Psychonomic Bulletin & Review
2005, 12 (2), 314-320

Recognition memory for distractor faces depends on attentional load at exposure

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Incidental recognition memory for faces previously exposed as task-irrelevant distractors was assessed as a function of the attentional load of an unrelated task performed on superimposed letter strings at exposure. In Experiment 1, subjects were told to ignore the faces and either to judge the color of the letters (low load) or to search for an angular target letter among other angular letters (high load). A surprise recognition memory test revealed that despite the irrelevance of all faces at exposure, those exposed under low-load conditions were later recognized, but those exposed under high-load conditions were not. Experiment 2 found a similar pattern when both the high- and low-load tasks required shape judgments for the letters but made differing attentional demands. Finally, Experiment 3 showed that high load in a nonface task can significantly reduce even immediate recognition of a fixated face from the preceding trial. These results demonstrate that load in a nonface domain (e.g., letter shape) can reduce face recognition, in accord with Lavie's load theory. In addition to their theoretical impact, these results may have practical implications for eyewitness testimony.

Recognition memory for faces has traditionally been considered good compared with memory for other types of images (e.g., buildings, airplanes, dogs; see A. G. Goldstein & Chance, 1970; Scapinello & Yarmey, 1970; Yin, 1969; but see Hancock, Bruce, & Burton, 2000). In these previous studies, however, the faces were fully attended at exposure. A separate literature has suggested that attention versus inattention at exposure can modulate later recognition memory, at least for fairly neutral stimuli such as geometric shapes (e.g., Rock, Schauer, & Halper, 1976), line drawings (Goldstein & Fink, 1981; Rock & Gutman, 1981), or words (e.g., Gardiner & Parkin, 1990). The possible effects of attention on face memory have rarely been examined, though. We consider some exceptions to this general rule below.

Kellogg (1980) compared recognition memory for faces that subjects were instructed to concentrate on during exposure with memory for faces exposed as distractors while subjects performed multiplication on heard numbers. In the latter condition, face memory was reduced. However, as the display duration (about 10 sec) permitted eye movements, the subjects might simply have looked less at the faces when performing multiplication, effectively reducing exposure. Kellogg, Cocklin, and Bourne (1982) found similar effects using a multiplication task presented visually, with face exposure reduced to 2 sec, but shifts of fixation away from the faces during multiplication were still possible. Reinitz, Morrissey, and Demb (1994) compared incidental memory for line-drawn faces that were either fully attended during exposure or exposed while subjects counted rapid sequences of dots, presented alternately on the top and bottom of a face. Face recognition was worse after the latter task, but as the counting task involved alternation between the top and the bottom of the face, it could have disrupted the holistic processing associated with face encoding (see, e.g., Tanaka & Farah, 1993; Tanaka & Sengco, 1997). Indeed, holistic processing might also have been disrupted by the attentional manipulation in Kellogg et al. (1982), which involved presentation of the math problem on the left and right sides of the face.

In both Kellogg et al.'s (1982) and Reinitz et al.'s (1994) studies, memory for faces was compared in conditions when faces were either fully attended or fully task-irrelevant. Although this comparison is a useful starting point, Lavie's (1995, 2000, 2001) recent "perceptual load" theory suggests that when addressing the role of attention, a more subtle and telling comparison might be to examine memory for stimuli that always appear as task-irrelevant distractors, but under different conditions of load in an unrelated task. A central point of Lavie's load theory is that merely instructing participants that a stimulus is "task-irrelevant" may not always guarantee that attentional resources can be voluntarily withheld

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This research was supported by a studentship awarded to J.D., in support of R.J., from the Biotechnology and Biological Sciences Research Council (BBSRC, U.K.); a postdoctoral fellowship award from the British Academy to R.J.; a BBSRC Project Grant to N.L.; and a Medical Research Council (U.K.) Career Award to N.L. Correspondence concerning this article should be sent to R. Jenkins, Department of Psychology, University of Glasgow, Glasgow, G12 8QB, Scotland (e-mail: rob@psy.gla.ac.uk).

