Positive effect of heterogeneity of difference on the *same-different* disparity in letter matching

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Subjects judged whether two adjacent letters were identical or different. *Different* pairs were similar, for example HM, DO, VY, or dissimilar, for example DY, HV, MO. According to the noisy-operator theory, increasing the heterogeneity of difference (external noise) by intermixing similar and dissimilar *different* pairs ought to produce faster but less accurate responses on *different* trials. As predicted, the tendency to make more false-*different* responses (i.e., errors on *same* pairs) decreased when the similar and dissimilar *different* pairs were intermixed rather than presented in separate blocks. The fast-*same* effect did not change, however, seemingly due to criterion misadjustment. Proctor and Rao apparently found no effect of heterogeneity of difference on RT and errors because they used a less sensitive procedure (between-subjects design; different set of letters for more and less heterogeneous conditions). Consistent with the internal-noise principle, but not with the response-competition model of Eriksen, O'Hara, and Eriksen, the enhanced fast-*same* effect on blocks containing only similar (vs. dissimilar) *different* pairs was accompanied by an increased preponderance of false-*different* errors.

When people judge whether two letters are identical or not, *same* judgments typically are faster than *different* judgments. According to the noisy-operator theory (Krueger, 1978), internal noise more often changes physical matches into spurious perceived mismatches than vice versa. As a result, *different* judgments are slower, owing to more rechecking of perceived mismatches, and subjects typically make more false-*different* responses (i.e., errors on *same* trials) than false-*same* ones.

External noise also must be considered, however. Variability in the perceived difference count is the joint effect of variability within the subject (internal noise) and variability dependent on the investigator (external noise), who controls the number of differing features present (Krueger, 1978, 1979). While internal noise ought to produce faster but less accurate responses on *same* trials, external noise ought to produce faster but less accurate responses on *different* trials. When the *different* pairs vary in the degree of their featural overlap with the *same* pairs, then the similar *different* pairs would tend to be confused with *same* pairs and produce false-*same* errors, and the rechecking needed to eliminate such errors would slow down the *same* judgments. In effect, the similar *different* pairs would undermine the *same* distribution on the perceived difference count.

Typically, responses are faster but less accurate on *same* pairs in letter matching, which indicates that internal noise predominates. Krueger and Shapiro (1981) concluded that "external noise is largely absent in single-letter match-

ing. . . . English letters apparently have evolved so as to be nearly equally discriminable from each other, especially uppercase letters, which are the mainstay of letter-matching studies. Krueger (1978) fitted the noisy-operator theory satisfactorily to various data using the assumption of uniform discriminability of English letters" (p. 575). However, Proctor and Rao (1983b) disputed Krueger's assumption "that external noise is not a significant factor" (p. 27) in letter matching. They found considerable variability in letter differences in Krueger's (1978) letter sets, and concluded that "because the internal noise principle relies on the assumption of homogeneity of difference to predict the *same-different* disparity and this assumption is not even approximately correct, internal noise is most likely not the basis for the *same-different* disparity" (p. 29).

However, Proctor and Rao presented no quantitative analyses to show that sufficient external noise was present to neutralize the effect of internal noise, and their concern that the presence of external noise "seems to be fatal to the internal noise principle" (p. 23) would seem to have been laid to rest when they themselves (Proctor & Rao, 1983a, Experiment 3) subsequently tested the external-noise principle. Using various confusion matrices and distinctive feature systems, they devised two letter sets which differed in the heterogeneity of difference within the set. In their own data, they confirmed that *different* RTs on pairs from the set A, E, N, T (homogeneous set) varied less than those on pairs from the set E, P, R, W (heterogeneous set). Letter set was a between-subjects variable; 12 subjects received *same* and *different* pairs constructed from the homogeneous set, and another 12 received pairs constructed from the heterogeneous set. Proctor and Rao found slight and insignificant

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effects in the predicted direction: subjects receiving the heterogeneous set were 8 msec lower on the fast-*same* effect and 0.1% lower on the preponderance of false-*different* errors. Their null finding is consistent with the view that letters, for all their differences, are remarkably similar or alike in many or most respects (Eriksen, O'Hara, & Eriksen, 1982). Quite likely, they would have found a definite effect had they used materials permitting greater heterogeneity of difference. Krueger and Shapiro (1985) tested pairs of lines, whose difference ratio on length varied fourfold (i.e., from 1:2 to 1:8), and they found an effect in the predicted direction on both errors and RT, although only the error effect was significant. When the difference ratio was varied rather than kept constant for the subject, the error disparity shifted toward false-*same* responses by 2%, whereas the fast-*same* effect decreased by 7 msec.

