

Negative priming between response modalities: Evidence for the central locus of inhibition in selective attention

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Considerable research has demonstrated that distractor stimuli impair response to targets. Such observations suggest that distractor stimuli are analyzed at least to the level of incipient response (Eriksen, Eriksen, & Hoffman, 1986). There is also debate about the mechanisms that enable the subject to make the correct response to the target rather than the incorrect response to the distractor. One model proposes that the internal representations of distractor stimuli are inhibited during selection and execution of the response to the target (Neill, 1977; Tipper, 1985). This inhibition occurs at, or beyond, the level of abstract categorical representation, rather than at the earlier level of representations of physical properties of the distractor stimulus (Tipper & Driver, in press). An experiment is reported in which we further investigated the locus of inhibition by looking at whether or not inhibition is isolated in output modalities (for example, verbal naming or manual keypress). The evidence suggests that inhibition is isolated *not* in response systems, but rather at some central locus common to a variety of separate perceptual inputs and response outputs.

Most visual environments are complex; they contain many objects upon which an organism may act. It is very important, therefore, to understand how action is directed to one object in preference to another. This understanding is achieved by the analysis of visual selective attention.

A number of models of selective attention have been proposed. One such model proposes that objects are selected to be acted upon only when they achieve a particular level of perceptual analysis. For example, stimuli can be selected for further processing via physical cues such as color (filtering). Only the object selected receives further analysis that results in the internal representation of semantic information and of the possible actions toward the object. Those objects that are not selected are analyzed only in terms of their physical properties. Hence, selection is by default; only one stimulus evokes action (see D. E. Broadbent, 1958, 1971).

Substantial research, however, has demonstrated that in many situations there is analysis of the meaning of objects that are irrelevant to the current behavior of the organism. Furthermore, these studies show that the presence of irrelevant distractors can interfere with responses to the relevant selected object. One of the best examples of such interference is the Stroop effect (Stroop, 1935), whereby response time to name the ink of a color word is impaired by the meaning of the irrelevant word.

Interference effects have been found to occur in a wide variety of tasks (Lewis, 1970; Shaffer & LaBerge, 1979; Underwood, 1976, 1977). In the present study we examined the selection mechanisms in the paradigm developed by C. W. Eriksen (B. A. Eriksen & C. W. Eriksen, 1974; C. W. Eriksen & Schultz, 1979). The Eriksen paradigm permits the study of how responses to a target letter are influenced by irrelevant distractor letters. The basic finding is that distractor letters with identities different from that of the target impair the response to the target. It is hypothesized that these distractor letters instigate competing responses. In fact, competing responses produced by distractors have been observed at such peripheral locations as the electromyographic (EMG) responses of flexor muscles when responses were manual keypresses (Coles, Gratton, Bashore, C. W. Eriksen, & Donchin, 1985; C. W. Eriksen, Coles, Morris, & O'Hara, 1985). In sum,

The evidence has become quite clear that the human subject cannot selectively process only a single designated form if other forms are present in the effective visual field. These irrelevant forms are processed to the point of recognition and semantic analysis . . . , and if overt signifying or identifying responses are appropriate in the situation, they receive a preparatory priming. (B. A. Eriksen, C. W. Eriksen, & Hoffman, 1986, p. 483)

Although it is well established that distractors produce competing responses, little research has attempted to reveal the actual mechanisms of selection. In other words, it is not clear how the correct response to a target stimulus, rather than an incorrect response to a distractor, is produced. Most models of attention assume that visual

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attention has a single excitation mechanism: the further processing, or maintenance of the activation level, of the internal representations of the to-be-attended object (D. E. Broadbent, 1970; Van der Heijden, 1981). Other models, however, propose an inhibitory mechanism as well as the above excitatory mechanism. The latter models of selection propose that the internal representations of distractor objects are inhibited during selection and execution of the action to the target stimulus (Neill, 1977; Tipper, 1985). A similar view was proposed by C. W. Eriksen and Schultz (1979). They suggested that as perceptual representations of visual stimuli are produced, they prime their associated responses. These responses are held in check by an inhibitory mechanism until one response reaches an evocation threshold. Inhibition is then removed, and a response is released. Thus the distinguishing feature between the selected stimulus and the ignored stimulus is that the latter remains inhibited, preventing incorrect responses.

