

Priming and intrusion errors in RSVP streams with two response dimensions

Daniel Loach · Juan Botella · Jesús Privado ·
John K. Tsotsos

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Abstract Loach and Marí-Beffa (Vis Cogn, 10:513–526, 2003) observed that a distractor stimulus, presented immediately after a behaviorally relevant target stimulus, negatively primed a related probe stimulus indicating that the distractor had been inhibited. They argued that “post-target inhibition” may be a mechanism for preventing interference from temporally proximal stimuli; interference that could potentially result in a binding/intrusion error. In order to test this hypothesis, the authors carried out two rapid serial visual presentation (RSVP) experiments in which participants had to report either the identity (Experiment 1) or color (Experiment 2) of a target letter surrounded by distractor letters. In Experiment 1, a close relationship between priming and errors was observed. When a distractor stimulus showed evidence of being inhibited the participant was less likely to commit a binding error. The opposite was true when a distractor stimulus showed evidence of being facilitated. The results of Experiment 2 showed limited evidence of the same relationship.

Introduction

How do we partition our experiences of everyday life into episodes or events that make sense to us? When there is

enough of a temporal interval between events this is not a problem. However, studies have shown that when two events or objects occur within about half a second of each other, people find it difficult to accurately report one or both events (Kanwisher, 1987; Pashler, 1994; Raymond, Shapiro, & Arnell, 1992). From this robust finding, we can deduce that objects occurring very close in time interfere with each other at some level of information processing in the brain. In order to select one or both objects for action, this interference must be resolved somehow.

Loach and Marí-Beffa (2003) demonstrated that distractor stimuli presented soon after a target stimulus showed evidence of being inhibited. They presented a rapid serial visual presentation (RSVP) stream of black letters, amongst which a single red target letter was presented. The task was to make a mental note of the identity of the red target letter and then make a speeded response to the identity of a probe letter presented at the end of the RSVP stream. On half the trials, the probe stimulus was the same letter as one of the black distractor letters presented soon after the target letter. After the probe response, participants made a non-speeded response to the identity of the target. When the probe letter and the distractor letter were the same (i.e., the Repeated condition), response times to the former were slower than when they were different (i.e., the Unrepeated condition). This negative priming effect was what led Loach and Marí-Beffa to postulate that post-target distractors were being inhibited.

It was suggested that inhibition could in part be responsible for post-target response deficits such as the *attentional blink* (AB). The AB finding is that participants are impaired in responding to the second of two targets (T1 and T2), when they are presented within 500 ms of one another. Loach and Marí-Beffa (2003) argued that T2 might be inhibited in order to prevent interference and ensure

D. Loach (✉)
Macquarie Centre for Cognitive Science, Macquarie University,
Building C5A, Room 505, Sydney, NSW 2113, Australia
e-mail: dloach@maccs.mq.edu.au

J. Botella · J. Privado
Universidad Autónoma de Madrid, Madrid, Spain

J. K. Tsotsos
Centre for Vision Research, York University, Toronto, Canada

successful identification of T1. When reading the AB literature one comes across a number of experimental findings which may and have been used to contradict an inhibitory account of the AB. For example, Shapiro, Driver, Ward and Sorensen (1997) found that a T2 stimulus that could not be reported (i.e., was blinked) nevertheless primed a semantically related probe stimulus (designated T3). This positive priming would seem to invalidate the suggestion that post-target stimuli are inhibited. But Shapiro et al. themselves differentiate between an object's identity (its *Token*) and the category to which it belongs (its *Type*). They maintained that the AB reflects an inability to extract an object's token rather than its type. Thus, positive priming of a semantically related T3 by a blinked T2 need not be inconsistent with an inhibitory account of the AB if one assumes that inhibition was applied at the token or identity level of T2's representation.