One ought not to be too hasty, however, in dismissing completely the external-noise factor in letter matching. Even if external noise is not all-powerful and rarely overwhelms the internal noise present, it ought nonetheless to have at least some effect. Proctor and Rao may have erred in both directions, first in overstating the role of external noise in letter matching, and then in understating it. The true assessment may lie somewhere in between. The present study was undertaken to test whether certain factors in Proctor and Rao's (1983a) experimental design prevented them from obtaining a positive effect.

Both of the previous tests of the external-noise principle (Krueger & Shapiro, 1985; Proctor & Rao, 1983a) used between-subjects experimental designs. If more sensitive, within-subjects designs had been used instead, as will be done here, more reliable effects on both RT and errors might have been found. In addition, the use of different letters in Proctor and Rao's two letter sets may have introduced extraneous, confounding factors. Responses tended to be slower, but more accurate, with their heterogeneous letter set, so it is not clear which letter set was more difficult to process. An increased level of internal noise on the heterogeneous set, if present, would have tended to counteract the RT and error effects of its increased level of external noise or heterogeneity of difference, and this might explain their null effect. Furthermore, in the heterogeneous set, only one of the six *different* pairs (i.e., PR) differed considerably in RT from the other pairs, whose variability on RT was about the same as that of the homogeneous set.

In the present test, a within-subjects design was used, and the same letter pairs were used in the low- and high-external-noise conditions, which not only removed possible confounding factors, but also ensured that half of the *different* pairs differed considerably in RT from the other half. The same six letters (D, H, M, O, V, Y) that Chignell and Krueger (1984) used in their Experiment 2 were used here. Chignell and Krueger had found that the dissimilar *different* pairs they used (HV, OM, DY) were responded to about 50 msec faster and 2% more accurately than were the similar pairs (HM, OD, VY). They

intermixed the similar and dissimilar *different* pairs, but never tested them in separate blocks, which was done here, using all six dissimilar and six similar pairs, that is, both orders of each pair. If letters differ sufficiently in their discriminability from each other, and if the external-noise principle is correct, then, it was felt, the present test ought to be sensitive enough to detect the predicted effect of increased external noise, that is, faster but less accurate responses on *different* trials.

Response-Competition Principle

Chignell and Krueger found that, with simultaneous presentation, *same* and dissimilar *different* pairs were responded to equally fast, whereas false-*same* errors as well as RT were much higher on similar than on dissimilar *different* pairs. These results support the Eriksen et al. (1982) response-competition model, which attributes slower *different* judgments to matching features on similar *different* pairs. Chignell and Krueger said that the response-competition model must be supplemented by the internal-noise principle, however, because false-*different* errors on *same* pairs consistently exceeded even false-*same* errors on similar *different* pairs.

A second objective of the present study was to determine whether the same evidence supporting the response-competition model would be found when similar and dissimilar *different* pairs were presented in separate blocks of trials. By intermixing the two types of *different* pairs, Chignell and Krueger forced their subjects to use a common decision criterion (Krueger, 1985), irrespective of *different* type. The evidence supporting the response-competition model (equally fast RT on *same* and dissimilar *different* pairs; smaller preponderance of false-*different* errors with similar than with dissimilar *different* pairs) may have resulted because the criterion for responding versus rechecking was set too low on the perceived difference count relative to the dissimilar *different* pairs and too high relative to the similar *different* pairs. According to the internal-noise principle, the fast-*same* effect ought to be smaller, but still be present, on pure blocks with dissimilar (vs. similar) *different* pairs, and the preponderance of false-*different* errors ought to be larger, not smaller, on pure blocks with similar (vs. dissimilar) *different* pairs. In previous studies, errors increased more on *same* trials under difficult conditions (e.g., Krueger & Gott, 1985; Krueger & Shapiro, 1985), and increased similarity on *different* trials may simply be one more way in which task difficulty may be increased.