from it. Processing of "task-irrelevant" stimuli may only be prevented if the perceptual load of the task prescribed for task-relevant stimuli is sufficiently high to exhaust available attentional capacity. If the relevant task fails to exhaust capacity, then in Lavie's account, excess capacity will be involuntarily allocated to the processing of irrelevant stimuli. Thus, irrelevant processing will only be eliminated when the relevant task exhausts capacity for it, as a natural consequence of all capacity being consumed. Lavie's theory therefore predicts that the perceptual load of a prescribed task will affect the degree of processing that task-irrelevant distractor stimuli undergo, even when the observer is equally motivated to ignore the distractors in all cases.

In this study, we examined whether the perceptual load of a nonface task can affect subsequent recognition memory for faces exposed during that nonface task, as Lavie's account predicts. Unlike previous studies, we always examined memory for task-irrelevant faces (now under different task-relevant loads), rather than comparing memory for task-irrelevant and task-relevant faces (cf. Kellogg, 1980; Kellogg et al., 1982; Reinitz et al., 1994). Faces encountered during daily life will often be irrelevant to the ongoing task at that time, yet may need to be recognized later (as by eyewitnesses). Note that since the faces were always task-irrelevant when exposed in our study, we did not impose different encoding strategies for them, unlike previous studies of attention and face memory.

EXPERIMENT 1

To manipulate load in a nonface task, we employed letter search tasks used in previous perceptual load studies (reviewed in Lavie 2000, 2001). Each display comprised a letter string superimposed on a task-irrelevant unfamiliar face. In the low-load condition, the letter task involved simple color discrimination, typically thought to impose low attentional load (e.g., Treisman & Gelade, 1980). The high-load task required difficult letter shape discrimination, which should be more attentionally demanding (e.g., Lavie, 1995; Treisman & Gelade, 1980) and has reduced processing of nonface distractors in previous load studies (see Lavie, 2000, 2001). Any effect of load in the letter task on subsequent explicit recognition of the distractor faces was assessed in a surprise recognition test at the end of the experiment.

Method

Subjects and Apparatus. Twelve naive undergraduates from University College London participated. All reported normal or corrected-to-normal vision. Viewing distance was 60 cm.

Stimuli. As illustrated in Figure 1, each display comprised a face with the middle of the nose at fixation and a letter string superimposed across this middle point. The letter string could be red or blue, and comprised one target letter (*X* or *N*) and five nontarget letters (*H*, *K*, *M*, *W*, or *Z*) arranged in random order (cf. Lavie, 1995; Lavie & Cox, 1997). Each letter measured 0.4° × 0.5° of visual angle, separated from its neighbors by 0.2°. Faces were photographic grayscale images edited to remove extraneous background. Each face measured 4.3°–6.2° horizontally and 6.2° vertically against a light gray background.

Seventy-two anonymous faces were used: 24 apiece for the low- and high-load conditions and 24 serving as new faces (foils) in the subsequent recognition test. Each set of 24 contained 12 male and 12 female faces. The particular faces used for low load, high load, or foils were counterbalanced across subjects. Combinations of target letter identity, target letter position, string color, and face identity were also counterbalanced so that high- and low-load displays were equivalent.

Procedure. Each trial began with a central fixation point for 500 msec, followed by the face-plus-string display for 200 msec (i.e., too brief for saccades). The subjects made a speeded response, pressing one key for red and another for blue letter strings (low load) or one for target *X* versus target *N* (high load). A tone gave feedback for errors or failures to respond within 3 sec. Alternating blocks had the high- or low-load letter task (starting condition counterbalanced). In the high-load condition, string color was constant through a block (red or blue) to minimize any congruency effects from response associations carrying over from the low-load task. The experiment began with two practice blocks of 12 trials for each load condition with just the letter strings presented, followed by 12 experimental blocks, each consisting of 48 trials in random order. Thus, each particular face was shown 12 times in total.