To observe whether the internal representations of irrelevant ignored stimuli are actively inhibited as a mechanism of target selection, the nature of these internal representations must be examined after successful selection and response to the target. A priming paradigm effectively addresses this issue. Thus, if the internal representations of ignored objects are actively inhibited, the subsequent processing of an object requiring the same internal representations should be impaired.

Several studies have provided support for this model of active inhibition. Dalrymple-Alford and Budayr (1966), Lowe (1979, 1985), and Neill (1977) employed the Stroop task to demonstrate that if the ink requiring naming on trial $N+1$ (the probe display) had the same identity as the color word previously ignored in trial N (the prime display), reaction times (RTs) were impaired. Tipper and his associates (Allport, Tipper & Chmiel, 1985; Tipper, 1985; Tipper & Cranston, 1985) extended this demonstration to show that if a drawing to be named in the probe display ($N+1$) possessed the same identity as the drawing ignored in the previous prime display (N), RTs were impaired—the negative priming effect.

It seems clear that in these situations at least, one of the mechanisms of selective attention is inhibition of the internal representations of ignored objects. There is probably a long sequence of processes and representations from retinal activation to response initiation. A pertinent question, therefore, is this: Where in the sequence of processing does selective inhibition take place?

A number of findings suggest that inhibition is relatively late in the sequence of processes from perception to action. Thus, it is not the case that the internal representations of the physical properties of the stimulus are inhibited. Tipper and Driver (in press) demonstrated that ignoring a picture impairs the subsequent response to a word naming the picture. In this situation there is no physical relationship between representations of the same object when they are in different symbolic domains (e.g., the picture and the word representing *dog*). Similarly,

Greenwald (1972) and J. L. Driver (personal communication, February 1987) demonstrated that ignoring a number presented auditorily impairs the naming response to the same number when it is subsequently presented visually. Again, there is no physical relationship between these two forms of perceptual input. This suggests that ignored information is achieving abstract semantic internal representations, and that inhibition must be at, or beyond, this level of analysis.

In the present study we proposed to examine whether the active inhibition of distractors observed in negative priming is isolated in response modalities. C. W. Eriksen et al. (1985) showed that response competition can actually be observed in the muscles involved in producing competing action to the irrelevant stimulus. Such muscle activity must be inhibited or decoupled from response when the correct response is output to the target. The inhibition of action may be isolated within the peripheral motor system, or, alternatively, it may be located at a more central locus controlling the release of action.

In this experiment, therefore, we considered the following situation. When a key to the target letter, A, is pressed and response to the distractor, B, is prevented, does inhibition act specifically on the muscle movements controlling the response to B? In this case, should inhibition be isolated within a particular response modality, negative priming will be observed only when the responses to both the prime and the probe display are within the same modality; that is, manual keypressing to letters in both the prime and the probe display, or verbal naming in both the prime and the probe display. Conversely, when responses to the prime and to the probe display are in different modalities, such as verbal naming of the prime letter and manual keypressing to identify the probe, negative priming should not be observed, and perhaps even a facilitatory priming effect may be obtained (Tipper & Cranston, 1985).

On the other hand, if inhibition of distractors has a more central locus common to different response modalities, then negative priming should be observed between, as well as within, response modalities. Furthermore, if inhibition is confined to a central locus, and is not present in peripheral response systems, then the negative priming effect that is obtained should be equivalent in the between- and within-modality priming situations, with no observable interaction.

METHOD

In this experiment we studied negative priming within the Eriksen paradigm. This paradigm was employed for two reasons: (1) The literature demonstrating analysis of irrelevant distractor letters and response competition by these letters is extensive, and (2) our pilot studies suggest that the Eriksen interference effects are consistently observed with both verbal and manual responses. Therefore, negative priming can be studied when these two forms of response are employed. Research with other paradigms, such as the Stroop, however, show that interference and priming effects are not necessarily of the same magnitude with these two modes of response

(Chmiel, 1984; Neill, 1977; Virzi & Egeth, 1985; but see Neill & Westberry, 1987, for further discussion concerning this issue).