EXPERIMENTS 1 AND 2

The present two experiments were identical, except that, to remove all external noise from the pure block, each subblock of a pure block in Experiment 2 was restricted to pairs formed from just two of the six letters. Experiment 1 found the predicted effect of external noise on errors, but not RT, and it seemed likely that the residual external noise present on the pure block, owing to varia-

tion in difficulty among similar or dissimilar *different* pairs, had attenuated the effect of pure versus intermixed blocks. In Experiment 1, mean RTs on the six *different* pairs used ranged from 584 to 616 msec in the pure similar blocks and from 506 to 542 msec in the pure dissimilar blocks. However, the results of Experiment 2 were nearly identical to those of Experiment 1, indicating that within-set heterogeneity had relatively little effect, and therefore the results from the two experiments will be considered together.

Method

Subjects. Twenty Ohio State University undergraduates participated in Experiment 1 and 20 participated in Experiment 2 in order to receive credit in an introductory psychology course. Data from 6 additional subjects were discarded, 3 because of equipment failure and 3 for exceeding an 8% error criterion. All subjects had at least 20/30 vision (corrected), as tested with a Snellen chart.

Apparatus. Uppercase letters were presented at a 60-Hz refresh rate and 32-cd/m² intensity on a greenish-tint, fast-decay P31 phosphor (decay to 1% intensity at .25 msec after display offset) by an Imlac PDS-4 graphics computer, which also measured RT to an accuracy of 1 msec. The letters, presented as thin, illuminated lines on a dark screen, were software generated, using short line vectors, so as to resemble normal English uppercase letters. Each subject sat alone in a dark room, with the head held fast in a chinrest located 70 cm from the display screen.

Stimulus materials. Each letter was .29 cm wide and .43 cm high, and .19 cm separated the two letters. The pair thus was 0.77 cm (0.63°) wide, and it was centered 0.3 mm above a small (1.6×1.6 mm) plus sign, which was the fixation mark at the center of the screen.

Six letters (D, H, M, O, V, Y) were used to form 6 *same* pairs, and 12 *different* pairs, 6 of which were similar (DO, OD, HM, MH, VY, YV) and 6 of which were dissimilar (DY, YD, HV, VH, MO, OM). Each block of 144 regular trials contained 72 *same* pairs (12 of each of the 6 *same* pairs) and 72 *different* pairs (12 each of the 6 similar or 6 dissimilar *different* pairs on pure blocks; 6 each of the full set of 12 *different* pairs on mixed blocks). There were four blocks: one pure similar, one pure dissimilar, and two mixed, which were presented contiguously, either before or after (half of the subjects each) the two pure blocks. Half of the subjects received the pure similar block before the pure dissimilar block, and the other half had the reverse order. Four different randomized sequences of letter pairs and trials were used in each experiment.

Each block consisted of four subblocks of 36 trials each in Experiment 1, and three subblocks of 48 trials each in Experiment 2. In Experiment 2, after the 144 trials in a pure block were randomly assigned to the three subblocks, the six letters were reduced or collapsed to a different pair of two letters in each subblock. For half of the subjects, the order of the pairs used in the three subblocks was HM, DO, VY for the pure similar block, and DY, HV, MO for the pure dissimilar block. The other half of the subjects had the reverse order (i.e., VY, DO, HM; MO, HV, DY). Thus, each subblock in a pure block in Experiment 2 contained four particular letter pairs (e.g., HH, MM, HM, MH for the pair HM), which appeared approximately 12 times each; equal weight was given to each of the four particular letter pairs in computing cell means.

Each subblock was preceded by 4 practice trials, and a practice subblock containing the same letter pairs as the first regular subblock preceded the pure similar block, the pure dissimilar block, and the first of the two contiguous mixed blocks. Thus, there were 19 subblocks, or 760 trials (576 regular, 184 practice) in Experiment 1 and 15 subblocks, or 780 trials (576 regular, 204 practice) in Experiment 2.

Procedure. In each trial, the fixation mark appeared alone for .6 sec, then the letter pair appeared as well until the subject

responded. No feedback was given on the accuracy of the response during the .5-sec interval between trials. There was a 15- to 20-sec interval between subblocks, which allowed the next set of trials to be read in from the host computer.

The subjects were instructed to keep their eyes focused at all times just above the fixation mark, between where the two letters would appear, and to respond as rapidly as possible, but not at the expense of accuracy. For half of the subjects, the "same" response was assigned to the right-hand button, and the "different" response to the left-hand button; the other half had the reverse hand assignment. Trials with an RT greater than 3 sec or less than 200 msec were discarded prior to data analysis. Mean RT was computed for correct trials only.

