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I'd know that face anywhere!

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Mandler (1980) provided the classic "butcher on the bus" example illustrating the feeling of familiarity without recollection that may arise when an acquaintance is encountered in an unusual context. We studied this phenomenon by pairing photos of faces with photos of distinctive contexts at study and later testing recognition memory and *remember/know* judgments for faces presented with studied, switched, or new contexts. Estimates of recollection and familiarity, based on the assumption that these processes are independent, showed that switching contexts significantly lowered recollection while leaving familiarity intact, just as Mandler described. False alarm rates were higher with old contexts, suggesting that subjects tended to misattribute memories of contexts to memories of faces. These results provide the first evidence of context effects on the subjective experience of recognizing faces. One-dimensional signal-detection models fit the data, but such models do not explain the difference in remember responses between studied and switched items, whereas dual-process models (which also fit the data) do while also capturing the phenomenology of the butcher-on-the-bus experience in an intuitively appealing way.

You've probably experienced the powerful (and nagging) feeling of knowing-without-remembering that sometimes arises when an acquaintance is encountered in an unusual context. Mandler (1980) provided the classic example of this phenomenon with his description of seeing the butcher from your supermarket on the bus: You're sure you know the person, but you can't recollect the source of the familiarity and are left wondering, "Who *is* that?" Today, it's more likely to be the video store clerk than the butcher one encounters on the bus, but both cases illustrate the experience of familiarity in the absence of recollection. We studied this phenomenon by assessing the effects of manipulating context on the subjective experience of face recognition. In addition to exploring an inherently interesting real-world phenomenon, this work speaks to fundamental theoretical issues regarding recognition memory.

The memorial awareness associated with recognition can be assessed with Tulving's (1985) *remember/know* (RK) test, in which subjects are instructed to report "remember" if recognition of an item is accompanied by conscious recollection of details of encountering that item during the study phase and to report "know" if they are confident that they had encountered an item on the study list but do not recollect any details of that prior encounter. From a dual-process perspective, remember reports depend on retrieval of episodic details whereas know reports reflect an undifferentiated feeling of familiarity in the absence of such recollection (e.g., Gardiner & Parkin, 1990; Jacoby, Yonelinas, & Jennings, 1997).

Most studies of the distinction between knowing and remembering have used word lists as stimuli, but faces may be particularly likely to produce feelings of knowing without remembering (e.g., Yovel & Paller, 2004). Faces are highly complex and distinctive stimuli. They tend to attract attention, and there may be innate specialized neuronal mechanisms for encoding them (e.g., Damasio, Tranel, & Damasio, 1990). These characteristics support the encoding of faces as individual stimuli, but they do not necessarily support the kinds of associative binding between item and context that often contribute to remember reports (e.g., Chalfonte & Johnson, 1996; Mäntylä, 1997).

Many studies have explored what makes faces so memorable (e.g., Farah, Wilson, Drain, & Tanaka, 1998) but few have assessed the subjective experience of memory for faces (e.g., Brandt, Macrae, Schloerscheidt, & Milne, 2003; D'Argembeau & Van der Linden, 2004; Dewhurst, Hay, & Wickham, 2005; Moscovitch & McAndrews, 2002; Parkin, Gardiner, & Rosser, 1995). There has been much research on the effects of context on recognition memory (e.g., Godden & Baddeley, 1980; Macken, 2002; McKenzie & Tiberghien, 2004), including studies of context manipulations on face recognition (e.g., Memon & Bruce, 1985). Study/test differences in the appearance of faces (e.g., with vs. without glasses) have been shown to impair old/new discrimination (Cutler, Penrod, O'Rourke, & Martens, 1986), and Hockley, Hemsworth, and Consoli (1999) reported that such appearance changes decrease remember reports and increase know reports. But there appear to have been no published studies of the role of context in supporting remembering versus knowing faces. The lack of studies in this area seems odd. For one thing, as noted above, a face out of context has provided the classic example of knowing in the absence of recollection for a quarter of a century. For another, we rely on phenomenal experiences to guide everyday decisions about people we encounter. For example, familiarity in the absence of

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recollection might lead one to classify a person as an acquaintance, perhaps thereby according that person some confidence and trust; recollecting that the person was seen on a Wanted poster might lead to dramatically different behavior.

