signal detection analyses are shown in Figure 2. A one-sample t test of d' scores showed that, for all conditions, d' was significantly above 0 (all ps < .001) for both "old" and "remember" judgments.

A 2 (face fame) × 2 (background fan) × 2 (background reinstatement) repeated measures analysis of variance (ANOVA) was performed on hit rates and on d' scores for both "old" and "remember" responses. Effects that were not significant are not reported. These analyses revealed a significant main effect of face fame—"old" hits: $F(1, 37) = 132.58$, $p < .001$, $\eta_p^2 = .78$; "remember" hits: $F(1, 37) = 410.57$, $p < .001$, $\eta_p^2 = .92$; "old" d': $F(1, 37) = 105.7$, $p < .001$, $\eta_p^2 = .74$; "remember" d': $F(1, 37) = 129.48$, $p < .001$, $\eta_p^2 = .78$. This main effect of face fame is consistent with previous findings that famous faces are better recognized than unknown faces (Carbon, 2008; Jackson & Raymond, 2008; Voss & Paller, 2006; Zion-Golumbic et al., 2010).

Memory performance was also significantly better when the background was reinstated than when it was swapped—"old" hits: $F(1, 37) = 14.8$, $p < .001$, $\eta_p^2 = .29$; "remember" hits: $F(1, 37) = 20.90$, $p < .001$, $\eta_p^2 = .36$; "old" d': $F(1, 37) = 17.5$, $p < .001$, $\eta_p^2 = .32$; "remember" d': $F(1, 37) = 15.49$, $p < .001$, $\eta_p^2 = .3$. There was an interaction between background reinstatement and face fame for "remember" hits, $F(1, 37) = 23.96$, $p < .001$, $\eta_p^2 = .39$, and "remember" d' scores, $F(1, 37) = 12.4$, $p < .005$, $\eta_p^2 = .25$, and also a significant three-way interaction of Face Fame × Background Fan × Background Reinstatement for "remember" d' scores, $F(1, 37) = 4.8$, $p < .05$, $\eta_p^2 = .12$.

We conducted separate 2 (background fan) × 2 (background reinstatement) ANOVAs for famous and unknown faces. Although accuracy for unknown faces was reliably above chance, neither reinstatement of background nor background fan, nor their interaction, affected recognition accuracy. However, when the same comparison of d' scores was done for famous faces, there was a main effect of reinstatement for all "old" responses, $F(1, 37) = 12.1$, $p < .005$, $\eta_p^2 = .25$, a still stronger main effect for "remember" responses, $F(1, 37) = 21.3$, $p < .001$, $\eta_p^2 = .37$, and a Background Fan × Background Reinstatement interaction, $F(1, 37) = 6.3$, $p < .05$, $\eta_p^2 = .15$,

Table 1. Proportion of Hits and False Alarms in Experiment 1

	"Old" responses		"Remember" responses	
Face type and background	Hits	False alarms	Hits	False alarms
Famous face				
High fan, reinstated background	.83 (.03)	.22 (.03)	.67 (.03)	.07 (.01)
High fan, swapped background	.76 (.03)	.22 (.03)	.55 (.04)	.07 (.01)
Famous face				
Low fan, reinstated background	.89 (.02)	.20 (.03)	.77 (.03)	.08 (.02)
Low fan, swapped background	.75 (.04)	.20 (.03)	.52 (.04)	.08 (.02)
Unknown face				
High fan, reinstated background	.39 (.04)	.20 (.03)	.13 (.02)	.03 (.01)
High fan, swapped background	.34 (.04)	.20 (.03)	.12 (.03)	.03 (.01)
Unknown face				
Low fan, reinstated background	.39 (.04)	.21 (.03)	.12 (.02)	.03 (.01)
Low fan, swapped background	.38 (.04)	.21 (.03)	.11 (.02)	.03 (.01)

Note: Standard errors are shown in parentheses. The proportions for "know" responses can be determined by subtracting the proportions for "remember" responses from the proportions for "old" responses.

