Research Article

Attention and the Processing of Emotional Words and Names

Not So Special After All

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ABSTRACT—*Previous research has suggested that a person's own name or emotionally charged stimuli automatically "grab" attention, potentially challenging limited-capacity theories of perceptual processing. In this study, subjects were shown two digits surrounding a word and asked to make a speeded judgment about whether the parity of the two digits matched. When the subject's own name was presented on a few scattered trials, responses were markedly slowed (replicating a previous study). However, in a subsequent block of trials in which half the words were the subject's name, the slowing did not occur. The same slowing occurred (but even more fleetingly) when an emotionally charged word was presented between the digits. When the name was embedded among multiple distractor words, it ceased to slow reaction times. The results suggest that perceptual analysis of high-priority stimuli is subject to the usual capacity limitations of other stimuli, but when enough capacity is available for a high-priority stimulus to be perceived, a transient surprise reaction may interrupt ongoing processing.*

People often seem to notice when their names are spoken in a conversation they were not consciously attending to, as if the names "jump out." Similarly, people sometimes report noticing emotionally charged words in unattended conversations or print. However, research on attention to such high-priority stimuli presents a confusing picture. In the present study, we attempted to shed more light on the topic using an experimental design in which high-priority stimuli occasionally appeared as distractors while subjects performed a perceptual-cognitive task.

EARLY FINDINGS AND CONFLICTING RESULTS

The commonplace observation that one's own name may attract attention was first confirmed by Moray (1959; see also Wood & Cowan, 1995). Subjects shadowed spoken messages played in one ear, ignoring the message played in the other ear. When the unattended input consisted of ordinary words, subjects neither noticed nor recognized the words. However, about one third of the listeners noticed when their own names were presented to the unattended ear and commented on this. Moray's result is cited in most current textbook discussions of attention (e.g., Reisberg, 2001; Solso, 2000), where it is usually viewed as evidence for late-selection theory. According to this interpretation, all perceivable stimuli, whether attended or not, are analyzed to a semantic level. Monitoring for high-priority stimuli is thought not to require limited-capacity processing resources.

In a visual analogue to Moray's (1959) study, Wolford and Morrison (1980) presented two digits flanking a word and had subjects indicate whether the digits had the same parity (odd vs. even). When the word was the subject's last name, responses were substantially slowed. The authors concluded that names frequently attracted attention, impairing performance on the digit task.

However, Bundesen, Kyllingsbaek, Houmann, and Jensen (1997) found a startlingly different result. Brief displays of two red and two white names were presented (a random 5% of these being the subject's own first name). The subject's task was to report the red items. When the subject's name was one of the (white) distractors, this did not impair performance. Similarly, in recent visual search studies involving displays of 2 to 12 words, we found no evidence that the subject's name is an especially potent distractor (Harris, Pashler, & Coburn, in press). However, like Bundesen et al., we found that subjects were quicker to detect their own names than to detect other words, presumably because of greater practice identifying their own names.

Given this evidence that casts doubt on whether one's own name attracts attention, we began the present study by asking whether the Wolford and Morrison (1980) phenomenon could be replicated. Finding that it could, we explored its theoretical significance by asking whether the effect persists with repeated exposures of the word, and determining how the effect may be modulated when the visual processing load is varied.

EXPERIMENT 1

This experiment used the digit-parity task described by Wolford and Morrison (1980). During the first block of trials, the subject's own name

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was presented infrequently, as in the original study. In the second block of trials, however, the name was presented on half of the trials.

Method

Subjects

Sixty-one college students participated in return for payment or course credit in Experiment 1a, and another 58 participated in Experiment 1b.

Equipment and Stimuli

Displays were presented on 15-in. Sony Trinitron Multiscan 100GS SVGA monitors controlled by PC computers. Displays consisted of two digits flanking a word and were viewed from approximately 70 cm. Stimuli were black against a gray background. The digits were 1 cm high by 0.6 cm wide, spaced 14.5 cm apart. The words were four to eight letters long, with frequency between 25 and 100 per million (Kucera & Francis, 1967). Centered at fixation, they measured 1 cm high by 3 to 8 cm wide.

Design

Experiment 1a consisted of two blocks of 50 trials each. In Block 1, the subject's first name was shown on Trials 30 and 40, with random neutral words shown on the other trials. In Block 2, the name appeared on a random 25 trials, with neutral words on the remaining 25. In Experiment 1b, subjects performed one practice block of 50 trials with neutral words, followed by two blocks with the same sequence of trials as in Experiment 1a.

Procedure

Subjects were told to focus on the parity task and ignore the words. Each trial began with a cross presented in the center of fixation for 1 s; the cross was followed, after 500 ms, by a 150-ms (unmasked) exposure of the digits and word. The subject pressed the "M" key of a computer keyboard if the digit parity matched, and otherwise pressed the "N" key. A 1-s interval separated successive trials.