There is controversy regarding the mechanisms underlying remember versus know responses. Some hold that remember and know map on to mutually exclusive processes (e.g., Gardiner & Parkin, 1990), others that they reflect two independent processes (e.g., Jacoby et al., 1997), others that they are different criteria along a strength dimension (e.g., Donaldson, 1996; Dunn, 2004), and yet others that responding is "based on an aggregate strength variable that consists of a combined recollection and familiarity signal" (Wixted & Stretch, 2004, p. 617). This paper does not aim to settle this controversy, but we include measures that follow from the view that recollection (R) and familiarity (F) reflect independent processes (e.g., Jacoby, 1991). From this perspective, R can be estimated directly as the probability of remember responding, but the probability of know responding underestimates F due to instances in which both R and F contribute to responding and the subject says "remember." Jacoby et al. (1997) proposed an independence remember/know (IRK) equation in which F is the proportion of know responses considering only trials on which subjects did not respond "remember":

$$F = K/(1 - R).$$

In the present experiment, subjects studied photographs of faces, each presented with a unique context photograph. At test, studied faces (intermixed with nonstudied faces) were presented with either the studied context, a switched context (i.e., a context viewed with another face during study), or a new context for old/new recognition judgments and remember/know judgments. As in the dual-process account of the butcher-on-the-bus example, we expected that changing context from study to test would impair R and hence reduce remember responses. In contrast, if F for faces is relatively unaffected by context then from an independent-processes perspective one would expect that changing context would increase know responses.

METHOD

Subjects

Forty-eight University of Victoria undergraduate students participated for extra credit in an introductory psychology course.

Materials

A pool of 120 color head-and-shoulder photographs of unfamiliar adults was created with an equal number of female and male faces. The pool was divided to form a set of 96 critical faces (8 sets of 12 faces) and a set of 24 noncritical faces. A pool of 120 unique context photographs was obtained from Internet searches; these included scenes featuring building interiors and exteriors, travel scenery, animals, and sports.

Stimuli consisted of face–context pairs with context photographs placed to the left of each face. A sample face–context pair is shown in Figure 1. Eight unique study/test lists were formed by rotating face and context photographs through item types: studied face/studied context; studied face/switched context; studied face/new context; new face/old context; and new face/new context. Study lists included 48 critical face–context pairs (four sets of 12 faces paired with four sets of 12 contexts) and 8 buffer items at the beginning and end of each study list. For the test, half of the 96 critical items consisted of studied faces paired with studied contexts (12 items), switched (and thus, studied) contexts (12 items), or new contexts (24 items). The remaining 48 items consisted of an equal number of new-face/old-context and new-face/new-context items. The test included 8 filler items at the beginning and end of the list. The position of items on the test was constrained such that no more than three consecutive same correct recognition answers (yes or no) were allowed.

Procedure

Subjects were tested individually using a personal computer and color monitor. At study, subjects rated the likelihood that the person in the photo would be associated with the context (1 = *very unlikely*, 6 = *very likely*). This orienting task was expected to promote deep and integrative encoding of information about each face and context pair. Each study trial began with presentation of a face–context photo for 2,250 msec followed by a subject-paced period for recording a rating on a sheet of paper. Subjects were not informed of the memory test.

The test immediately followed the study session. Each test face was paired with a context photo; subjects were informed that they were to make judgments about the faces only. In addition to indicating whether or not they recognized a face as one presented during the initial encoding task, subjects were asked to provide remember/know judgments for recognized faces.

RESULTS AND DISCUSSION

The proportions of remember and know responses were computed for each subject as a function of whether a target face was studied or new and as a function of context status. Estimates of familiarity for studied and new items for each context condition were computed for each subject using the independence assumption [IRK familiarity; $F = K/(1 - R)$].[1] Means are shown in Figure 2.