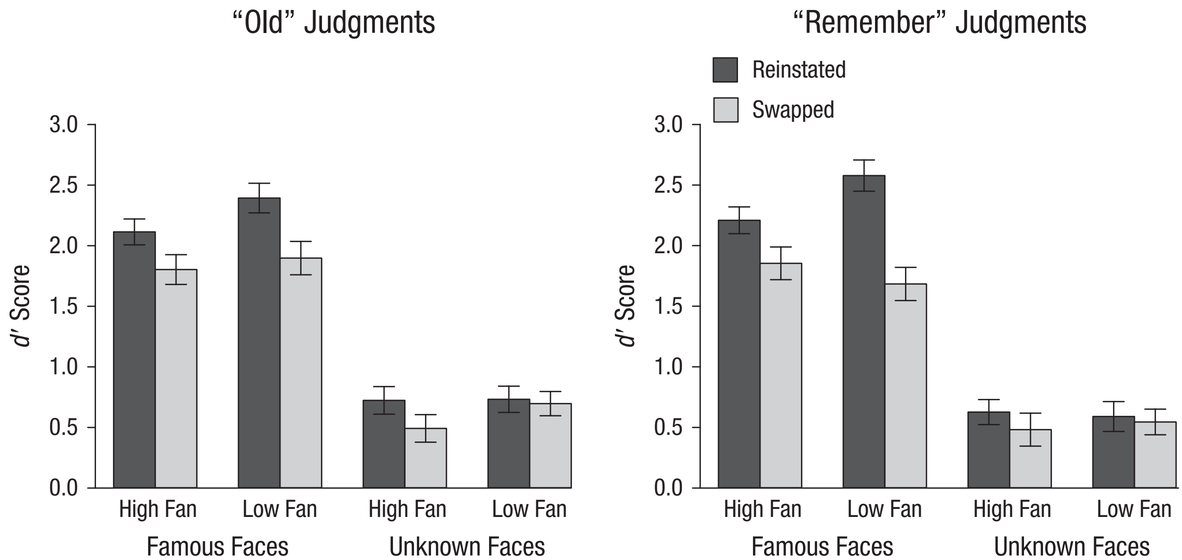

Fig. 2. Results from Experiment 1: mean *d*′ score as a function of the fame of the depicted face, the frequency with which the background appeared during encoding (fan), and whether the background during encoding was reinstated or swapped at test. Results are shown separately for "old" and "remember" judgments. Error bars show standard errors.

such that memory accuracy for "remember" responses was better when reinstated backgrounds were low fan than when they were high fan. The follow-up analyses of famous faces revealed that the proportion of "remember" hits and "remember" *d*′ scores was greater for reinstated than for swapped trials for both the high-fan condition—hits: $t(37) = 2.7$, $p < .05$; *d*′: $t(37) = 2.1$, $p < .05$—and the low-fan condition—hits: $t(37) = 5.8$, $p < .001$; *d*′: $t(37) = 5.2$, $p < .001$.

These results support the prediction that reinstatement helps more for low-fan backgrounds of famous individuals because it is easier to access the episodic memory trace when there are fewer competing associations (Diana et al., 2006; Reder et al., 2002). Neither background reinstatement nor background fan matters for unknown faces because the faces are not likely to be bound to the background during encoding. Given that it is difficult to build an episodic memory trace for these stimuli, "old" judgments for them are based on familiarity, and there are fewer "remember" judgments.

Experiment 2

The goal of Experiment 2 was to provide an even stronger test of our hypothesis that faces known to the subjects before the experiment are easier to bind to context. We did this by using a drug intervention that affects the ability to create new associations (Evans & Viola-McCabe, 1996; Hirshman, Passannante, & Arndt, 1999, 2001).

Subjects

Twenty-eight subjects who had not participated in Experiment 1 were drawn from the campus communities of the University of Pittsburgh and Carnegie Mellon University to participate in Experiment 2. Subjects were compensated $170 for participating in this experiment, which was comprised of two sessions.

Materials and design

Experiment 2 followed the same procedure as Experiment 1, except that half of the subjects performed the task under midazolam (the other 14 subjects were given a saline solution instead of the drug), and the posttest was administered at a second session. During the posttest, subjects in the midazolam condition were given saline, and subjects in the saline condition received midazolam. Midazolam affects only memory formation, not retrieval of information, so posttest performance was unaffected by the drug at the second session. Experimental procedures began approximately 15 min after drug or saline administration.