Results and Discussion

Experiment 1a

Data from 2 subjects were discarded because of computer problems. The mean reaction time (RT) for the digit task showed a marked elevation of RT on the first trials in which the subject's own name was presented (see Fig. 1). RT was significantly slower on Trial 30 (1,823 ms) than on Trials 21 through 29 (1,203 ms), $t(58) = -3.8$, $p < .001$, and Trials 31 through 39 (1,240 ms), $t(58) = 3.7$, $p < .001$. RT on Trial 40 (1,365 ms) was not significantly slower than RT on Trials 31 through 39, $t(58) = 1.4$, $p > .15$, but was significantly slower than RT on Trials 41 through 49 (1,173 ms), $t(58) = 2.1$, $p < .05$. In Block 2, however, the mean RTs for the 25 name trials (1,062 ms) and the 25 trials with neutral words (1,048 ms) did not differ reliably, $t(58) = 1.4$, $p > .15$.

Experiment 1b

Figure 2 shows the RTs for Blocks 2 and 3 (which had the same stimulus sequence as Blocks 1 and 2 in Experiment 1a). The same M-shaped pattern is evident. RT was significantly slower for critical Trial

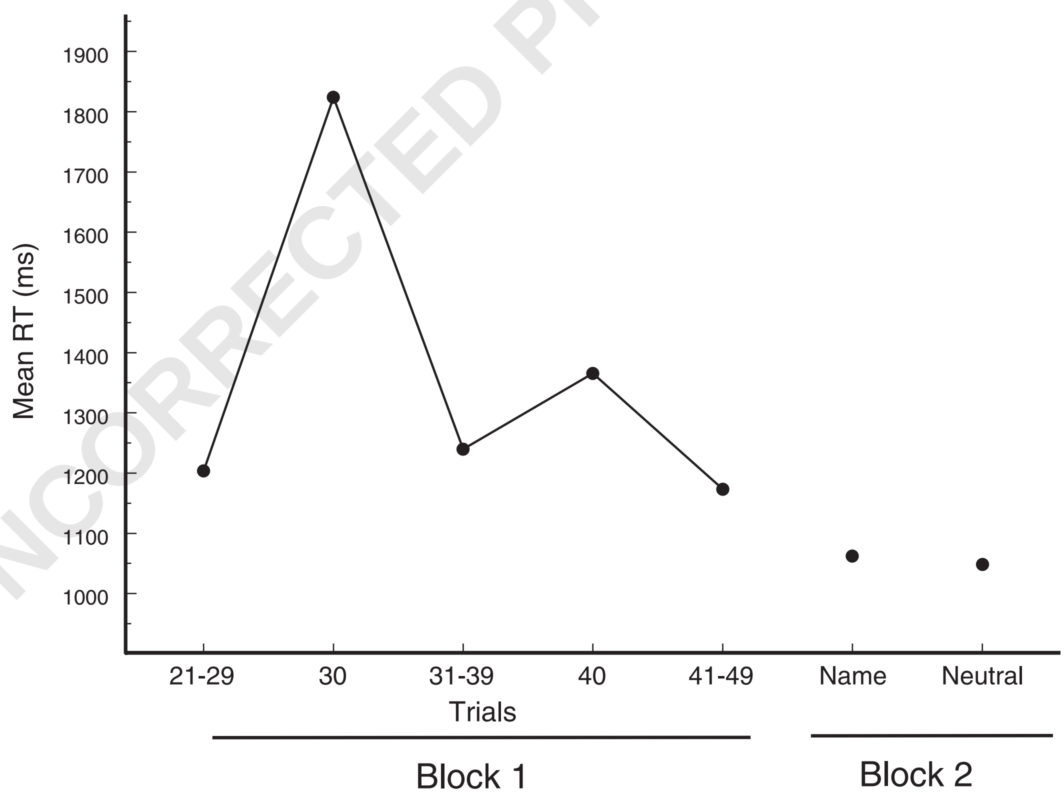

Fig. 1. Mean reaction time (RT) for the parity judgment task in Experiment 1a. In Block 1, Trials 30 and 40 contained the subject's name; in Block 2, the name was presented on a random half of the trials.