The influence of context on hit and false alarm rates and on the IRK familiarity estimates was evaluated using separate ANOVAs with the significance level set at .05. Capturing Mandler's (1980) butcher-on-the-bus speculation perfectly, remember responses were substantially less common when studied faces were encountered in switched contexts or in new contexts than when they were tested in the same context as at study [$F(2,94) = 57.01$, $MS_e = .022$]. Conversely, know responses were more common when studied faces were encountered in switched con-

Figure 1. Black-and-white sample of a face–context pair.

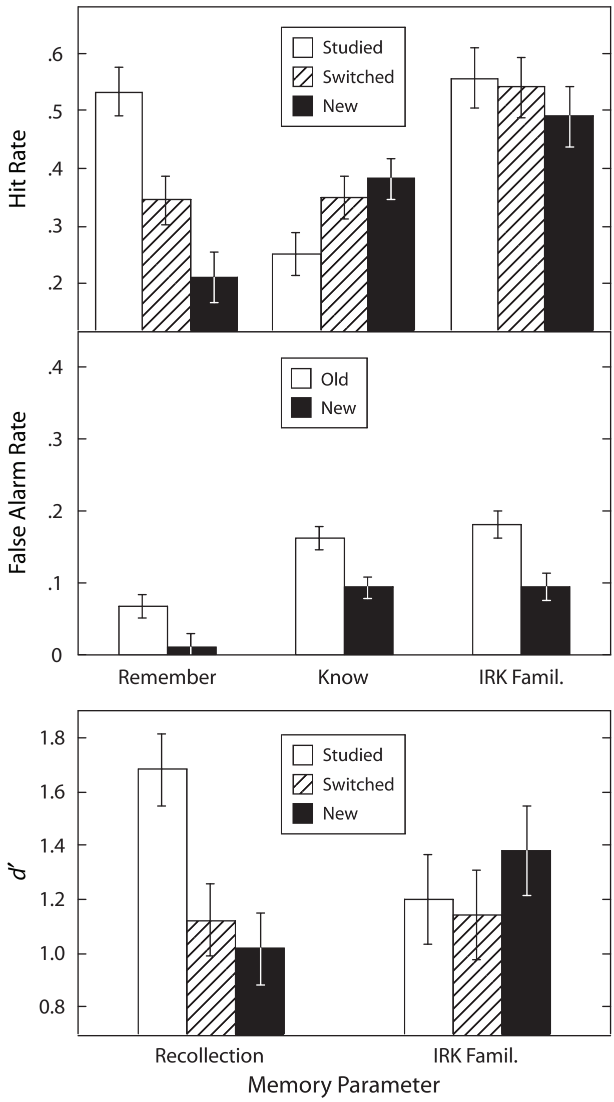

Figure 2. Hit rates (upper panel), false alarm rates (middle panel), and *d′* values (lower panel) as a function of context (i.e., studied, switched, or new) and memory parameter (i.e., remember and know responses, and recollection and IRK familiarity processes). Error bars are 95% within-subjects confidence intervals based on the MS_e for each cluster of two or three means (Loftus & Masson, 1994).

texts or in new contexts than when they were presented at test in the same context with which they had been studied [$F(2,94) = 13.60$, $MS_e = .016$]. IRK estimates of familiarity for studied items did not show an overall influence of context [$F(2,94) = 1.70$, $MS_e = .033$]. False alarms to new faces were more likely when they were tested with old contexts (ones that had been presented with a face during study) than when they were tested with new contexts. This effect was reliable for all three memory parameters (Fs > 20).

The observed pattern of context effects on responses to new faces suggests that subjects tended to misattribute memories of the context to memories of the face.[2] Some or all of the influence of context on hit rates might also be due to this misattribution process. To assess that possibility, we calculated a sensitivity measure, d', for recollection and IRK familiarity as a function of context for each subject, using remember hit and false alarm rates for recollection and IRK familiarity hit and false alarm rates for IRK familiarity. Hit rates for faces tested with studied or switched contexts were paired with the false alarm rate to new faces tested with old contexts; hit rates for faces tested with new contexts were paired with the false alarm rate to new faces tested with new contexts (see Feenan & Snodgrass, 1990). The means of the resulting d' scores are shown in the bottom panel of Figure 2.