The subjects were requested to focus on the letter strings and ignore the irrelevant faces throughout. The surprise face recognition test followed these blocks. The subjects were presented with an isolated face on each trial, and they judged whether it had been presented before in the experiment.

Results

As can be seen from Figure 2A, mean response times (RTs) and error rates in the letter string tasks were higher

Figure 1. Example display from Experiment 1. In the low-load condition, subjects responded to the color of the letter string (red vs. blue). In the high-load condition, they responded to the identity of a target letter (*X* vs. *N*) among other angular letters in physically equivalent displays. In both conditions, subjects were instructed to ignore the irrelevant face distractor.

in the high-load condition (mean RT = 876 msec, 16% errors) than in the low-load condition (mean RT = 422 msec, 2% errors), confirming that perceptual load was effectively manipulated [$t(1,11) = 13.99$, $p < .01$ for RTs; $t(1,11) = 8.90$, $p < .01$ for errors].

The percentage of "yes" responses in the recognition task was computed separately for faces originally exposed under low-load (51%) versus high-load (28%) conditions. The false-positive rate for new foil faces was 23%; see Figure 2B. A one-way analysis of variance (ANOVA) revealed an effect of experimental condition [$F(2,22) = 10.7$, $p < .01$]. Planned comparisons showed that in accordance with the load hypothesis, recognition was highest for faces exposed as irrelevant distractors under low-load conditions in the letter string task, significantly higher than for faces exposed under high load [$t(1,11) = 3.01$, $p < .01$] or for new faces [$t(1,11) = 4.06$, $p < .01$]. There was no difference between responses to faces exposed under high load versus new faces [$t(1,11) = 1.13$, $p > .10$].

Discussion

Experiment 1 showed a clear effect of attentional load in the relevant nonface task on incidental memory for irrelevant face distractors. Although face distractors from the low-load condition were often recognized later in the low-load condition (despite having been completely irrelevant to the ongoing task at exposure), such recognition was eliminated in the high-load condition. Thus, later face recognition depended on nonface load at exposure, rather than just on the (fixed) task-irrelevance of the faces.

The second experiment sought to replicate this load effect and to extend it to a case where the high- and low-load tasks now both required shape judgments for the letter strings. Since the face recognition task used was primarily shape- rather than color-based, the differential demands of the shape versus the color judgments on the letter strings might in principle have produced the differential impacts on face processing in Experiment 1.

EXPERIMENT 2

Subjects were now required to indicate whether an *X* or *N* was present in the letter string for both low-load and high-load tasks. Thus, both target shape discrimination and mapping of targets to responses were strictly matched across load conditions. In the high-load condition, the nontarget letters in the string were angular as before. In the low-load condition, homogenous strings of six *X*s or six *N*s were presented, so that attentional search was not required. If incidental memory for distractor faces depends on the attentional demand of the letter shape task, then a pattern similar to that in Experiment 1 should be observed. If, instead, any shape processing interferes with face processing, but color processing (as in Experiment 1) does not, then poor memory for the faces should now be found in both the high- and low-load conditions.