Results and discussion

Data for 8 subjects were dropped from analysis because of issues with a computer program. As in Experiment 1, trials were eliminated when subjects identified a famous face as unknown during the posttest. Posttest performance was unaffected by drug condition. The saline group's accuracy on the posttest (administered under midazolam) was 92% (SE = 0.03%), which did not differ significantly from the midazolam group's accuracy 90% (SE = 0.02%) on the posttest (administered under saline), $t(17) = -0.3$. This finding provides additional evidence that midazolam does not affect retrieval of information from semantic memory. We also examined encoding time (time to decide the appropriateness of the background) as a function of stimulus type and drug condition. Although subjects under midazolam were a bit slower to

Table 2. Proportion of Hits and False Alarms in the Two Drug Conditions of Experiment 2

Face type and background	"Old" responses		"Remember" responses	
	Hits	False alarms	Hits	False alarms
Saline condition				
Famous face				
High fan, reinstated background	.78 (.04)	.18 (.04)	.46 (.06)	.07 (.03)
High fan, swapped background	.71 (.07)	.18 (.04)	.42 (.08)	.07 (.03)
Famous face				
Low fan, reinstated background	.85 (.05)	.13 (.04)	.54 (.05)	.03 (.01)
Low fan, swapped background	.67 (.06)	.13 (.04)	.31 (.06)	.03 (.01)
Unknown face				
High fan, reinstated background	.23 (.06)	.07 (.02)	.10 (.04)	.02 (.01)
High fan, swapped background	.15 (.05)	.07 (.02)	.05 (.05)	.02 (.01)
Unknown face				
Low fan, reinstated background	.21 (.04)	.07 (.02)	.06 (.02)	.02 (.01)
Low fan, swapped background	.15 (.02)	.07 (.02)	.02 (.02)	.02 (.01)
Midazolam condition				
Famous face				
High fan, reinstated background	.58 (.07)	.25 (.07)	.30 (.07)	.12 (.06)
High fan, swapped background	.51 (.07)	.25 (.07)	.25 (.07)	.12 (.06)
Famous face				
Low fan, reinstated background	.54 (.06)	.27 (.07)	.28 (.06)	.08 (.05)
Low fan, swapped background	.57 (.08)	.27 (.07)	.20 (.06)	.08 (.05)
Unknown face				
High fan, reinstated background	.19 (.07)	.14 (.06)	.13 (.06)	.06 (.05)
High fan, swapped background	.23 (.07)	.14 (.06)	.09 (.04)	.06 (.05)
Unknown face				
Low fan, reinstated background	.21 (.06)	.15 (.07)	.08 (.03)	.07 (.05)
Low fan, swapped background	.15 (.05)	.15 (.07)	.05 (.03)	.07 (.05)

Note: Standard errors are shown in parentheses. The proportions for "know" responses can be determined by subtracting the proportions for "remember" responses from the proportions for "old" responses.

respond than subjects in the saline condition, and although responses for famous faces were slightly faster than responses to unknown faces, these effects were not significant—midazolam-famous: 1,023.0 ms (SE = 164.2), midazolam-unknown: 1,057.9 ms (SE = 136.2), saline-famous: 890.0 ms (SE = 248.4), saline-unknown: 913.8 ms (SE = 225.7).

Table 2 presents the same information as Table 1 does, with the added between-subjects factor of whether subjects performed the experiment after being administered midazolam or saline. Figure 3 illustrates the d' scores for "old" and "remember" judgments.