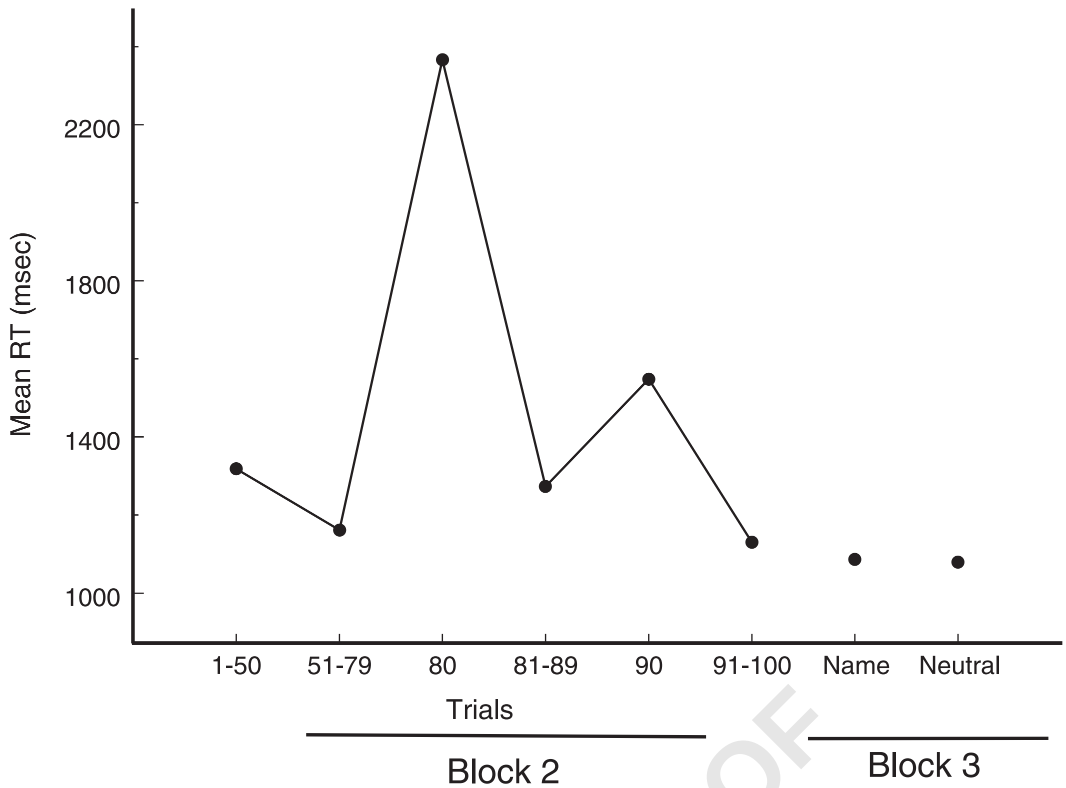

Fig. 2. **Mean reaction time (RT) for the parity judgment task in Experiment 1b. In Block 2, Trials 80 and 90 contained the subject's name; in Block 3, the name was presented on a random half of the trials.**

80 (2,366 ms) than for Trials 51 through 79 (1,162 ms), $t(57) = 6.0$, $p = .001$, and Trials 81 through 89 (1,273 ms), $t(57) = 6.1$, $p < .001$. RT on Trial 90 (1,548 ms) was significantly slower than RTs on Trials 81 through 89, $t(57) = 3.0$, $p < .01$, and 91 through 100 (1,130 ms), $t(57) = 5.1$, $p < .001$. However, in Block 3, the mean RTs for the 25 name trials (1,087 ms) and 25 trials with neutral words (1,079 ms) did not differ reliably. The only significant effect on error rates was a decline in errors between the first and second block.

Discussion

In both experiments, when subjects encountered their own names on a few isolated trials, there was a dramatic slowing on the primary (digit) task. This occurred regardless of whether the person had one block of experience with the digit task (Experiment 1b) or not (Experiment 1a). However, this intrusion effect evidently shrinks rapidly: It virtually disappeared in a subsequent block of trials in which the name appeared on half the trials.

EXPERIMENT 2

In Experiment 2, we asked whether negatively emotionally charged words presented between the flanking digits would produce similar effects. The effect of such stimuli on attention in normal individuals is unclear. For example, the "emotional Stroop effect" (slower color-naming responses to emotionally charged words than to neutral words) is commonly observed with anxious individuals (Eysenck, 1992; Mathews & MacLeod, 1985; Williams, Mathews, & MacLeod, 1996), whereas it occurs only rarely with unselected subjects (McKenna & Sharma, 1995). Other methods, too, have failed to find consistent evidence that negative stimuli draw attention in normal subjects (Broadbent & Broadbent, 1988; MacLeod, Mathews, & Tata, 1986). All of these designs involved averaging over many trials per subject.

Method

Experiment 2 was identical to Experiment 1 except that instead of the subject's own name, emotionally charged words randomly selected from the McKenna and Sharma (1995) stimulus set were presented on Trials 30 and 40 in Block 1, and on half of the trials in Block 2. One hundred twenty-four subjects from the same population participated.