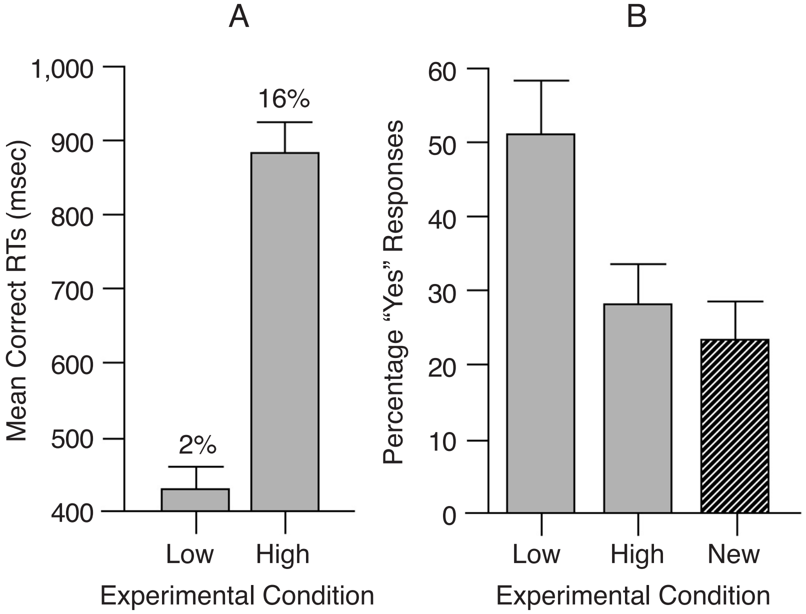

Figure 2. (A) Mean correct RTs (msec), percentage error rates, and standard errors in the letter string task in Experiment 1, shown as functions of load condition (low vs. high). (B) Mean percentage of "yes" responses in the surprise recognition test in Experiment 1. Memory performance is shown as a function of experimental condition: low or high load at exposure or new faces not previously exposed (foils). In the latter condition, the bar indicates the false-positive rate.

Method

Subjects. Twelve new undergraduates from University College London participated.

Stimuli and Procedure. These were like those of Experiment 1, except that the letter strings were always blue; in the low-load condition only, they comprised either six *X*s or six *N*s; and in both load conditions, the task was now an *X*/*N* discrimination.

Results and Discussion

As shown in Figure 3A, mean correct RTs and percentage error rates in the letter string task were again higher for high load (mean RT = 729 msec, 13% errors) than for low load (mean RT = 460 msec, 2% errors), confirming that perceptual load was effectively manipulated [$t(1,11) = 10.02$, $p < .01$ for RTs; $t(1,11) = 5.45$, $p < .01$ for errors]. In terms of RTs, this difference was smaller than that found in Experiment 1 [$F(1,22) = 10.15$, $p < .01$ in a between-experiments comparison; $F < 1$ for errors], mainly because of somewhat faster RTs in the high-load condition of Experiment 2, perhaps as subjects became more practiced at *X*/*N* discrimination when this was constantly required for the response mapping.

A one-way ANOVA on percentage recognition responses revealed a significant effect of condition [$F(2,22) = 28.75$, $p < .01$]. Planned comparisons showed that, as in Experiment 1, face recognition was higher for faces exposed as distractors under low load (56% "yes" responses) than under high load [27% "yes"; $t(1,11) = 5.36$, $p < .01$] or for new faces [17% "yes"; $t(1,11) = 5.98$, $p < .01$]; see Figure 3B. On this occasion, the poorer memory for faces under high load exceeded the false-positive rate [$t(1,11) = 2.62$, $p < .05$], presumably because the load manipulation was not quite as strong as before (see the between-experiments comparison above of the load effect on letter performance). Nevertheless, high load in an unrelated letter string task again significantly reduced explicit incidental memory for task-irrelevant faces, as compared with memory for faces that were equally task-irrelevant when exposed under a lower load.

EXPERIMENT 3

The preceding experiments established that incidental recognition memory for fixated but task-irrelevant faces can be greatly reduced by high load in an unrelated task, at least in a delayed recognition test. Our final experiment used a method adapted from studies of "inattentional blindness" (see Mack & Rock, 1998) to examine any effects of perceptual load in a nonface task upon immediate recognition of the distractor face presented on the preceding final trial of the letter task. Each subject thus now underwent recognition testing for one face only (the face from the immediately preceding trial). Note that repeated immediate testing was precluded, as subjects could then have known in advance of exposure that faces would become task relevant. Accordingly, load in the letter task for those faces whose recognition was tested now became a between-subjects factor.