In the Eriksen paradigm, subjects are presented with a prime display followed shortly thereafter by a probe display. Subjects are required to make speeded responses to target letters in each display. In the prime display, we were able to observe the typical Eriksen interference effect, to ensure that our paradigm produced response competition from irrelevant distractors. In the subsequent probe display, we were able to observe the priming effects of the ignored letter in the prime display on response to the probe.

Design

The experiment contained two components. In the first component, we studied Eriksen interference in the prime display; in the second, we studied the priming effects of ignored letters in the prime display on the response to the target in the probe display. These were within-subjects factors.

The interference effect was observed by comparing a condition in which the target (specified by a bar marker; Van der Heijden, 1981) and distractor letters had the *same* identity (e.g., -A A) with a condition in which they had *different* identities (e.g., -A C). It was predicted that the latter condition would have longer RTs due to response competition. There were 60 trials in the *same* identity condition and 120 trials in the *different* identity condition. These proportions were determined by the priming conditions discussed below.

The priming effects of the ignored stimulus in the prime display were observed in the responses to the subsequent probe stimulus. The probe stimulus always contained target and distractor letters with *different* identities. The differences between the conditions were determined by the contents of the previous prime displays. There were three priming conditions. In the first, the prime display contained the target, indicated by the bar, and the distractor with the *same* identity (-A A). The subsequent probe display contained a target and a distractor whose identities were *different* from that of the prime (e.g., -C D). This condition was necessary due to the design of the experiment, but it has no bearing on the theoretical basis of this paper and therefore will not be discussed further. In the control (C) prime condition, the target and distractor in the prime display had *different* identities (e.g., -A C), and these were different from the target and distractor in the probe display (e.g., -B D). Finally, in the ignored-repetition (IR) priming condition, the distractor in the prime display had the *same* identity as the target in the subsequent probe display (e.g., prime = -A C, probe = -C D). There were 60 trials in each of the C and IR conditions. Figure 1 illustrates these conditions.

There were four between-subjects conditions. Two were within-response-domain priming and two were between-response-domain priming. The first within-domain-priming condition was termed *voice-voice*: subjects verbally named both the prime and the probe target letter. The second within-domain condition was *key-key*: computer keys were depressed to identify both the prime and the probe target. The between-response-domain conditions were *voice-key* and *key-voice*.

Subjects

One hundred and sixty undergraduates from an introductory psychology course at Mount Allison University participated in the experiment. Twenty males and 20 females were assigned to each of the four between-subjects conditions.

Apparatus and Stimuli

The experiment was run on an Apple IIe computer with a red-green-blue (RGB) monitor. Approximate viewing distance was 47 cm. Vocal responses triggered a voice key through a small microphone clipped to the subject's shirt. Keypress responses were made on the computer keyboard. Target and distractor stimuli were regular

capital letters (A, B, C, D) in the Apple 40-column text mode, each subtending approximately .79° vertical and .55° horizontal visual angle. The letters were .73° apart in the prime display and .91° apart in the probe display. Masking stimuli were typewritten asterisks, each subtending .79° vertical and .55° horizontal visual angle. Prime displays as a whole subtended .79° vertical and 2.50° horizontal angle; probe displays subtended 3.53° vertical and 0.55° horizontal angle. Prime displays always presented the two stimuli side by side with the bar either to the left or to the right of the display (e.g., AB-). The probe displays, on the other hand, always appeared with the three components stacked one on top of another. This configuration ensured that prime and probe letters did not appear in the same spatial location, avoiding the possible confound of spatial priming. (See Figure 1 for an example of the stimulus displays.) RTs were recorded to the nearest millisecond.