Results and Discussion

Data from 2 subjects were discarded because of technical problems. Figure 3 shows the mean RT for the digit task. RTs were significantly slower for critical Trial 30 (1,470 ms) than for Trials 21 through 29 (1,258 ms), $t(121) = 2.62$, $p < .01$, or Trials 31 through 39 (1,210 ms), $t(121) = 3.11$, $p < .005$. RT on Trial 40 (1,241 ms) was not significantly different from RTs on Trials 31 through 39, $t(121) = 0.53$, $p > .50$, or Trials 41 through 49 (1,245 ms), $t(121) = 0.07$, $p > .90$. In Block 2, the mean RTs for the emotionally charged (1,058 ms) and neutral (1,058 ms) trials did not differ reliably. There were no significant differences in error rates between adjacent sets of trials.

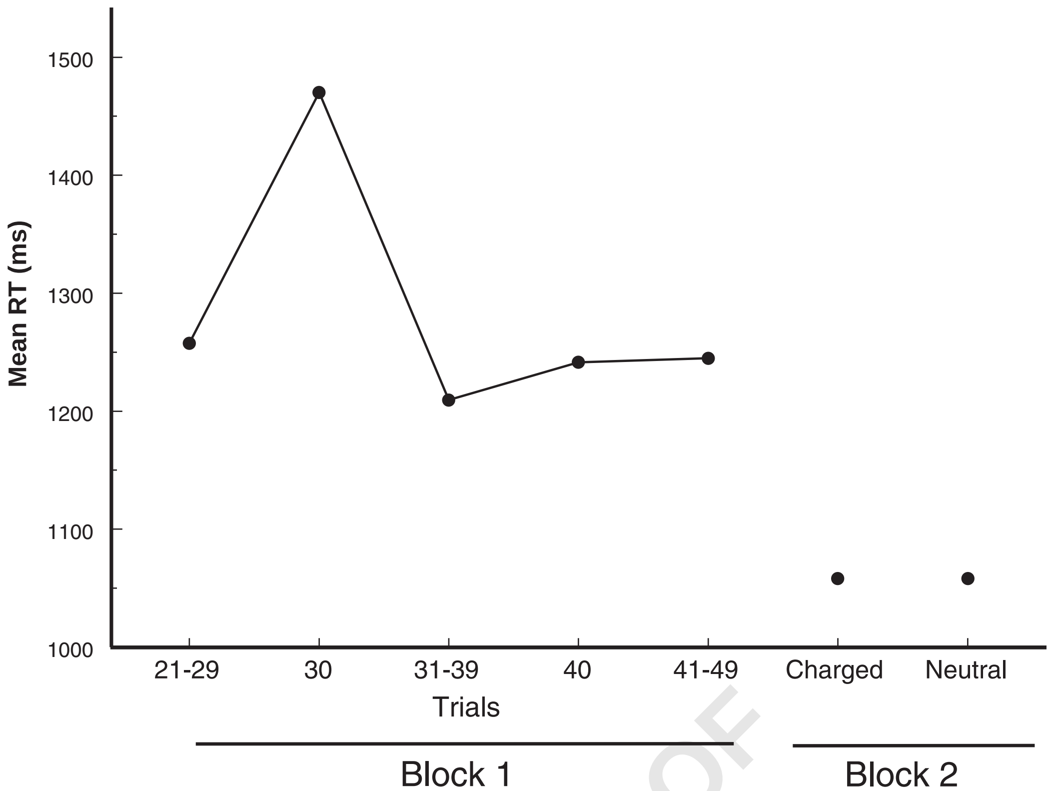

Fig. 3. Mean reaction time (RT) for the parity judgment task in Experiment 2. In Block 1, Trials 30 and 40 contained an emotionally charged word; in Block 2, such words were presented on a random half of the trials.

The first presentation of an emotionally charged word elicited a marked increase in the RT for the parity task, a result qualitatively similar to that observed when the subject's own name was presented the first time. However, this effect was only one third to one quarter the size of the own-name effect, and it became undetectable by the second presentation. One should not necessarily conclude that emotional stimuli always have weaker effects than names, of course; faces or emotional pictures might produce larger effects. The finding of an attention-grabbing effect of emotional stimuli, however fleeting, is of interest given the rarity of such effects with normal subjects. The present method may offer a particularly straightforward and face-valid measure of attention capture by emotional stimuli. Further, our results suggest that other methods, which average over numerous trials, may obscure a real but quickly habituating capture effect.

EXPERIMENT 3

The results thus far indicate that the intrusion effect described by Wolford and Morrison (1980) is real, that it generalizes to emotionally charged stimuli, and that it habituates rapidly. In our next experiment, we asked whether the intrusion effect is eliminated when a number of other words are presented simultaneously. Aside from its inherent interest, the question bears on the contrast between early- and late-selection interpretations of phenomena observed with high-priority stimuli.