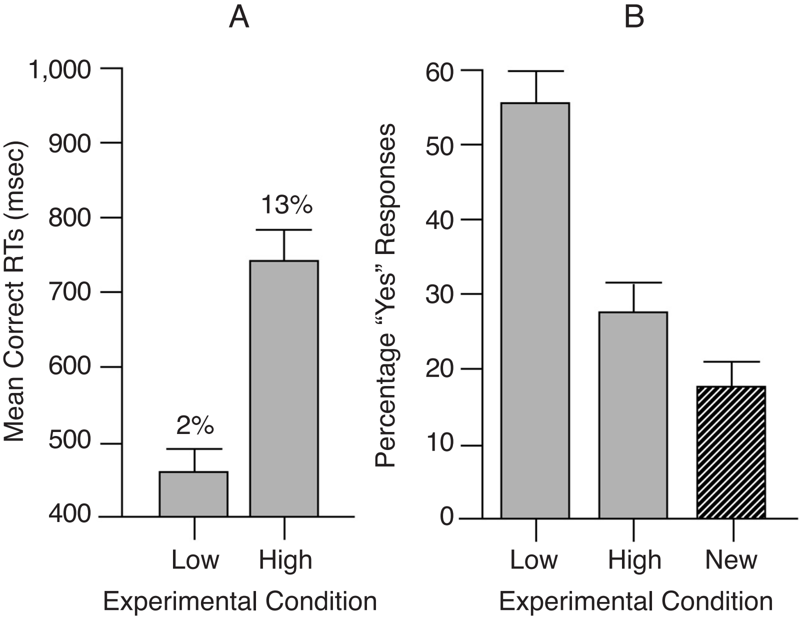

Figure 3. (A) Mean correct RTs (msec), percentage error rates, and standard errors in the letter string task in Experiment 2, shown as functions of load condition (low vs. high). (B) Mean percentage of "yes" responses in the surprise recognition test in Experiment 2. Memory performance is shown as a function of experimental condition: low or high load at exposure or new faces not previously exposed (foils). In the latter condition, the bar indicates the false-positive rate.

If the poor recognition performance for faces exposed under high-load conditions in Experiments 1 and 2 was due merely to impaired retention over a long delay, the load effect should be eliminated for immediate recognition. But if a load effect is found even with immediate testing, this would imply that a phenomenon akin to that often described as "inattentional blindness" (i.e., specifically here a failure of immediate forced choice recognition memory) can be determined by perceptual load at exposure, even for salient distractor stimuli such as faces, and even when the load arises in an unrelated nonface task.

Method

Subjects. Forty-eight undergraduates from the University of Glasgow participated.

Stimuli and Procedure. These were as before, except as follows: The subjects completed only one low-load block and one high-load block. Each block consisted of 24 trials showing different faces, with the face appearing in the 24th (final) trial being determined in advance on a subject-by-subject basis to counterbalance the critical stimuli across subjects. Thus, over the course of the whole experiment, each face appeared in the final trial under low- or high-load conditions exactly once. The final trial of the letter task was immediately followed by a surprise two-alternative forced choice (2AFC) question, presented on the screen along with two faces, asking the subjects to indicate which of the two faces was presented in the immediately preceding trial. In each case, the concurrently presented target and foil faces were gender matched to ensure that correct decisions had to be based on face identity.

Results and Discussion

As Figure 4A shows, mean correct RTs and percentage error rates in the letter string task were once again higher for high load (mean RT = 922 msec, 28% errors) than for low load (mean RT = 514 msec, 4% errors), indicating effective manipulation of load [$t(1,47) = 17.92$, $p < .01$ for RTs; $t(1,47) = 11.18, p < .01$ for errors]. We note that overall RTs and errors were somewhat higher than in Experiments 1 and 2, presumably due to reduced practice effects over just a single block.