Procedure

At the beginning of each session, the subject was seated in front of the computer and was informed that he/she would be dealing with four letters: A, B, C, and D. To initiate a trial, the subject pressed the space bar on the keyboard. For each trial, a pair of horizontally adjacent letters appeared briefly, followed by a mask (prime stimulus). The subjects were required to respond to the stimulus with the bar beside it as quickly as possible, either by keypress or by voice response, as determined by the between-subjects condition in which they were participating. They were told that the target stimulus would appear randomly to the left or right. A second display appeared immediately afterward; again, the subject responded to the stimulus with the bar beside it (probe stimulus). Stimuli in this second display were vertically adjacent, with the target appearing randomly above or below the distractor. After each trial, a display appeared telling the subject whether his/her responses were right or wrong; the display showed RTs for correct responses and the overall percentage of correct trials. The experimenter keyed in the subject's verbal responses to allow the computer to check for errors. Keypress responses were recorded by the computer; the keys D, C, M, and K were labeled as A, B, C, and D, respectively. The subjects used the index and middle fingers of each hand to make keypress responses. A trial was considered correct only if both prime and probe received correct responses. It was emphasized that subjects should respond as quickly as possible, while attempting to keep the percentage correct high. (See Neill & Westberry, 1987, for discussions concerning the importance of accurate performance for revealing negative priming effects.)

The sequence of events ran as follows: upon initiation of the trial, the screen was cleared for 1,800 msec. The probe stimulus appeared centrally on the screen for 150 msec, followed by presentation of the mask for 110 msec. The screen remained blank until a response was made. Then, 350 msec after the response, the probe stimuli appeared for 150 msec, again followed by a mask lasting 110 msec. After response to the probe, the RT and error feedback were displayed.

Each subject was given a practice phase of 30 trials (10 trials per condition) followed by a short rest. The test phase consisted of 60 trials per condition, randomly presented. The experiment lasted about 35 min. All subjects were tested between 1:00 and 7:00 p.m. in order to avoid the confounding time-of-day effect reported by D. Broadbent, M. H. P. Broadbent, and Jones (1984).

RESULTS

Interference Effects

Analysis of interference effects was carried out on median RTs in the prime display in a three-way ANOVA. The mean of median RTs and mean errors are shown in Table 1.

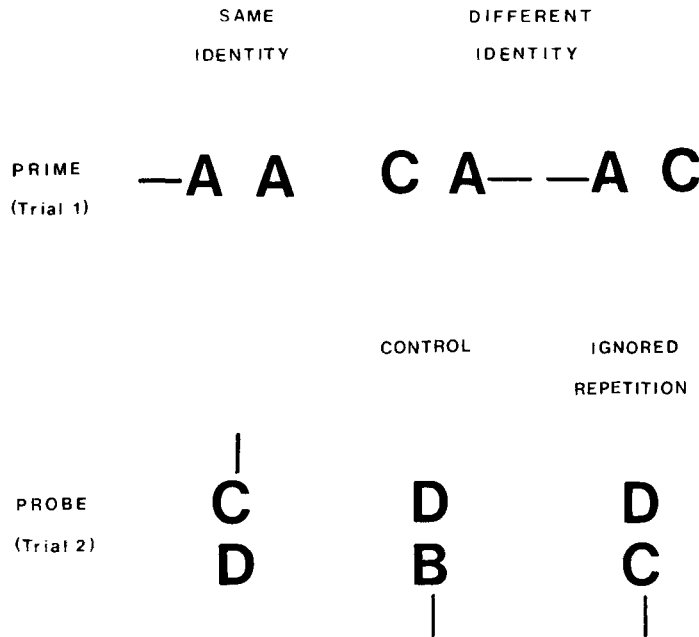


Figure 1. Examples of the stimuli and conditions employed in the experiment. The target letter was specified by the bar marker adjacent to it.

The between-subjects factor of within or between response domain was nonsignificant [$F(1,156) = 2.983$]. Thus, the time to respond on the prime display (Trial 1) was not influenced by whether the response to the probe (Trial 2) was in the same or a different response domain. The between-subjects factor of the mode of response to the prime, that is, voice or key, was significant [$F(1,156) = 136.437, p < .001$]; that is, RT to identify a letter was significantly longer for keypress than for verbal responses. The interaction between these two between-subjects factors (domain and response mode) was also significant [$F(1,156) = 8.509, p < .004$]. Basically, RT in the prime display for both voice and key responses was faster when the subsequent probe display required the relatively easy verbal response, rather than the keypress response.