Although semantically based intrusion effects have traditionally been taken as evidence supporting late-selection approaches to attention, the results presented here (and indeed the classical Moray, 1959, finding) are not difficult to explain within an early-selection framework. Note that the primary task imposes relatively minor perceptual demands, and the foveal presentation of the words may heighten the tendency for visual processing resources inadvertently to be allocated to the words, at least on some trials and to some extent. Because the cornerstone of early-selection theory is the postulation of severe capacity limitations, this account makes a distinctive prediction: When the number of irrelevant words in the display is increased, the effect of names or other intruding stimuli should effectively disappear, because the words should cease to be identified on most trials. Findings of both speeded (Flowers & Lohr, 1985) and unspeeded (e.g., Duncan, 1987) visual search tasks involving words reveal marked capacity limits in word identification: Target detection is impeded when additional words are added to a display (but not when objects unconfusable with words, such as placeholders or masks, are added). Thus, according to early-selection theories, a stimulus load of six words would greatly reduce the probability that the unattended word would be processed, regardless of its semantic significance and surprising nature.

Late-selection accounts, in contrast, propose that all stimuli are analyzed to a semantic level without capacity limitations or voluntary control, and that high-priority stimuli "pop out" automatically because of their semantic "pertinence" (Deutsch & Deutsch, 1963; see also Norman, 1968). The existence of marked effects of display load in visual search tasks involving words already poses a challenge to late-selection accounts. However, it may be accommodated by supposing

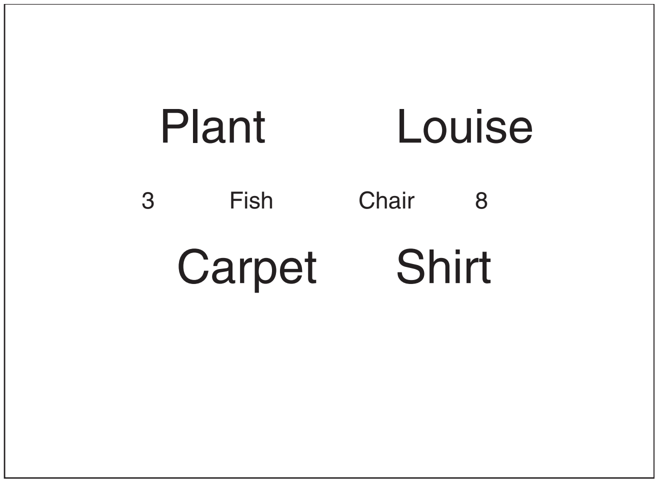

Fig. 4. **Approximate configuration of a typical display in Experiment 3a.**

that pertinence-based selection respects only long-standing dispositions (e.g., "orient to inputs with motivational importance"), and these are not sufficiently flexible to allow someone to detect an arbitrary target word. In search experiments involving hundreds of trials per subject, we recently found that names did not pop out in the sense of producing flat search slopes when they were targets or impairing performance when they were distractors (Harris et al., in press). To account for these results, late-selection accounts could be supplemented with the notion that pertinence-based selection habituates rapidly and therefore plays little role in conventional many-trial search experiments.[1] When modified in this way, the late-selection interpretation still makes a distinctive prediction: A high-priority word should produce an intrusion effect on its first or second appearance even when it is just one of a sizable number of simultaneously presented words.

In Experiment 3, instead of presenting only a single word between the digits, we varied display load by presenting six task-irrelevant objects in each display. All six of these objects were words in Experiment 3a and only one of them was a word in Experiment 3b.

Method

Experiments 3a and 3b were identical to the first block of Experiment 1 except for the intervening words. To ensure the words were readable from central fixation, we performed a rough M-scaling (increasing size of the words to compensate for retinal eccentricity; cf. Anstis, 1998). In Experiment 3a, displays contained six words, which appeared approximately as shown in Figure 4. In Experiment 3b, displays contained one word, and dark gray rectangles occupied the other positions. The presence of these rectangles in Experiment 3b roughly equated the (probably fairly minor) lateral masking that the critical word was subjected to in the two experiments, without drawing substantially on perceptual processing resources. The subject's name was presented on the same trials and in the same positions in the two experiments (the upper-right position on Trial 30 and the lower-left position in Trial 40). A group of 146 new subjects from the same population participated in Experiments 3a and 3b (40 in Experiment 3a, 106 in Experiment 3b).