Recognition memory performance in Experiment 3 is summarized in Figure 4B. Results from the immediate 2AFC recognition test (i.e., concerning the last face presented on the immediately preceding letter-task trial) showed that the probability of recognition memory was substantially reduced from low to high load (recognition rate was 67% in low load and 42% in high load). A one-tailed chi-square test confirmed that this reduction was significant [$\chi^2(1) > 2.71, p < .05$]. Given the salience of the distractor faces and the immediacy of the 2AFC test, this result may seem surprising, especially since the load was imposed in a nonface domain (i.e., letters). Nonetheless, load in the nonface task determined the level of immediate recognition for a distractor face, which was relatively good under low load but significantly reduced for high load, even on an immediate test.

GENERAL DISCUSSION

These experiments show that incidental memory for unfamiliar faces that were always exposed as task-irrelevant distractors depended on the attentional load of an unrelated task performed at exposure. In all three experiments, differential recognition rates were observed for

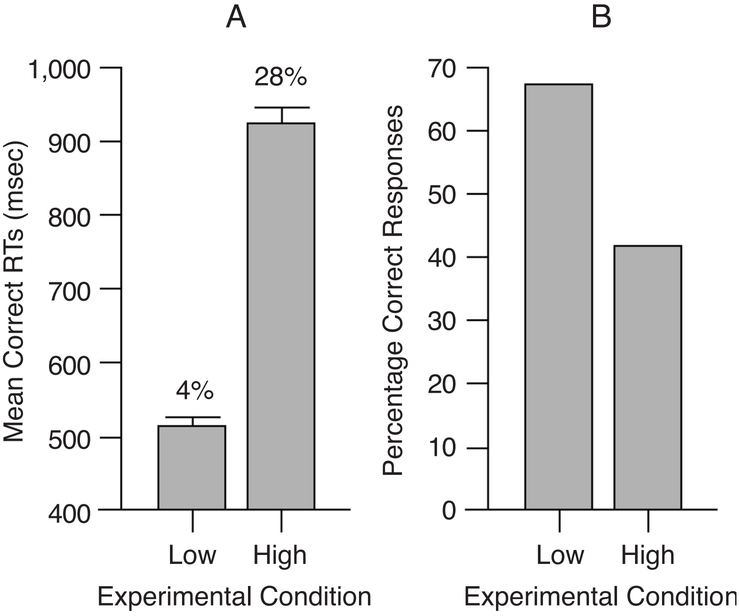

Figure 4. (A) Mean correct RTs (msec), percentage error rates, and standard errors in the letter string task in Experiment 3, shown as functions of load condition (low vs. high). (B) Mean percentage of correct responses in the surprise 2AFC recognition test in Experiment 3. Memory performance is shown as a function of load condition (low vs. high).

faces presented during high- versus low-load letter tasks, even though the faces were always equally irrelevant to the prescribed task. Given that faces are often claimed to be particularly memorable stimuli (e.g., Scapinello & Yarmey, 1970; see introduction) and that some even claim that faces may be processed by dedicated neural circuits (e.g., Farah, Levinson, & Klein, 1995; Kanwisher, 2000), it may seem remarkable that manipulating attentional load in an unrelated nonface domain at the time of exposure can so dramatically reduce recognition memory for faces, including immediate recognition. However, this result fully accords with the predictions of Lavie's (1995, 2000) load theory. It shows that attentional load in one visual domain (here shape processing for letters) can affect processing of stimuli in another domain (i.e., faces), thus confirming the generality of load effects.

The present findings also place new boundary conditions on previous claims (e.g., Farah et al., 1995; Fodor, 1983) that face processing may be "modular" in the sense of proceeding independently of attention (see also Wojciulik, Kanwisher, & Driver, 1998) or in relying solely on face-specific processing resources. Although some aspects of face-processing may depend upon face-specific mechanisms, our results show that memory for faces, including immediate recognition, is affected by concurrent demands for other (nonface) shape processing capacity at exposure.