Results and Discussion

Mean RT and error data are shown in Figure 1 for Experiment 1 and in Figure 2 for Experiment 2. Table 1 presents the *F* ratios for the two experiments, considered both separately and combined. For the two experiments combined, RT was lower on *same* pairs ($p < .001$) but errors were higher ($p < .001$), which is consistent with the internal-noise principle. Pure blocks had lower errors than mixed blocks ($p < .01$). Mean RT was lower ($p < .001$), as were errors also ($p < .001$), when the *different* type was dissimilar rather than similar, especially in Experiment 1 (vs. Experiment 2) on errors [$F(1,38) = 4.50, p < .05$]. *Different* type interacted significantly with the *same-different* and pure-mixed variables, both singly and combined (see Table 1), but these interactions are spurious, because the *same* RT and errors necessarily were held constant for the similar and dissimilar *different* conditions on mixed blocks. A truer view of the interaction of *different* type with *same-different* will be obtained when pure blocks are examined separately below.

The fast-*same* effect was virtually identical on pure and mixed blocks, both in Experiment 1 (26 vs. 28 msec,

Figure 1. Experiment 1: Mean response time (in milliseconds) and percentage of error rate by trial type (*same*, *similar different*, *dissimilar different*) and pure versus mixed blocks.

Figure 2. Experiment 2: Mean response time (in milliseconds) and percentage of error rate by trial type (*same*, *similar different*, *dissimilar different*) and pure versus mixed blocks.

$F < 1$) and in Experiment 2 (38 vs. 38 msec, $F < 1$). By contrast, the preponderance of false-*different* (vs. false-*same*) errors was much larger on pure than on mixed blocks, both in Experiment 1 (1.57% vs. 0.13%, $p < .05$) and in Experiment 2, (2.91% vs. 0.56%, $p < .01$) (see Figures 1 and 2). Thus, the predicted effect of external noise was found on errors, but not on RT. The constancy of the fast-*same* effect indicates, however, that the error shift was not due simply to an increased motor bias toward the "same" button on mixed blocks.

Letters thus differ sufficiently in their discriminability from one another so that a more sensitive test (i.e., within-subjects design; same letter set for pure and mixed blocks) can detect an effect of external noise. The effect of external noise was not sufficient, however, to reverse the preponderance of false-*different* errors, and it did not affect the fast-*same* effect at all, so its more modest presence in randomly selected letter pairs need not be as "fatal" to the internal-noise principle as Proctor and Rao (1983b) claimed.

It is not clear why external noise affected only errors. In a line-matching task, Krueger and Shapiro (1985) likewise found a significant effect of external noise on the *same-different* disparity for errors but not for RT. Perhaps criterion inertia (Krueger, 1985) prevented subjects from properly adjusting both RT and errors to the changed conditions on mixed blocks. The error data suggest that subjects used the same criterion on mixed blocks as on pure dissimilar blocks.

Pure blocks. On pure blocks analyzed separately, the fast-*same* effect was significant [$F(1,38) = 50.75$, $p < .001$], as was also the preponderance of false-*different* errors [$F(1,38) = 40.97$, $p < .001$]. Consistent with the internal-noise principle, the latter effects were

larger on pure similar (vs. dissimilar) blocks, both on RT [$F(1,38) = 14.40$, $p < .001$] and errors [$F(1,38) = 4.53$, $p < .05$]. Judgments on pure similar (vs. dissimilar) blocks were generally slower [$F(1,38) = 104.25$, $p < .001$] and more errorful [$F(1,38) = 28.17$, $p < .001$], indicating that increased similarity did indeed increase task difficulty.

The *same-different* disparity was significant on both RT and errors for pure dissimilar blocks analyzed separately as well as for pure similar blocks ($p < .001$ in all cases). In the mixed condition, by contrast, dissimilar *different* pairs were as fast as *same* pairs, which Chignell and Krueger (1984) also found with mixed, simultaneous presentation, presumably due to the presence of similar *different* pairs.