Results and Discussion

In Experiment 3a, there was no elevation of RT on the two trials in which the subject's own name was presented (Fig. 5). In fact, there was a nonsignificant reduction in RT from 1,231 ms on Trials 21 through 29 to 1,115 ms on Trial 30, $t(39) = 1.29$, $p = .21$. It seems improbable that this dip is real, but the result leaves little doubt that the increase observed in previous experiments was eliminated. The RT on Trial 40 was 1,200 ms, not significantly different from RTs on the preceding and following trials, $t(39) = 0.1$, $p > .90$, and $t(39) = 0.4$, $p > .60$, respectively. There were no significant differences in error rates.

In Experiment 3b, however, when only one word was presented among rectangles, RTs were elevated much as in Experiment 1 (thus the now-familiar M-shaped pattern is apparent in Fig. 6). The RT on Trial 30 was 1,474 ms, which was significantly slower than the RTs for Trials 21 through 29 (1,189 ms), $t(105) = 2.1$, $p < .05$, and Trials 31 through 39 (1,214 ms), $t(105) = 2.0$, $p < .05$. Trial 40 again showed a spike, to 1,498 ms, which was significantly higher than the RTs on the preceding and following trials, $t(105) = 2.6$, $p < .01$, and $t(105) = 2.6$, $p < .02$, respectively. The percentage of errors was higher on Trial 30 (18%) than on preceding or following sets of trials (12% and 10%, respectively—differences that were nonsignificant and significant at $p < .05$, respectively); in contrast, errors were significantly less frequent on Trial 40 (5%) than on either preceding or following trials ($ps < .05$). When the critical trials were averaged together, the error rate showed little difference from error rates on other trials, so there appears to be no interpretable change in this measure.

The results of Experiment 3a show that the presence of five additional words eliminated the disruptive effect of presenting the subject's own name. Thus, the effect of high-priority stimuli does not reflect a true pop-out that occurs independent of stimulus load. The effect was eliminated by the presence of accompanying neutral distractor words. It would be interesting to know if nonword letter-string distractors accompanying a single high-priority word would also attenuate the effects of that word.

GENERAL DISCUSSION

The question of whether an individual's own name or emotionally charged inputs pop out, and the relevance of such pop-out for attentional mechanisms, have been points of dispute. The findings reported here shed new light on this issue in several ways. The disruption of a concurrent task caused by presentation of a person's own name, as described by Wolford and Morrison (1980), was shown to be a replicable effect. It was also found to generalize to emotionally charged words. However, this effect proved fleeting, apparently reflecting a momentary response of surprise (or something akin to surprise) that habituates very rapidly (so rapidly that it was undetectable with the emotional words by the second presentation).[2] The disruption occurring on the first or second presentation of the subject's name was

[1]We are grateful to Anne Treisman for pointing out this possibility at a conference presentation of these results.

[2]Wolford and Morrison's own data suggested such a weakening, although they did not emphasize this point.

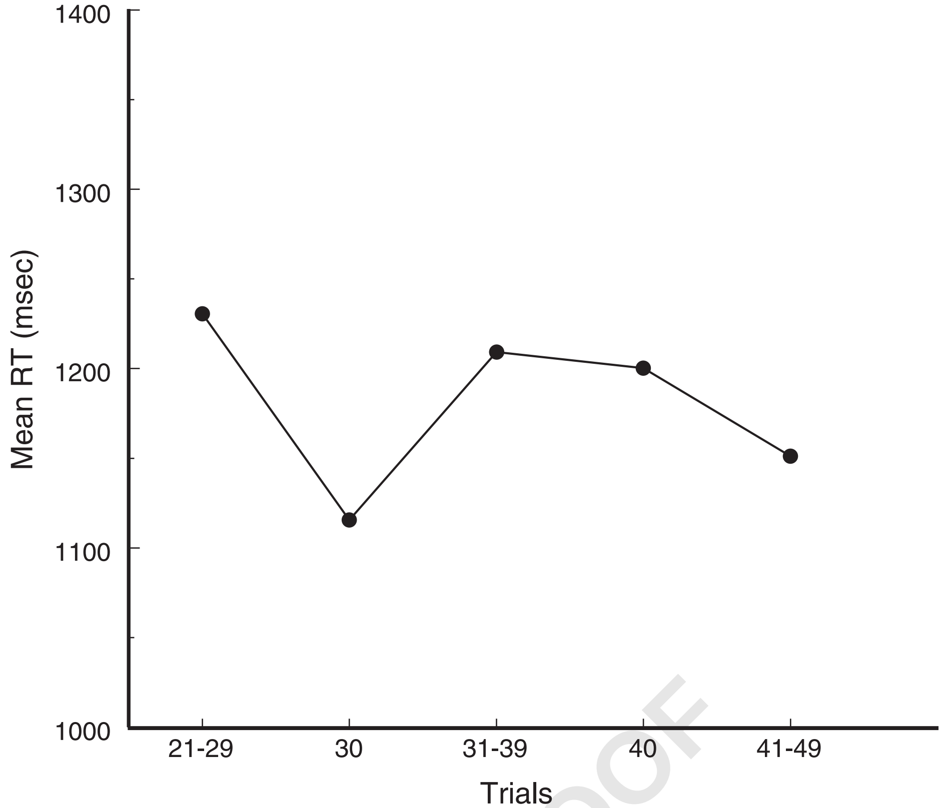

Fig. 5. Mean reaction time (RT) for the parity judgment task in Experiment 3a, in which six distractor words were presented simultaneously in each display. The subject's name appeared on critical Trials 30 and 40.

eliminated when the name was embedded in a large display of task-irrelevant words.