A 2 × 2 × 2 × 2 repeated measures ANOVA on accuracy (with face fame, background fan, and background reinstatement as within-subjects variables and drug condition as a between-subjects variable) revealed a significant main effect of face fame—"old" hits: $F(1, 17) = 246.4$, $p < .001$, $\eta_p^2 = .94$; "remember" hits: $F(1, 17) = 66.5$, $p < .001$, $\eta_p^2 = .8$; "old" d': $F(1, 17) = 69.1$, $p < .001$, $\eta_p^2 = .8$; "remember" d': $F(1, 17) = 103.0$, $p < .001$, $\eta^2 = .86$—as well as a significant main effect of background reinstatement—"old" hits: $F(1, 17) = 6.3$, $p < .05$, $\eta_p^2 = .27$; "remember" hits: $F(1, 17) = 12.5$, $p < .005$, $\eta_p^2 = .42$; "old" d': $F(1, 17) = 7.7$, $p < .05$, $\eta_p^2 = .3$; "remember" d': $F(1, 17) = 12.7$, $p < .005$, $\eta_p^2 = .43$. For "remember" hits, there was a significant main effect of background fan, $F(1, 17) = 4.8$, $p < .05$, $\eta_p^2 = .22$, a Face Fame × Background Reinstatement interaction, $F(1, 17) = 6.0$, $p < .05$, $\eta_p^2 = .26$, and a Face Fame × Background Fan × Background Reinstatement interaction, $F(1, 17) = 7.2$, $p < .05$, $\eta_p^2 = .3$.

There was also a main effect of drug condition on "old" d' scores, $F(1, 17) = 14.4$, $p < .005$, $\eta_p^2 = .46$, and "remember" d' scores, $F(1, 17) = 8.7$, $p < .01$, $\eta_p^2 = .34$. Consistent with our expectations, results showed that memory was better for famous than for unknown faces, but the size of the advantage was significantly smaller in subjects in the midazolam condition than in subjects in the saline condition. There was a significant Face Fame × Drug Condition interaction—"old" hits: $F(1, 17) = 12.9$, $p < .005$, $\eta_p^2 = .43$; "remember" hits: $F(1, 17) = 9.5$, $p < .01$, $\eta_p^2 = .36$; "old" d': $F(1, 17) = 10.1$, $p < .005$, $\eta_p^2 = .37$; "remember" d': $F(1, 17) = 15.4$, $p < .005$, $\eta_p^2 = .48$.

We conducted separate 2 (face fame) × 2 (background fan) × 2 (background reinstatement) ANOVAs for saline and midazolam. Results of the saline condition replicated the results of