The larger fast-*same* effect on pure similar (vs. dissimilar) blocks is consistent with Eriksen et al.'s (1982) response-competition model. They attributed the slow "different" response to competing matching features, which are largely absent on dissimilar *different* pairs. However, contrary to their model, a fast-*same* effect nevertheless was found on pure dissimilar blocks, and also the preponderance of false-*different* errors increased rather than decreased on pure similar (vs. dissimilar) blocks. The present results did not rule out response competition as a factor, but indicate that whatever effect it had was overridden by that of internal noise, which predominated in the present situation.

Table 1
Analysis of Variance of Mean Response Time (RT) and Percentage of Error Rate (PE) for Experiments 1, 2, and 1 and 2 Combined

Source	df	F Ratio	
		RT	PE
Experiment 1			
Same-different (SD)	1,19	19.27‡	3.04
Different type (DT)	1,19	108.83‡	44.29‡
Pure-mixed (PM)	1,19	1.48	0.20
SD × DT	1,19	39.95‡	19.27‡
SD × PM	1,19	0.06	5.05*
DT × PM	1,19	9.52†	0.00
SD × DT × PM	1,19	9.64†	10.15†
Experiment 2			
Same-different (SD)	1,19	28.48‡	28.77‡
Different type (DT)	1,19	92.56‡	13.72†
Pure-mixed (PM)	1,19	6.70*	2.36
SD × DT	1,19	41.45‡	0.24
SD × PM	1,19	0.00	9.07†
DT × PM	1,19	16.75‡	0.50
SD × DT × PM	1,19	23.63‡	12.43†
Experiments 1 and 2			
Same-different (SD)	1,38	47.73‡	19.49‡
Different type (DT)	1,38	201.25‡	53.79‡
Pure-mixed (PM)	1,38	7.04*	0.16
SD × DT	1,38	77.84‡	6.13*
SD × PM	1,38	0.04	14.09‡
DT × PM	1,38	24.23‡	0.29
SD × DT × PM	1,38	31.81‡	22.33‡

* $p < .05$. † $p < .01$. ‡ $p < .001$.

Mixed blocks. On mixed blocks analyzed separately, the fast-*same* effect was significant [$F(1,38) = 36.29$, $p < .001$] but the preponderance of false-*different* errors was not ($F < 1$). The increased external noise on mixed blocks thus largely neutralized the typical *same-different* error disparity, but not the fast-*same* effect, owing perhaps to a criterion misadjustment or decision bias toward "same" on mixed (vs. pure) blocks. Criterion misadjustment could have been produced by the immediately preceding trials as well as the block as a whole. Krueger (1985) found a significant shift in the *same-different* disparity on errors, but not on RT, depending on whether the preceding judgment was easy (foveal presentation) or difficult (parafoveal presentation).

In a second analysis, each trial in the two mixed blocks was categorized as to its current (Trial N) and preceding (Trial $N-1$) type (*same*, similar *different*, dissimilar *different*). Preceding trial type had a significant effect on RT [$F(2,76) = 4.10$, $p < .025$] but not on errors ($F < 1$), and current and preceding trial type interacted significantly on RT [$F(4,152) = 3.61$, $p < .01$] and on errors [$F(4,152) = 4.28$, $p < .01$]. As Table 2 shows, RT was lower, but only on *same* trials, following a *same* trial, and there was a preponderance of false-*same* errors if Trial $N-1$ was dissimilar *different*. A further analysis involved similar versus dissimilar *different* on Trial $N-1$ and *same* versus *different* on Trial N . Following a dissimilar (vs. similar) *different* trial, the fast-*same* effect increased (24 vs. 15 msec), but not significantly so [$F(1,38) = 1.27$], whereas the preponderance of false-*different* errors decreased [-1.52% vs. 1.18% ; $F(1,38) = 6.57$, $p < .025$]. Subjects apparently expected an equally substantial difference on subsequent *different* trials, and adjusted the criterion upward accordingly on the perceived difference count. Following a similar *different* trial, the reverse would have occurred, although the net bias toward "same" evident in the mixed blocks suggests that a preceding dissimilar *different* pair had much more impact than a preceding similar *different* pair.