Relation to Prior Literature

This elimination of the effect has intriguing implications for the question of whether these high-priority stimuli pop out or not; we discuss these implications later. This result also suggests a natural explanation of why Moray (1959) and Wolford and Morrison (1980) found strong intrusion effects from names, but recent studies (Bundesen et al., 1997; Harris et al., in press) found no sign that observers' names grabbed attention involuntarily: The recent studies with negative results used substantial display loads and averaged over many trials. From the present results, it seems that one needs to use small display loads and to focus on the very first appearances of high-priority stimuli to detect this kind of capture.

The effects of display load (Experiment 3a) reflect a general trend in the selective attention literature: Phenomena initially seen as demonstrating parallel semantic analysis turn out to weaken or disappear when distractor load is increased. For example, Kahneman and Chajczyk (1983) found that the Stroop effect caused by presenting a color word next to a color patch could be "diluted" by adding neutral words to the display. Similarly, the Eriksen flanker effect can be eliminated by presenting many flankers (Yantis & Johnston, 1990) or many target characters (Lavie & Cox, 1997). These findings are directly predicted by early-selection theories (which suppose that the additional materials prevent or slow the perceptual analysis of the critical item by competing for limited-capacity perceptual processing resources), and problematic for late-selection accounts.

However, as an anonymous reviewer pointed out, it is always possible to modify late-selection accounts to accommodate these results. To do so, one could hypothesize that the automatic recognition of both high-priority and innocuous stimuli occurs without capacity limitations (i.e., just as efficiently in the presence of many distractor words as when there are no distractors), but that this identification is not sufficient to produce intrusion effects; a pertinence-based selection that follows analysis of the stimuli is necessary, and it is subject to display-load effects. Thus, for example, when surrounded by five other irrelevant words, the name is always identified, but this has no effects on behavior unless the name receives the benefit of pertinence-based selection, and that selection is delayed by the need to sort through the neutral words (but not nonlexical objects such as rectangles). This type of explanation can be offered in response to essentially any possible challenge to late-selection theory, including neurophysiological as well as behavioral challenges. However, in our opinion, such explanations have a somewhat post hoc flavor, and their testability can be questioned (cf. Broadbent, 1982). It is always possible to theorize that a process occurs but its presence is hidden by a host of different factors; once the putative set of concealing factors becomes large and diverse enough, however, the burden of proof shifts, and positive evidence for the process becomes needed.