Di Lollo, Kawahara, Ghorashi and Enns (2005) recently observed that the AB is eliminated when targets are separated from one another by other targets rather than distractors (see also, Olivers, van der Stigchel, & Hulleman, 2007). In this study with three targets (T1, T2, and T3), performance at the T2 and T3 positions was preserved at stimulus onset asynchronies (SOAs) that would normally elicit a blink, as long as these targets followed one another with no intervening masks/distractors. Again, this is not inconsistent with an inhibitory account of the AB as long as one makes the commonsense assumption that inhibition is only applied in the case when the potential for committing a binding error exists, i.e., once a distractor stimulus has been presented. Di Lollo et al. argued that the AB reflects a disruption of the attentional set by a non-target. Could this disruption be a trigger for an inhibitory mechanism that prevents interference from distractor stimuli?

The need for such a mechanism is evidenced by studies of intrusion errors. Such studies typically present letters or words, one after the other at rates of about 10 items/s (Botella, Barriopedro, & Suero, 2001). The experimental finding is that participants will sometimes substitute the identity of a target stimulus with the identity of a neighboring non-target. These intrusion errors are also known as illusory conjunctions or temporal binding errors in reference to the mechanism that has apparently broken down. Botella and Villar (1986) examined the distribution of intrusion errors around a target. They showed that most migrations originate from the $T - 1$ and $T + 1$ positions, i.e., from the stimuli presented immediately before and after the target in an RSVP stream. This is consistent with the idea that two objects are more likely to be confused with one another, the closer in time they appear to one another. In addition, Botella, García and Barriopedro (1992) demonstrated that depending upon the target task, the pattern of intrusion errors shifts from post- to pre-target

pattern. They had participants report either the color or identity of a target uppercase word in an RSVP stream of lowercase words. They observed intrusion errors from stimuli in positions $T - 2$ to $T + 2$. They found a predominance of post-target errors when a color response was required and a pre-target pattern when the identity of the word was required.

If it is the case that the negative priming observed by Loach and Marí-Beffa (2003) reflects an inhibitory mechanism whose function is preventing intrusion errors then one might expect a relationship between the pattern of priming (both positive and negative) and the pattern of intrusion errors. The present paper reports experiments designed to test this hypothesis.

Experiments 1 and 2

The experiments in this paper used a similar procedure to Loach and Marí-Beffa (2003) and Botella et al. (1992). One difference from the former was that the distractor stimulus (the letter that was probed) could appear at varying positions in the RSVP stream, both before and after the target stimulus. Loach and Marí-Beffa (2003) did not assess priming of pre-target distractors. Thus, this paper presents a bridge between studies of temporal binding and post-target response deficits. The target stimulus was a colored uppercase letter presented amongst colored lowercase letters. In Experiment 1, participants were required to identify the target letter after making a speeded response to the identity of a probe letter presented at the end of the RSVP stream. In Experiment 2, participants were required to respond to the color of the target and probe stimuli. Other than this response difference, the two experiments were identical.

The reason for using both identity (Experiment 1) and color (Experiment 2) response dimensions was as follows. If it were demonstrated that the pattern of intrusion errors were different in the two dimensions (as in Botella et al., 1992) and this difference was accompanied by a similar change in the pattern of priming then this would provide strong evidence that the two are related.

Methods

The experimental method was similar to that employed by Loach and Marí-Beffa (2003) but had some features of an intrusion error study. The critical items were the target, distractor, and probe letters. The distractor letter was presented in various positions, in an RSVP stream of colored letters, relative to the target letter, i.e., $T - 2$, $T - 1$, $T + 1$, and $T + 2$. These positions were chosen because they are the positions from which most intrusion errors originate (Botella & Villar, 1986). The probe letter could be the same

(the Repeated condition) as the distractor letter or different (the Unrepeated condition) on either identity (Experiment 1) or color (Experiment 2) dimensions.

One departure from the procedure used by Loach and Mari-Beffa was that the identities and colors of the two letters presented before and after the target stimulus were letters from the target/probe identity/color set. Thus, when participants were required to report the identity or color of the target letter and they made a mistake, it was possible to observe the position of the feature that they had substituted for the target on that trial. In other words, one could observe the pattern of intrusion errors around the target letter. So for each of the four distractor letter positions ($T - 2$, $T - 1$, $T + 1$, and $T + 2$), it was possible to calculate a priming score (Unrepeated minus Repeated trials) and an intrusion error score (number of errors originating from that position) (Fig. 1).