CONCLUSIONS

The present results support the external-noise principle of the noisy-operator theory. Using a more sensitive

experimental procedure (within-subjects design; same set of letters in more and less heterogeneous conditions) than Proctor and Rao's (1983a), the preponderance of false-*different* errors was eliminated when similar and dissimilar *different* trials were intermixed, thus increasing the level of external noise or heterogeneity of difference. No RT shift was found, however. The criterion for rechecking is not always properly adjusted when the internal noise level changes (Krueger, 1985) or, apparently, when the external noise level changes, as the present data indicate, so a given effect might be expressed solely on RT in some cases and solely on errors in other cases. As shown on the right sides of Panels c and d in Figures 1 and 2, errors on the dissimilar portion of the mixed blocks closely matched those on the pure dissimilar block. Therefore, on mixed blocks, the criterion was set too high on the perceived difference count, thus stifling the shift toward faster *different* judgments, but enhancing the shift toward more false-*same* errors. If the criterion had been set too low, owing to relatively greater attention or weight having been accorded to the similar *different* pairs, then the shift on mixed blocks would have been mainly on RT rather than on errors, with a large decrease or even reversal occurring on the fast-*same* effect. Perhaps the similar *different* pairs had less influence on mixed blocks because they occurred only half as frequently as the *same* pairs, which shared with them the lower region of the perceived difference count.

External noise had a discernible effect on letter matching, but it was not robust enough to neutralize the effect of internal noise, and thus is not as "fatal" to the internal-noise principle as Proctor and Rao (1983b) claimed. The fast-*same* effect persisted on mixed blocks, along with a small, nonsignificant preponderance of false-*different* errors. Thus, to a first approximation, letters do seem to be nearly uniformly discriminable (Krueger, 1978; Krueger & Shapiro, 1981). External noise was intentionally maximized in the present study, but most other studies have avoided introducing additional external noise, so it normally should have even less effect. In my own studies, I have typically used the letters F, G, J, K, and L, which are all highly and about equally discriminable from each other.

External noise can produce huge RT effects, on the order of 300 msec, in unidimensional tone comparisons (Krueger, 1979). With tones, the second stimulus may be higher or lower in frequency than the first stimulus, and thus the *same* distribution may be undermined from both directions by the *different* distribution (i.e., from negative and positive perceived difference counts). With letters, both portions of the *different* distribution (similar, dissimilar *different* pairs) lie on the same (i.e., upper) side of the *same* distribution and may be quite close together, thus introducing relatively little external noise on mixed blocks, as the present results indicate.

Using mixed blocks and the same letter set as that used here, Chignell and Krueger (1984) found not only a significant fast-*same* effect, but also a significant prepon-

Table 2
Experiments 1 and 2, Mixed Blocks: Mean Response Time (RT; in Milliseconds) and Percentage of Error (PE)
Rate $\times$ Trial $N-1$ Type and Trial N Type

Trial $N-1$ Type	Trial N Type					
	<i>Same</i>		Similar <i>Different</i>		Dissimilar <i>Different</i>	
	RT	PE	RT	PE	RT	PE
<i>Same</i>	528	3.75	602	4.81	544	0.97
Similar <i>Different</i>	559	3.82	600	2.88	547	2.39
Dissimilar <i>Different</i>	552	2.53	604	5.92	546	2.17

derance of false-*different* errors, contrary to the present results. Their subjects dealt with a variety of horizontal letter separations, letter sizes, and pair durations, however, which presumably made processing more difficult and thus increased the effect of internal noise.

A second objective of the present study was to determine whether the same evidence in favor of Eriksen et al.'s response-competition model would be found here, using pure blocks, as Chignell and Krueger (1984) found, using mixed blocks. The present results with pure blocks proved to be consistent with the internal-noise principle, but not with the response-competition model. First, there was a significant fast-*same* effect even on pure dissimilar blocks, whose *different* pairs contained few matching features that could produce response competition. Second, the larger fast-*same* effect on pure similar (vs. dissimilar) blocks was accompanied by an increased, not decreased, preponderance of false-*different* errors. Thus, there was no discernible effect of response competition, and increased similarity seems mainly to be one more way to increase task difficulty, which, as previous studies showed, results in a greater increase in errors on *same* than on *different* trials (e.g., Krueger & Gott, 1985; Krueger & Shapiro, 1985). It should be noted, though, that the latter results on task difficulty, like the present ones, pertain only to late processing. In early processing, letters apparently tend to look very much alike, since, "on the average, the percept will need to develop rather fully before a difference is detected" (Eriksen et al., p. 263). Under high speed stress, the missing-feature principle, not the internal-noise principle, predominates (Krueger & Chignell, 1985), and the pure blocks containing simi-

lar *different* pairs would have produced a greater number of false-*same*, not false-*different*, errors.

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