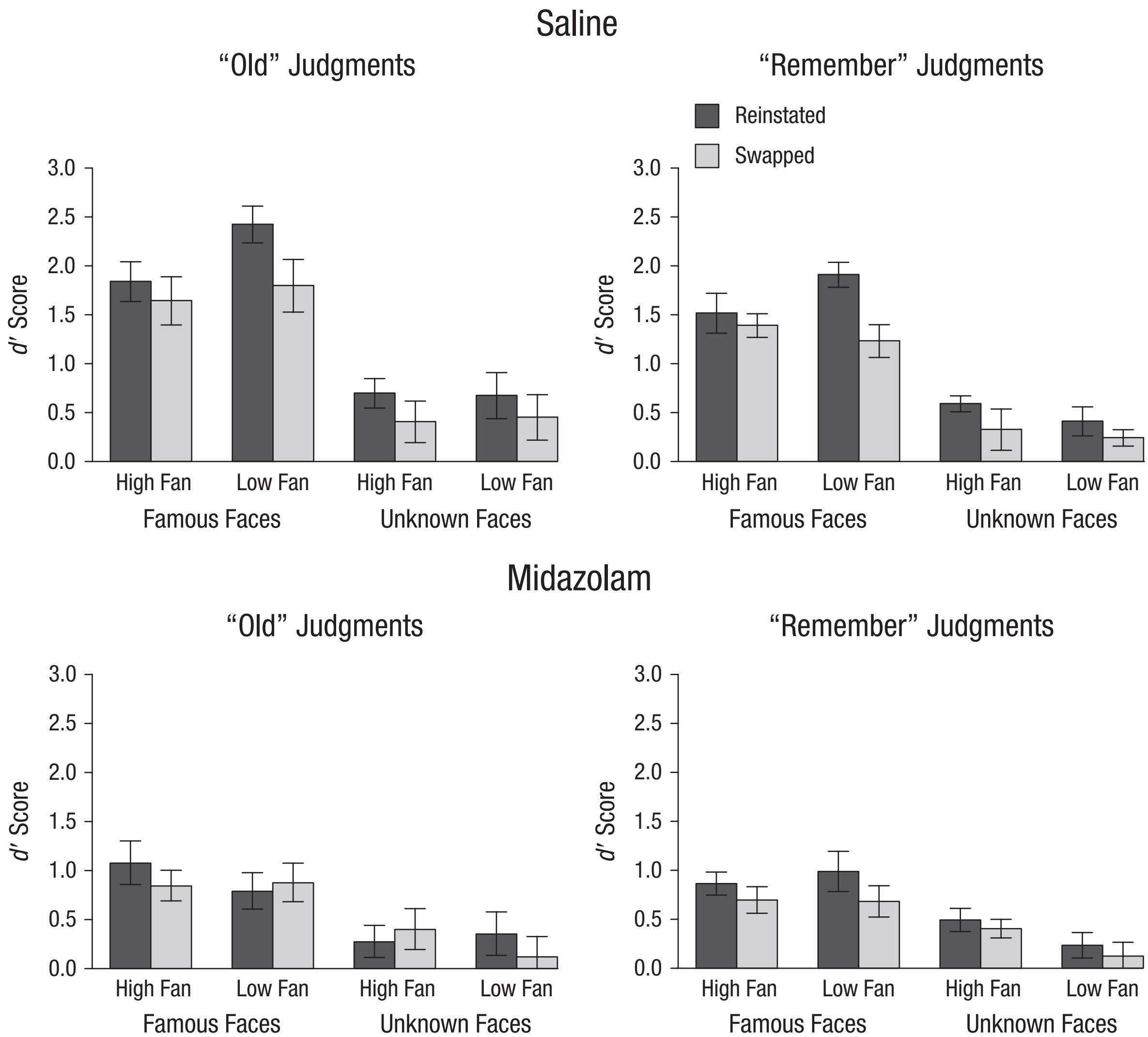

Fig. 3. Results from Experiment 2: mean d' score as a function of the fame of the depicted face, the frequency with which the background appeared during encoding (fan), and whether the background during encoding was reinstated or swapped at test. Results are shown separately for "old" and "remember" judgments in each drug condition. Error bars show standard errors.

Experiment 1: There was a main effect of face fame—"old" hits: $F(1, 8) = 203.7$, $p < .001$, $\eta_p^2 = .96$; "remember" hits: $F(1, 8) = 142.9$, $p < .001$, $\eta_p^2 = .95$; "old" d': $F(1, 8) = 61.6$, $p < .001$, $\eta_p^2 = .89$; "remember" d': $F(1, 8) = 92.9$, $p < .001$, $\eta_p^2 = .92$—and a main effect of background reinstatement—"old" hits: $F(1, 8) = 8.93$, $p < .05$, $\eta_p^2 = .53$; "remember" hits: $F(1, 8) = 5.6$, $p < .05$, $\eta_p^2 = .41$; "old" d': $F(1, 8) = 8.8$, $p < .05$, $\eta_p^2 = .52$; "remember" d': $F(1, 8) = 5.5$, $p < .05$, $\eta_p^2 = .4$. There was also a significant Face Fame × Background Fan × Background Reinstatement interaction for "remember" judgments—hits: $F(1, 8) = 22.5$, $p < .005$, $\eta_p^2 = .74$; d': $F(1, 8) = 14.7$, $p < .01$, $\eta_p^2 = .65$.

