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Negative priming without probe selection

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Responses to an object may be slower or less accurate if that object shares attributes with a recently ignored object (*negative priming*). Some studies have found negative priming only if the probe trial required selection against a distractor stimulus. In the present experiment, subjects responded to the location of a target (O), ignoring a distractor (X) if it appeared in another location. Reaction time was slower to probe targets that appeared in the same location as the prime distractor, regardless of whether or not the probe target was accompanied by a distractor.

Responses to an object may be slower or less accurate if that object shares attributes with a recently ignored object. For example, in the Stroop (1935) color-word task, color naming is slower if the color corresponds to the immediately preceding distractor word (Dalrymple-Alford & Budayr, 1966; Lowe, 1979; Neill, 1977). Similar results have since been demonstrated in a wide variety of selective attention tasks (see Neill, Valdes & Terry, in press, for a comprehensive review). Tipper (1985) proposed the term *negative priming* to describe the inhibitory effects of ignored objects.

Negative priming is often taken as evidence that the processing of an ignored object has been inhibited, and the persistence of this inhibition hampers the processing of related objects. From this perspective, it should not matter whether the related object is accompanied by other distracting information. For example, if the word BLUE has just been ignored in the Stroop task, then the response "blue" should be slower to oooooo in blue ink, as well as slower to YELLOW in blue ink. Neill (1982; Neill & Westberry, 1987) in fact found equivalent negative priming for nonconflict and conflict probes.

Other studies, however, have found contradictory results. In Lowe (1979), Stroop distractor words produced facilitation (positive priming) for probes consisting of colored dots. Furthermore, Lowe found negative priming for nonword probes (e.g., IHXT) when other probes were color words, but found positive priming for nonword probes when the other probes were color patches.

Tipper and Cranston (1985) required subjects to attend to a target letter that was distinguished by color from a distractor letter. Probe targets were named more slowly when they matched the distractor (i.e., negative priming occurred), but only if the probe target was accompanied by another distractor letter. As in Lowe (1979), the ignored distractor produced positive priming when the probe target letter appeared alone.

The theoretical importance of probe selection for negative priming is made explicit in a neural network (connectionist) model described by Houghton and Tipper (in press). Their computer simulations yielded negative priming for probes with distractors, but not for probes without distractors. Houghton and Tipper concluded that negative priming occurs specifically because the probe target is rendered more vulnerable to interference from a simultaneously present distractor.

Tipper, Brehaut, and Driver (1990) found slower localization responses when the target appeared in either the same location (for static objects) or the expected location (for moving objects) as a recently ignored distractor. Thus, negative priming occurs for the location of an ignored object, as well as for its identity. But, Tipper et al. (1990, Experiment 5) again failed to find negative priming if probe trials did not include a distractor.

Tipper et al. (1990, Experiment 5) did not directly compare negative priming effects for probes with and without distractors. Rather, they reported a null result for an experiment that did not include distractors on probe trials and inferred, by comparison to other experiments, that probe distractors are critical. However, factors specific to that experiment might have jeopardized its power to detect negative priming. The present experiment directly compares negative priming effects in the localization task, with or without a distractor present on the probe trial.

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METHOD

Subjects

The subjects were 19 Adelphi University undergraduates recruited from introductory psychology courses. Each subject participated in an individual session of approximately 30 min to satisfy experiment participation requirements.

Stimuli and Apparatus

Stimuli were presented on an AMDEK Color-I Plus video monitor controlled by an Apple IIe microcomputer. Four equal signs (=) appeared as location markers on the 11th print line of the monitor screen, centered, and separated by three print spaces. A plus sign (+) served as a fixation point and warning signal, presented at the center of the

10th print line. Target and distractor letters (O and X, respectively) were presented on the 10th print line immediately above the location markers.

The subjects responded by pressing the S, C, M, and L keys of the computer keyboard. Response latencies were measured with a Mountain Hardware Apple Clock.

Procedure

The subjects were instructed to use the middle and index fingers of each hand to press the key corresponding, left to right, to the location of a target O on each trial. Instructions emphasized that responses should be fast, but that errors should be avoided. Error feedback was provided by a computer-generated tone, with the word ERROR displayed for approximately .5 sec.

A prime trial began with the onset of the fixation cross. Approximately .5 sec later, a target O and a distractor X appeared over two randomly selected location markers and remained in view until the subject responded. Probe stimuli appeared approximately .5 sec after a correct prime trial response. The probe target O randomly appeared in the prime target location (25% *repeated*), in the prime distractor location (25% *ignored*), or in one of the two remaining locations (50% *neutral*). On half of the probe trials, selected randomly, a distractor X also appeared in one of the neutral locations.

The fixation cross remained continuously in view during the prime and probe trials. After a probe trial response, the probe stimuli and fixation cross were removed, leaving only the location markers in view. Approximately 3.5 sec elapsed before the next prime trial. The subjects received 12 blocks of trials, each consisting of 25 prime-probe trial pairs.

RESULTS

Geometric mean latencies for correct responses on probe trials were computed in each condition for each subject. These were entered into a 3 × 2 analysis of variance (ANOVA), with within-subject variables of location (repeated, ignored, or neutral) and distractor (present or absent). The overall condition means are displayed in Table 1.