The theoretically most important Eriksen interference effect, found by comparing the *same* identity and different conditions, was highly significant [$F(1,156) = 376.154, p < .001$]. For all groups of subjects, RTs were

faster when the distractor letter had the *same* identity as the target than when the distractor was in the response set but had an identity *different* from that of the target ($p < .01$ in all conditions, by Wilcoxon test). Finally, the interaction between response mode and interference was significant [$F(1,156) = 3.9, p < .05$]. The Eriksen interference effect was relatively larger in verbal than in keypress response tasks (see Figure 2).

Analysis of errors was also carried out in a mixed three-way ANOVA. The between-subjects factor of domain was significant [$F(1,156) = 10.456, p < .01$]. Errors were greater in the between- than in the within-response-domain priming conditions. Furthermore, errors were greater for keypress responses than for verbal responses [$F(1,156) = 19.965, p < .01$]. No other effects or interactions were significant.

In summary, then, the Eriksen interference effect is observed in a variety of situations. Ignored letters are analyzed and competed with the target response. The inter-

Table 1
Means of Median Reaction Times and Mean Errors in the Prime Display

	Within Response Domain			
	Voice-Voice		Key-Key	
	Same Identity	Different Identity	Same Identity	Different Identity
Reaction Time	544	586	756	789
% Errors	1.5	1.9	4.9	4.3
	Between Response Domain			
	Voice-Key		Key-Voice	
	Same Identity	Different Identity	Same Identity	Different Identity
Reaction Time	557	607	686	727
% Errors	3.4	4.5	5.4	6.0

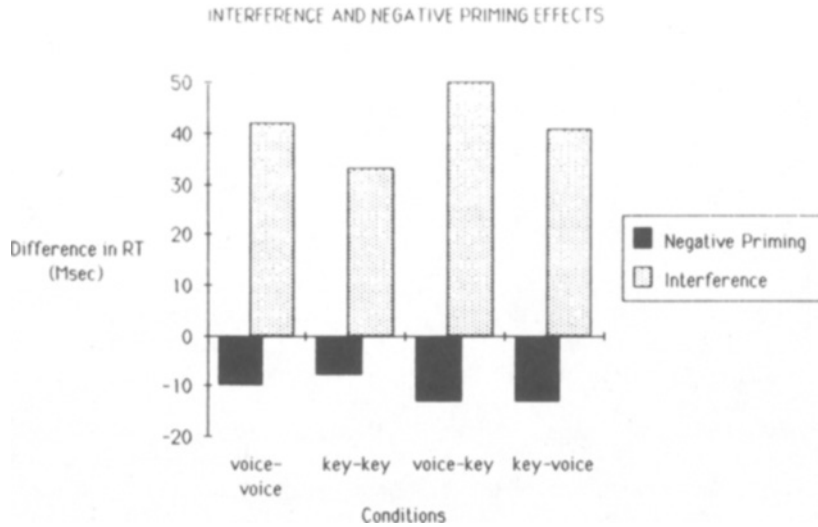


Figure 2. Interference and negative priming effects. Interference is produced by the *different* distractor condition minus the *same* distractor condition in the prime display; negative priming is produced by the control condition minus the ignored-repetition condition in the probe display.

ference effect is found with both verbal and keypress responses, and both when the response on the subsequent trial is of the same kind and when it is qualitatively different. The size of the effect, however, appears to have been influenced to some extent by the former factor, as revealed by the interaction.

The observation that the distractor was processed in all situations provides a clearer understanding of the priming effects discussed below. It was predicted that priming effects would be revealed within response domain, replicating previous findings, but that, between response domains, negative priming might not be revealed if inhibition were confined to a particular response modality. In the latter situation, the priming effects of the previously ignored letter, which achieved internal representations at least to the level of incipient response, might be facilitatory.

Priming Effects

Analysis of priming effects was carried out on median RTs in a three-way mixed ANOVA. Means of median RTs and mean errors are reported in Table 2.

The first between-subjects factor of between or within response domain was nonsignificant [$F(1,156) = .852$]; that is, RTs to the probe display were not influenced by whether response to the previous prime display was in the same or a different response modality. The second between-subjects factor, mode of response, was highly significant [$F(1,156) = 98.439, p < .001$]. This supports the observations in the prime display, as RT was substantially longer to press a key when identifying a letter than when naming it.