Follow-up planned comparisons revealed that for the saline condition, the background reinstatement effect on "remember" judgments was evident for famous low-fan stimuli, $t(8) = 4.1$, $p < .005$, but not for famous high-fan or unknown stimuli. In the saline condition, the background reinstatement effect was also reliable for "old" judgments for famous low-fan stimuli, $t(8) = 3.2$, $p < .05$, but not for famous high-fan or unknown high-fan stimuli, $p > .1$. The d' results for "old" judgments were also reliable for low-fan famous faces, $t(8) = 3.3$, $p < .05$. The d' results replicated those for "remember" responses, with the significant background reinstatement effect for famous low-fan stimuli, $t(8) = 3.2$, $p < .05$. The same 2 (face fame) × 2 (background fan) × 2 (background reinstatement) ANOVA for midazolam subjects revealed a main effect of face fame—"old" hits: $F(1, 9) = 69.2$, $p < .001$, $\eta_p^2 = .89$; "remember" hits: $F(1, 9) = 8.9$, $p < .05$, $\eta_p^2 = .5$; "old" d': $F(1, 9) = 14.1$, $p < .005$, $\eta_p^2 = .6$; "remember" d': $F(1, 9) = 20.6$, $p < .005$, $\eta_p^2 = .7$. There was also a significant effect of background reinstatement for "remember" judgments—hits: $F(1, 9) = 11.8$, $p < .01$, $\eta_p^2 = .57$; d': $F(1, 9) = 12.8$, $p < .01$, $\eta_p^2 = .59$. No other effects were reliable.[3]

The Face Fame × Drug Condition interaction can be understood as reflecting the fact that the hit rate for unknown faces was essentially the same in the saline and midazolam conditions. Our interpretation is similar to the one offered by Huppert and Piercy (1976, 1978) in their recognition-memory study involving organic amnesic patients. Their patients could recognize pictures well above chance but were unable to indicate whether the picture had been seen a few minutes earlier or on the previous day.[4] We hypothesize that people are generally unable to associate contextual information to faces that lack a preexisting representation in long-term memory. Therefore, because recollection is unlikely for unknown faces under saline, midazolam will not hurt performance for those stimuli. This hypothesis also explains why the benefit of reinstatement of a low-fan background for famous faces was much greater when those faces were encoded in the saline condition than in the midazolam condition. The ability to bind to context was diminished in the drug condition, so background reinstatement was of little use.

Given that midazolam affects the ability to bind stimuli to encoding context, the drug effect should be most pronounced for "remember" responses. "Remember" responses are given when contextual information can be retrieved. Indeed, planned comparisons showed that in the low-fan, reinstated-background condition, subjects under midazolam had significantly fewer "remember" hits than did subjects in the saline condition, $t(17) = -3.0$, $p < .01$.

General Discussion

A number of variables affect the ability to associate the encoding context to the presented stimulus, including available working memory resources. When there are insufficient working memory resources, as sometimes occurs with older adults (Buchler, Faunce, Light, Gottfredson, & Reder, 2010) or in a dual-task setting (Castel & Craik, 2003), it is more difficult to associate context with a stimulus. In that case, memory performance relies more heavily on familiarity than on recollection. The two experiments reported here demonstrate that another variable that also affects the ease of associating a stimulus to its encoding context is stimulus familiarity. The added value of context reinstatement for recognition memory is much greater when the stimuli have preexisting memory representations (e.g., famous faces) than when they are unknown (e.g., faces of strangers). Furthermore, the benefit of reinstatement is modulated by the fan of the context. We hypothesized that stimuli with a long-term memory representation require less working memory resources than unfamiliar stimuli and therefore are easier to bind (see Reder, Paynter, Diana, Ngiam, & Dickison, 2007).

Additional support for our interpretation of these results comes from some of the converging findings in these experiments. First, the advantage of fame and the context reinstatement was more pronounced for "remember" responses, that is, the recognition judgments that are based on recollection. Second, the fact that the memory advantage for reinstatement was greater when the background was shown with only a few faces than when the background was shown with many faces supports the interpretation that the benefit of reinstatement involves the prior formation of an association.

Third, in Experiment 2, we used a drug intervention that specifically impaired the ability to form new associations (Hirshman et al., 1999, 2001; Park et al., 2004; Reder, Oates, et al., 2007; Reder et al., 2006). Retrieval of contextual associations enables recollection ("remember" responses). There were far fewer "remember" responses in the midazolam condition than in the saline condition. Recognition judgments for unknown faces were not affected by the drug intervention because these stimuli would be recognized on the basis of familiarity in any case.