Separate ANOVAs were used to evaluate the influence of context on accuracy of recollection and IRK familiarity as measured by d'. For recollection, there was a clear influence of context [$F(2,94) = 28.60$, $MS_e = .215$], with sensitivity over 50% greater for faces tested in their studied contexts than for those tested in switched or new contexts. Thus the misattribution of context memory cannot explain the entire influence of context on recollection. Moreover, sensitivity in the recollection measure was similar in switched and new contexts. Thus it was only when both face and context had been studied *together* that recollection sensitivity was heightened by context. This is exciting evidence of a synergistic effect of the binding of face and context information in memory (see Chalfonte & Johnson, 1996; Reinitz, Lammers, & Cochran, 1992). In contrast to the influence of context on recollection, sensitivity for IRK familiarity was not significantly affected by context [$F(2,94) = 2.19$, $MS_e = .338$].

The pattern of remember and know responses across our context conditions can be fit with a one-dimensional signal detection theory (SDT) model of the form proposed by Donaldson (1996), Dunn (2004), and Wixted and Stretch (2004), in which old and new items vary on a single dimension characterized as memory strength. In the simplest case, each condition in the experiment is represented as a normal distribution of items with unit variance and its own mean on the strength dimension. Two decision criteria are used to partition the strength dimension into regions corresponding to remember, know, and new responses. The parameters of the model are the means of the distributions representing the conditions in the experiment and the positions of the two decision criteria. Assuming that the mean of the distribution of new items tested with new contexts is zero, the parameter values shown in Table 1 produce mean remember and know proportions that exactly fit the observed data in Figure 2.

The perfect fit is not surprising, given that one can always find a set of parameters to perfectly fit a set of 2×2 recognition data (Murdock, 2006). The challenge for SDT models is that they do not explain why the studied-context condition produced more remember reports than the switched-context condition (in which face and context were also studied previously, but not together). Explaining that finding requires a mechanism describing how items and their particular contexts combine in memory.

An extension of Murdock's (1982) theory of distributed associative memory (TODAM) model also provides a perfect fit to the data (for the reason stated above). More im-

Table 1
Parameter Estimates for the Strength Model and the Extended TODAM Model

Parameter Type	One-Dimensional Strength		TODAM	
	Parameter	Estimate	Parameter	Estimate
Criterion	r	2.25	a	2.25
	k	1.25	i	1.31
Distribution mean	$\mu_{st/st}$	2.33	$\mu(a_{st/st})$	2.33
	$\mu_{st/sw}$	1.85	$\mu(a_{st/sw})$	1.85
	$\mu_{st/new}$	1.45	$\mu(a_{st/new})$	1.45
	$\mu_{new/old}$	0.76	$\mu(i_{st/st})$	1.41
	$\mu_{new/new}$	0.00	$\mu(i_{st/sw})$	1.40
			$\mu(i_{st/new})$	1.27
			$\mu(a_{new/old})$	0.76
			$\mu(i_{new/old})$	0.37
			$\mu(a_{new/new})$	0.00
			$\mu(i_{new/new})$	0.00

Note—*r*, remember criterion; *r*, know criterion. For the means of distributions (μs), the first part of the subscript indicates whether the item was studied (st) or new, and the second part indicates whether the context with which an item was presented was studied (st), switched (sw), or new. For distribution means from TODAM, *a* designates associate information, and *i* designates item information.

portantly, this model provides an a priori account for the dramatic change in remember responding between studied and switched contexts. Murdock (2006) developed this extended version of TODAM to account for performance in the remember/know paradigm. In this model, Murdock assumed that two sources of information, item and associative, contribute to recognition memory decisions (see also Yonelinas, 1997). He further assumed that in making a recognition decision, subjects first assess the strength of associative information. If that strength is above the associative criterion, then a remember response is produced. If associative strength is not above the criterion, then subjects consider the strength of item information. In that case, if the item strength exceeds a criterion placed on the item dimension, then a know response is given, otherwise a *new* response is given. Effectively, the model treats associative and item information as independent contributors to a recognition memory decision, with precedence given to the former source. This approach is compatible with the Jacoby et al. (1997) independence assumption for recollection and familiarity processes that support remember and know phenomena. It is also very similar to the independence model proposed by Yonelinas (1994, 1997). Yonelinas characterized recollection as a threshold process, but Parks and Yonelinas (2007) made it clear that recollection decisions can be based on a continuous distribution of graded information (although they made no commitment as to the shape of such distributions).