Responses were slower with distractor present (M = 492 msec) than with distractor absent [469 msec; $F(1,18) = 35.95$, $MS_e = 453.3$, $p < .0001$]. Responses to a repeated location (432 msec) were faster than responses to a neutral location (494 msec), which were in turn faster than responses to an ignored location [516 msec; $F(2,36) = 65.55$, $MS_e = 1092.0$, $p < .0001$]. The interaction approached significance [$F(2,36) = 2.78$, $MS_e = 303.4$, $p < .10$], reflecting a numerically *larger* negative priming effect without a probe distractor (29 msec) than with a probe distractor (16 msec). Planned comparisons indicated that both negative priming effects were significant [$F(1,18) = 26.24$, $MS_e = 303.4$, $p < .0001$, and $F(1,18) = 7.96$, $MS_e = 303.4$, $p < .02$, respectively].

More errors occurred for the ignored location (2.6%) than for the neutral location (1.0%) or the repeated location [0.5%; $F(2,38) = 9.16$, $MS_e = 5.02$, $p < .001$]. No other effect was significant in the overall ANOVA. Planned comparisons indicated that the 2.5% negative priming effect without a distractor was significant [$F(1,18) = 17.06$, $MS_e = 3.41$, $p < .0001$], but the 0.7% effect with a distractor was not [$F(1,18) = 3.14$, $p > .20$].

DISCUSSION

The results clearly indicate that negative priming of location occurs even when the probe target is not accompanied by a distractor. In reaction time, negative priming without a distractor was nearly twice that with a distractor. Furthermore, the effect in errors was significant only without a distractor. As such, the results are clearly inconsistent with the hypothesis that negative priming is due to increased vulnerability of the probe to interference (Houghton & Tipper, in press).

Tipper and Cranston (1985) suggested that negative priming depends on a "selection state" during the probe trial. If subjects anticipate interference, they may continue to inhibit the processing of distractor-related information. However, if interference is not anticipated, or a nonconflict probe is easily distinguished from a conflict probe, then the selection state may be abandoned. The relaxation of inhibition may even allow positive priming effects to emerge, reflecting the distractor activation at earlier levels of representation.

A selection state might explain the discrepant results in the Stroop color-naming task (Lowe, 1979; Neill, 1982; Neill & Westberry, 1987): Lowe's colored dots were probably easy to distinguish from conflict words; subjects could therefore relinquish the selection state despite the presence of conflict words on other probe trials. Neill's zeroes may have been less discriminable from conflict words: they were from the same letter set as the conflict words and also varied in string length (ooo, oooo, ooooo, oooooo). As in Lowe's random-letter nonword condition, subjects would have to maintain the selection state if they knew that conflict words might appear on probe trials.

A selection state does not, however, account for other discrepant results. For example, Yee (1991) required subjects to respond to a geometric figure flanked by one or two irrelevant words. Subjects then made a word/nonword judgment on a string of letters. Negative priming was manifested by slower reaction time to a word related to one of the ignored words. Here, the probe target was never accompanied by a distractor, and subjects had no reason to maintain a selection state.

The present results are also not easily explained by a selection state. The explanation of Lowe's results for color patches assumes that easy discrimination allows the subject to immediately abandon the selection

Table 1
Mean Probe Reaction Time (in Milliseconds) and Error Percentages as a Function of Probe Target Location and Distractor Presence/Absence

Condition	Examples	Probe Target Location: Repeated	Ignored	Neutral
	Prime	O _ X _	O _ X _	O _ X _
	Probe	O _ _ (X)	_ _ O (X)	_ O _ (X)
Distractor Present		448	523	507
		0.7%	2.1%	1.3%
Distractor Absent		416	509	480
		0.3%	3.2%	0.7%

state for nonconflict stimuli. Tipper and Cranston (1985) imply that detection of one item, rather than two, is a sufficient cue for subjects to abandon the selection state. If so, then negative priming should not have been obtained for nonconflict probes in the present experiment.

Neill, Valdes, and Terry (1992) reported four additional localization experiments in which negative priming was obtained for probe targets without distractors. Clearly, probe selection is not a necessary condition for negative priming to occur. As such, these results are consistent with the view that inhibition of ignored objects persists over time, slowing the processing of subsequent related objects.

However, it is equally clear from other studies that negative priming is sometimes affected by presence or absence of a probe distractor. We have recently proposed an episodic retrieval theory of negative priming that might better account for the conflicting results (Neill & Valdes, 1992; Neill, Valdes, Terry, & Gorfein, 1992). According to this theory, the probe stimulus cues the retrieval of past processing episodes involving related stimuli (cf. Logan, 1988). Negative priming occurs if a retrieved episode contains information that is incompatible with the correct response (see also Treisman, 1992).

The presence or absence of a distractor may affect the contextual similarity of a probe trial to the preceding prime trial. A nonconflict probe might therefore provide a less effective cue for retrieving a related prime trial. In such cases, negative priming would be diminished. In the present experiment, however, target location may have provided a sufficiently potent retrieval cue, such that retrieval was unaffected by presence or absence of a distractor.

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