The interaction of within- and between-response-domain priming and mode of response (keypress and naming) was significant [$F(1,156) = 14.749, p < .001$]. Performance was facilitated when response to the prime display was verbal naming, rather than the more difficult keypress response. This result is analogous to the interaction observed in the prime data; that is, performance was facilitated both when the previous response was easier and when the subsequent response was easier (naming). Such observations have been previously established in the literature pertaining to the psychological refractory period (D. E. Broadbent & Gregory, 1967).

Table 2
Means of Median Reaction Times and Mean Errors in the Probe Display

	Within Response Domain			
	Voice-Voice		Key-Key	
	C	IR	C	IR
Reaction Time	559	569	751	759
% Errors	1.7	2.2	4.6	5.3
	Between Response Domain			
	Key-Voice		Voice-Key	
	C	IR	C	IR
Reaction Time	624	637	708	721
% Errors	2.8	3.2	8.6	8.8

More importantly, the within-subjects factor of priming was highly significant [$F(1,156) = 29.685$, $p < .001$]; that is, RTs were significantly longer in the IR condition than in the C condition. This negative priming effect was consistent over all conditions: comparisons between C and IR conditions with Wilcoxon tests in each condition (*key-key*, *voice-voice*, *key-voice*, and *voice-key*) were significant in every case ($p < .01$).¹ The fact that there was *no* evidence for an interaction between priming and between- and within-domain conditions [$F(1,156) = 1.030$] supports the conclusion that negative priming is equivalent whether the response modality to the probe is similar to or different from the response modality to the prime. This suggests that inhibition is *not* isolated in particular motor response modalities. No other interactions were significant (see Figure 2).

Analysis of errors in probe responses was also carried out in a three-way mixed ANOVA. The between-subjects factor of within or between domain priming was highly significant [$F(1,156) = 20.474$, $p < .001$]. Errors were larger when the probe was in a response domain different from that of the prime. This supports the error analysis of the prime display responses. It suggests that performance is impaired, in terms of accuracy, when responses to the prime and probe displays are in different modalities. The between-subjects factor of response mode (keypress or verbal) was highly significant [$F(1,156) = 66.073$, $p < .001$]. Supporting the RT data, there were more errors in keypress than in verbal responses. There was also a significant interaction between domain and response mode [$F(1,156) = 6.590$, $p < .01$]; that is, performance of the keypress response was more impaired by differences in response modality than was the relatively easy verbal response.

Finally, the within-subjects factor of priming condition (C vs. IR) was marginally significant [$F(1,156) = 2.894$, $p < .087$]. There were no significant interactions. Thus, the error data support the RT data. In all conditions, there were marginally more errors in the IR than in the C condition, supporting the larger RTs in IR than in C.

DISCUSSION

In summary, then, this experiment replicated the Eriksen interference effect in a variety of experimental situations. The interference effects demonstrate that human subjects are not always able to confine the analysis of irrelevant stimuli to peripheral perceptual stages of processing. Rather, the irrelevant stimuli appear to receive substantial processing, at least to incipient response stages. Furthermore, the data also suggest that one of the mechanisms enabling response to be output to the target, rather than to the distractor stimulus, is one of active inhibition of the internal representations of the distractor. This is revealed by the negative priming effect. Processing of a stimulus requiring the internal representations of a previously ignored stimulus is impaired. Furthermore, the in-

hibition does not appear to be isolated within peripheral response modalities.

The model we are proposing has a number of properties. First, it is in line with postcategorical theories of attention (see Allport, 1980; Van der Heijden, 1981) in that the perceptual analysis of objects with well-established internal representations can be automatic. Even though an object is irrelevant to the goal-directed behavior of the subject, it can still achieve categorical levels of analysis in parallel with other objects in the scene.