Our study goes beyond previous work (cf. Kellogg, 1980; Kellogg et al., 1982; Reinitz et al., 1994) in showing that face memory does not depend solely on whether the exposed faces are task-relevant or -irrelevant. All of the exposed faces were task-irrelevant at exposure in our study, and so were nominally "unattended" in this conventional sense. Nevertheless, the degree of recognition for them depended on the attentional load of the ongoing unrelated task, as predicted by Lavie's (1995, 2000, 2001) theory.

Although we have shown here that face recognition depends on attention, faces might nevertheless be particularly able to attract attention when it is not already committed elsewhere. Ro, Russell, and Lavie (2001) recently reported within a "change-blindness" paradigm that changing faces can be more effective at capturing attention than other types of changing object. That result occurred, however, in a situation in which all stimulus types, including faces, were equally task-relevant, so attention was not committed elsewhere. Given the present results, we suggest that when a relevant nonface task imposes a sufficiently high load (demanding that observers commit their attention to it), this demand may be sufficient to preclude attention capture by task-irrelevant faces, with consequences for their recognition even on immediate test.

We tested "explicit" recognition with a direct test here, so it remains possible that more "implicit" face recognition processes (see Burton, Young, Bruce, Johnston, & Ellis, 1991; Young & Burton, 1999) assessed by indirect means might be less dependent on attentional load. For example, Lavie, Ro, and Russell (2003) recently observed that on-line "response-competition" or "distractor congruency" effects from distractor faces were relatively impervious to load manipulations. However, this study involved a small set of very famous faces (e.g., Bill Clinton), whereas here we used a large set of anonymous faces, thus precluding direct comparison between these studies. Jenkins, Burton, and Ellis (2002) also presented famous faces as distractors and compared attentional effects for direct versus indirect measures of face recognition. It should be interesting in future work to implement such a comparison for previously unknown faces, as used here. For now, the present findings demonstrate that explicit face recognition depends on attentional load in a nonface task at exposure; this effect extends to immediate recognition, thus suggesting that phenomena akin to "inattentional blindness" can also depend upon load. Future experiments could determine whether these effects for faces are qualitatively similar to those found for nonface distractors. We make no claim that faces are necessarily "special" here; indeed, our main point is that nonface load can dramatically affect subsequent recognition of distractor faces.

In addition to their theoretical interest, the present findings may also have implications for the practical issue of eyewitness reliability (see Devlin, 1976; Wells, 1993; Wells et al., 2000), in which explicit recognition of faces is often critical. In daily life, faces will often be encountered while the observer is engaged in some other attention-demanding visual task. The present results show that even when a face is presented numerous times directly at fixation, observers may not explicitly recognize it afterward if their attention was fully engaged by a nonface task. Moreover, even immediate recognition of a fixated face can be disrupted by the load of a nonface task.

REFERENCES

Burton, A. M., Young, A. W., Bruce, V., Johnston, R. A., & Ellis, A. W. (1991). Understanding covert recognition. *Cognition*, **39**, 129-166.

Devlin, the Hon. Lord Patrick (1976). *Report to the Secretary of State for the Home Department of the Departmental Committee on Evidence of Identification in Criminal Cases*. London: Her Majesty's Stationery Office.

Farah, M. J., Levinson, K. L., & Klein, K. L. (1995). Face perception and within-category discrimination in prosopagnosia. *Neuropsychologia*, **33**, 661-674.

Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: MIT Press.

Gardiner, J. M., & Parkin, A. J. (1990). Attention and recollective experience in recognition memory. *Memory & Cognition*, **18**, 579-583.

Goldstein, A. G., & Chance, J. E. (1970). Visual recognition memory for complex configurations. *Perception & Psychophysics*, **9**, 237-241.