There are several alternative accounts for why famous faces are better remembered than unknown faces. One is that it is easier to generate an elaboration involving a face for which more is known (e.g., Kerr & Winograd, 1982; Voss & Paller, 2006; Zion-Golumbic et al., 2010). Extending this account, one could argue that reinstatement of background should aid memory when the subject has generated an elaboration that involves the background because there would be more features to match the original memory trace. This account (devoid of an assumption of associating the target to a context), however, does not explain why the advantage of reinstatement should be reduced when a background is shared with other faces.

Another possibility is that it is easier to generate a label (e.g., the person's name) for a famous face than for an unknown face and that having a label will facilitate binding to long-term memory. Although we agree that part of the advantage for famous faces is that each face affords a label, we do not believe that merely providing a name for an unfamiliar face will facilitate recognition for unknown faces, with or without a background. Part of the advantage of an item with a preexisting representation is that encoding the stimulus is more efficient by virtue of the label. That is, when there is a label, the stimulus is a known chunk, rather than a set of features to be described. In our view, ability to bind a stimulus to context requires working memory resources, and these resources would be diverted from binding the stimulus to context when subjects are trying to represent a previously unknown stimulus. In other words, if a stimulus is easily labeled, it consumes less working memory and is therefore easier to bind to context (Reder, Paynter, et al., 2007). This view is also consistent with findings of Lupyan, Rakison, and McClelland (2007). What if the unknown faces were provided with a name or profession? Would that make learning with the background as easy as learning famous faces? Just as it is not easy to bind an unfamiliar face to an encoding context, it will not be easy to learn the labels to those faces in a single trial. If those unknown faces have to be trained until those labels are easily retrieved, then those (previously) unknown stimuli would no longer be unknown.

Another possible explanation for these findings is that subjects spent more time encoding famous faces because the task of rating the appropriateness of the face to the background seemed more sensible because they knew something about the person. If they spent more time encoding them, the difference in encoding time could explain the memory advantage. We examined whether subjects spent more time encoding famous than unknown faces. Although the encoding times for the two stimulus types did not differ reliably, the mean times went in the opposite direction (as reported in the results section of Experiment 2).

In summary, we have provided evidence that memory is better for stimuli that already have an existing representation in semantic memory because they are easier to associate to encoding context. We showed that the benefit of contextual reinstatement is not observed for face stimuli that are previously unknown to the subject. The likelihood of a recollection response is affected by the ease of retrieval of the encoding context, which in turn is affected by whether the encoding background is reinstated, and if so, whether the background fan is low (i.e., relatively unique). These factors did not matter for unknown faces because an association to context was unlikely to occur for unknown faces. When subjects were under the influence of midazolam, a drug that blocks the formation of new bindings, these effects were greatly diminished, which provides additional support for our explanation of the memorial advantage of famous over unknown faces.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Notes

1. We chose an incidental-learning task in order to assess how easily associations were formed when there was no requirement to do so.
2. As part of the instructions, we made sure that subjects understood the distinction between "remember" and "know" and did not think that this was merely a confidence difference but rather that remembering reflected some recollection of a detail or an aspect of the actual encoding event. We have also used the method of asking first for "old"/"new" judgments followed by "remember"/"know" discrimination for old responses (e.g., Reder et al., 2000). We found no difference in performance in any meaningful way. This procedure seemed faster and less likely to encourage subjects to respond "new" (because there were fewer buttons to press).
3. There were more "remember" hits and false alarms for unknown faces in midazolam subjects than in saline subjects. We attribute this pattern to a more relaxed criterion for "remember" responses under midazolam. Unlike Yonelinas (2002), we did not assume a high-threshold model but a normally distributed activation value and criterion both for the representation that enables familiarity judgments and separate ones for the representation that enables recollection (e.g., Reder et al., 2000).
4. Both drug-induced amnesiacs and organic amnesiacs can recognize stimuli when a familiarity process will suffice but not when accurate discrimination of targets from foils requires a person to recollect the contextual information. Huppert and Piercy's (1976, 1978) data suggest that low-frequency words and pictures are sufficiently unfamiliar that a recent exposure makes them much more familiar than foils (nonpresented items) from the same stimulus class.

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