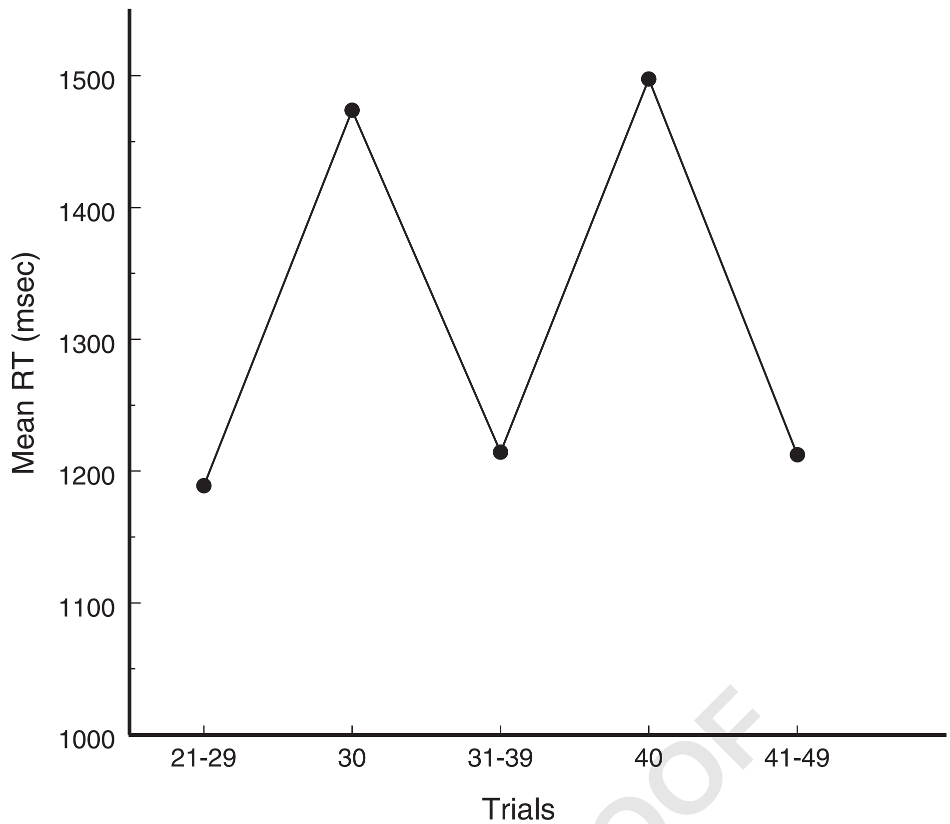

Fig. 6. **Mean reaction time (RT) for the parity judgment task in Experiment 3b, in which one distractor word and five gray rectangles were presented in each display. The subject's name appeared on critical Trials 30 and 40.**

To summarize, the results described here suggest that when a person's own name or an emotionally charged stimulus is presented, it may or may not be analyzed thoroughly enough to trigger recognition of the word. This analysis is likely subject to the same attentional capacity limitations found in tasks requiring detection of more "ordinary" stimuli. Given adequate processing resources, the first occurrence of such stimuli in a context where they are unexpected proves very disruptive, but the effect habituates rapidly. Thus, despite a lifetime of experience in which special significance has been ascribed to these classes of stimuli, people have no difficulty ignoring repeated occurrences of them, as in Experiments 1 and 2 here or our previous visual search experiments with names or emotional words as distractors (Harris et al., in press).

Pop Out (Or Not?)

In light of these results, it is of interest to return to the question that has framed a great deal of discussion of these topics: Do high-priority stimuli pop out on the basis of their semantics or not? The present findings suggest that it depends on what is meant by popping out. Such stimuli do indeed seem to pop out in the sense that their detection triggers an involuntary shift of attention that occurs even when a person lacks any voluntary intention to find them. In that sense, then, one could say that they pop out on their own. However, if irrelevant stimuli require significant perceptual processing, then presenting a sufficient number of them may prevent a concurrently presented high-priority stimulus from having any effect. Therefore, high-priority stimuli do not pop out in the sense that Treisman and Gelade (1980) documented for isolated discrepant feature targets (namely, that they can be located by means of a spatially parallel analysis of even a crowded display).

This interpretation of the effects of high-priority stimuli on attention is quite consistent with intriguing recent findings showing that a person's own name is subject to reduced attentional blink (Shapiro, Caldwell, & Sorenson, 1997), "repetition blindness" (Arnell, Shapiro, & Sorenson, 1999), and "inattentional blindness" (Mack & Rock, 1998). In these designs, stimulus load is very modest, and the inability to report something that characterizes the blink and blindness effects may reflect failures of consolidation in short-term memory or failures of retrieval, rather than lack of resources required for initial stimulus analysis (e.g., Luck, Vogel, & Shapiro, 1996; Vogel, Luck, & Shapiro, 1998).

This brings us back to the original impetus for Moray's (1959) study of names in dichotic listening: the commonplace observation that one's name sometimes seems to pop out in a conversation that one is not attending to. If we can safely generalize from the visual domain back to the auditory domain, the results described here suggest that this phenomenon probably occurs at moments when the perceptual demands of the conversation that a person is consciously focusing upon are relatively modest. This would be consistent with the fact that the name was detected only about 30% of the time in Moray's study (a point that is often overlooked in the literature; cf. Loftus, 1974). In the kind of visual cases analyzed here, as in dichotic listening, people lacking any conscious intention to monitor for their name or other high-priority stimuli often find their attention drawn to such a stimulus when its presence is surprising and demands on perceptual capacity are comparatively modest. So, too, in the blink and blindness designs cited in the previous paragraph, it seems that when display loads are small, names can evade the rapid forgetting that afflicts other stimuli. Given the results described here, then, we are led to conclude that although high-priority stimuli do not challenge limited-capacity theories of perceptual attention, they nonetheless remain "special" in ways that are both intriguing and, we suspect, functionally important.

Acknowledgments—This work was supported by the National Science Foundation (SBR 9729778) and the National Institute of Mental Health (MH45584). We are grateful to Joel Shotton, Trung Nguyen, and Phil Starkovich for programming assistance, and to Gurkirit Jhawar, Vera Irani, Jen Catabas, Eleanor Chu, and Andrew Tweet for assistance in data collection.

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(Received 10/17/01; Revision accepted 4/10/03)