Goldstein, E. B., & Fink, S. I. (1981). Selective attention in vision: Recognition memory for superimposed line drawings. *Journal of Experimental Psychology: Human Perception & Performance*, **7**, 954-967.

Hancock, P. J. B., Bruce, V., & Burton, A. M. (2000). Recognition of unfamiliar faces. *Trends in Cognitive Sciences*, **4**, 330-337.

Jenkins, R., Burton, A. M., & Ellis, A.W. (2002). Long-term effects of covert face recognition. *Cognition*, **86**, B43-B52.

Kanwisher, N. (2000). Domain specificity in face perception. *Nature Neuroscience*, **3**, 759-763.

Kellogg, R. T. (1980). Is conscious attention necessary for long-term storage? *Journal of Experimental Psychology: Human Learning & Memory*, **6**, 379-390.

Kellogg, R. T., Cocklin, T., & Bourne, L. E., Jr. (1982). Conscious attentional demands of encoding and retrieval from long-term memory. *American Journal of Psychology*, **95**, 183-198.

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception & Performance*, **21**, 451-468.

Lavie, N. (2000). Selective attention and cognitive control: Dissociating attentional functions through different types of load. In S. Monsell & J. Driver (Eds.), *Control of cognitive processes: Attention and performance XVIII* (pp. 175-194). Cambridge, MA: MIT Press.

Lavie, N. (2001). Capacity limits in selective attention: Behavioral evidence and implications for neural activity. In J. Braun, C. Koch, & J. L. Davis (Eds.), *Visual attention and cortical circuits* (pp. 49-68). Cambridge, MA: MIT Press.

Lavie, N., & Cox, S. (1997). On the efficiency of visual selective attention: Efficient visual search leads to inefficient distractor rejection. *Psychological Science*, **8**, 395-398.

Lavie, N., Ro, T., & Russell, C. (2003). The role of perceptual load in processing distractor faces. *Psychological Science*, **14**, 510-515.

Mack, A., & Rock, I. (1998). *Inattentional blindness*. Cambridge, MA: MIT Press.

Reinitz, M. T., Morrissey, J., & Demb, J. (1994). Role of attention in face encoding. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **20**, 161-168.

Ro, T., Russell, C., & Lavie, N. (2001). Changing faces: A detection advantage in the flicker paradigm. *Psychological Science*, **12**, 94-99.

Rock, I., & Gutman, D. (1981). The effect of inattention on form perception. *Journal of Experimental Psychology: Human Perception & Performance*, **7**, 275-285.

Rock, I., Schauer, R., & Halper, F. (1976). Form perception without attention. *Quarterly Journal of Experimental Psychology*, **28**, 429-440.

Scapinello, K. F., & Yarmey, A. D. (1970). The role of familiarity and orientation in immediate and delayed recognition of pictorial stimuli. *Psychonomic Science*, **21**, 329-331.

Tanaka, J. W., & Farah, M. J. (1993). Parts and wholes in face recognition. *Quarterly Journal of Experimental Psychology*, **46A**, 225-245.

Tanaka, J. W., & Sengco, J. A. (1997). Features and their configuration in face recognition. *Memory & Cognition*, **25**, 583-592.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, **12**, 97-136.

Wells, G. L. (1993). What do we know about eyewitness identification? *American Psychologist*, **48**, 553-571.

Wells, G. L., Malpass, R. S., Lindsay, R. C. L., Fisher, R. P., Turtle, J. W., & Fulero, S. M. (2000). From the lab to the police station: A successful application of eyewitness research. *American Psychologist*, **55**, 581-598.

Wojciulik, E., Kanwisher, N., & Driver, J. (1998). Covert visual attention modulates face-specific activity in the human fusiform gyrus: fMRI study. *Journal of Neurophysiology*, **79**, 1574-1578.

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

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

(Manuscript received February 19, 2002;
revision accepted for publication February 19, 2004.)