Associative and item information in Murdock's (2006) model are assessed on different dimensions using different criteria. Recollection is based on having sufficient associative information about an item and familiarity arises from item information. Both types of information are assumed to be normally distributed with unit variance. The model's parameters are the means of the associative and item information distributions for each condition and the criterion for each type of information. The parameter values, shown in Table 1, were estimated assuming a mean of zero for the item information and for the associative information distributions for new items tested with new contexts. With these parameter values, the model exactly fits the observed data shown in Figure 2. Importantly, the model's estimate of the means for associative information varies substantially depending on whether original face–context pairings are tested, reflecting a strong sensitivity of recollection to changes in context. In contrast, the item information distributions for studied faces in the studied- and switched-context conditions are virtually the same (1.41 and 1.40).[3]

Both the Wixted and Stretch (2004) and Murdock (2006) models fit our data perfectly. The key difference between these two categories of models lies in their characterizations of the difference between know and remember responses: SDT models characterize the difference purely in terms of strength, whereas dual-process models such as Murdock's (2006) hold that remember responses reflect qualitatively different sorts of memory information than know responses. We agree with Murdock's (2006) assessment that the primary contribution of the models is discovering "how the parameter values change given the experimental manipulations and whether these changes agree with the predicted results" (p. 653). The extended TODAM model recovers the phenomenology of familiarity without recollection in an intuitively appealing way. SDT models can accommodate remember/know phenomenology by using two response criteria, but such models are unconstrained as to the contribution of underlying memory processes to strength and as to the relationship between underlying memory processes and subjective experience, so they cannot be falsified by any pattern of phenomenological reports. The TODAM model and others that assume an independence relation between recollection and familiarity and that posit a special (but not necessarily exclusive) role of item-context associations in supporting remember reports provide a better account for our finding that switched versus studied contexts selectively impaired remember reports—a pattern inherent in Mandler's (1980) concept of familiarity without recollection.

CONCLUSION

To the best of our knowledge, this is the first published test of the effects of context on the subjective experience of recognizing faces, as in Mandler's (1980) butcher-on-the-bus example. Studied faces were substantially more likely to be remembered if they were encountered in their studied contexts at test. Importantly, this was not simply because memory for any old context added to memory for any studied face; rather, it was the combination of the particular context in which a particular face had been studied (as in seeing the butcher working in the market) that led to the greatest recollection accuracy. Whereas switching context lowered recollection, it had no significant effect on IRK familiarity. This pattern of reduced recollection and preserved familiarity as a consequence of context change (from studied to switched) underlies the butcher-on-the-bus phenomenon. Thus, whether one thinks "Who *is* that?" or "There's the butcher" depends on whether or not one recollects sufficient source-specifying information to make the identification, and one is less likely to recollect such information (but no less likely to access familiarity) when the butcher is encountered in an atypical context.

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NOTES

1. The values $.5/N$ and $1 - .5/N$ were substituted for floor and ceiling hit and false alarm rates, respectively (Kadlec, 1999).

2. Anecdotally, the second author once attended a meeting of clinical psychologists at a hotel where he had previously attended several meetings of the Psychonomic Society: He kept thinking he recognized people he'd never seen, perhaps because of the familiar context.

3. The mean of the item information distribution for the studied-item/new-context condition is somewhat lower than the means for the other two studied-item context conditions (1.27 vs. 1.41 and 1.40). There is also a nearly offsetting difference in the means of the corresponding new-item conditions, as the mean of the item information distributions for the new-item/old-context condition (0.37) is not zero in this model. We suspect that the small influence of studied context on the estimates of item information reflects a tendency for familiarity with associative or contextual information to be misattributed to an item's study history, although this idea awaits further research.

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