Second, as discussed, visual attention is considered to contain at least two mechanisms—excitatory and inhibitory components. The excitatory component is viewed as processing the internal representations of the to-be-selected object beyond that of initial perceptual analysis. Some theorists have proposed a spotlight analogy (D. E. Broadbent, 1982; Posner, Snyder, & Davidson, 1980; Treisman & Gelade, 1980), according to which attention is directed to various regions like a beam of light moving in space. Processing of stimuli within the beam is facilitated. We propose, in addition, that attention also contains a mechanism of active inhibition. The internal representations of ignored objects do not passively decay back to resting levels, as suggested, for example, by Van der Heijden (1981). Rather, these competing representations can be inhibited during selection of the target.

It should be noted that other accounts of negative priming have been put forward (e.g., Lowe, 1979). These accounts argue that negative priming is not a result of inhibitory mechanisms of attention, but rather, as proposed by an anonymous reviewer, that selection is based on an enhancement of the to-be-attended object's representations. In this case only excitatory processes are involved in selection. After successful selection and response to the target, a variety of links in the relevant networks would be adjusted. The strength of these links might be adjusted downward in the case of activated letter units that did not correspond to the correct response. Thus, distractor letter units would have an attenuated gain function. Such a process of weight adjustments in networks is unrelated to the processes of selective attention, but would account for negative priming.

The crucial aspect of these accounts is that the adjustment process responsible for negative priming takes place *after* the response has been executed. Such an explanation, however, cannot account for the relationship between efficiency of selection and negative priming. In the study of individual differences in attention, subjects who are efficient selectors with small interference effects tend to produce larger negative priming effects (Beech, Baylis, & Claridge, 1987; Beech & Claridge, 1987; Tipper & Baylis, 1987). Such observations suggest that inhibition *is* important for efficient selection. Thus, the argument that negative priming is unrelated to selection, and is produced after selection is complete, cannot account for the relationship between selection performance and negative priming. (See also Tipper & Cranston, 1985, for ar-

guments against the alternative accounts proposed by Allport, Tipper, & Chmiel, 1985, and by Lowe, 1985.)

In light of the individual differences data, then, we prefer to interpret negative priming as reflecting an inhibitory mechanism of attention. As discussed, the previous research demonstrating negative priming between symbolic domains (such as picture and word; Tipper & Driver, in press) and between input modalities (Greenwald, 1972) suggests that inhibition is not located in the perceptual representations that encode the physical properties of ignored objects. Rather, inhibition must be of some more central abstract semantic internal representation, or must occur at the response stages (see Tipper & Cranston, 1985). The present data provide further evidence relevant to identifying the locus of inhibition. The fact that negative priming was observed between response modalities suggests that distractor inhibition must be present at a central location prior to the separation of information into independent response modalities. Furthermore, the failure to observe any interaction between negative priming and within or between response modality suggests that the size of inhibition is equivalent in within- and between-domain responses. It may therefore be proposed that there is no active inhibition associated with ignored stimuli in peripheral response modalities.

In conclusion, the inhibition observed via negative priming is confined to a central locus of processing between perception and action. This location is common to a variety of different perceptual inputs and response outputs: inhibition is tied neither to specific physical properties of the stimulus nor to specific motor responses to the stimulus.

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NOTE

1. The size of the negative priming effect in this experiment is equivalent to that found in other, unpublished, studies employing letters as experimental stimuli in our laboratory and to that found by Tipper and Cranston (1985). Some comments may be in order, however, in reference to the observation that the interference effects are somewhat larger than negative priming effects.

In interference effects, the distractor and the target it affects are presented simultaneously. Therefore the effects of the distractor on the target are relatively immediate. Eriksen and Schultz (1979) showed that such a situation produces substantial interference. However, when the distractor is delayed by only 50 msec, the interference effects are greatly reduced. In the priming paradigm, the effects of the distractor are observed through time. After prime offset there is a 110-msec mask, a

variable response time, and a 350-msec delay before the probe is presented. Therefore, the interstimulus interval between the ignored prime and the subsequent probe range from approximately 1,000 to 1,250 msec. In the model proposed by Tipper and Cranston (1985), inhibition can be very labile, returning to resting levels quickly. Thus, over the time intervals used in these studies it is possible for inhibition to decay to some extent by the time the probe is presented, hence the relatively small effects. In support of this suggestion, Neill and Westberry (1987) reported that at 2,000 msec response stimulus interval inhibition has completely dissipated.

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