Stimuli and apparatus

Participants used a chin rest such that their eyes were approximately 52 cm from the computer monitor. Each letter subtended approximately 1.1° of visual angle.

Participants

Nineteen students participated in Experiment 1. Ten out of the nineteen students were from the Universidad Autónoma de Madrid and nine were from York University. Nineteen (new) students participated in Experiment 2. Seven out of

the nineteen students were from the Universidad Autónoma de Madrid and twelve were from York University. Participants had normal or corrected to normal vision and were not dyslexic.

Design and procedure

The letter identities from which the target/probe stimuli could be drawn were B, D, F, H, K, or T. The colors from which the target/probe stimuli could be drawn were blue, yellow, purple, green, cyan, and red. For B, D, F, H, K, and T, respectively, the response keys were q, w, e, i, o, and p on the computer keyboard. For blue, yellow, purple, green, cyan, and red, the response keys were q, w, e, i, o, and p.

The RSVP stream of colored letters was preceded by a fixation asterisk presented for 500 ms. Letters that were neither the target, the probe, nor the two letters on either side of the target letter were alternately teal and olive in color and were chosen randomly from the remaining letters of the alphabet. The target, the probe, and the two letters on either side of the target letter ($T - 2$, $T - 1$, $T + 1$, and $T + 2$) were randomly drawn from the aforementioned target/probe set, i.e., B, D, F, H, K, and T and were presented in one of the six colors, i.e., blue, yellow, purple, green, cyan, and red.

Each letter in the stream was presented for 66 ms with no inter-stimulus interval. The length of the stream (number of letters presented) depended on the position of the target letter in the stream and the position of the distractor letter relative to the target letter. The target letter could appear in positions 6, 7, or 8 and the distractor would appear in one of the four positions surrounding the target (i.e., $T - 2$, $T - 1$, $T + 1$, and $T + 2$). There were always ten letters presented after the distractor letter, followed by the probe letter (the last letter in the stream).

Participants were first required to make a speeded response to the probe letter at the end of the stream by pressing the appropriate key as quickly as possible. After this response, participants were prompted by an onscreen message to respond to the target letter. The target letter was defined as the only uppercase letter in the RSVP stream. As already stated, participants responded to the identity of the target and probe letters in Experiment 1 and their color in Experiment 2.

Variables and conditions

There were two independent variables: *Repetition* and *Position*. There were two levels of *Repetition* corresponding to whether or not the distractor letter and the probe letter were the same (i.e., Repeated) or different (i.e., Unrepeated). There were four levels of the variable *Position* corresponding to the four positions in which the distractor could be

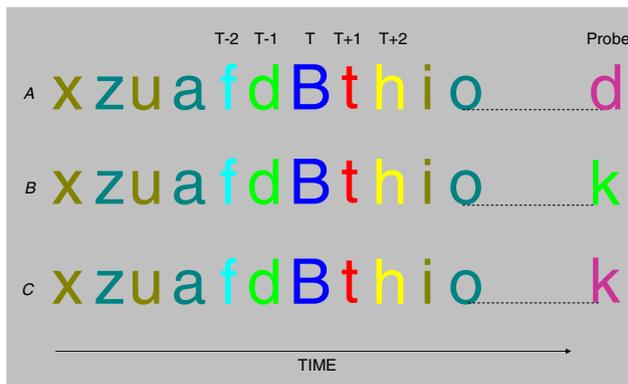


Fig. 1 Stream A shows an example from an Experiment 1 trial. The probe letter has the same identity as the $T - 1$ letter. Thus for the purposes of calculating a priming score, this is a Repeated identity $T - 1$ trial. Stream B shows an example from an Experiment 2 trial. This is also a Repeated trial, however in this case, the probe and $T - 1$ letters have only their color in common. Stream C shows an example of an Unrepeated trial from both experiments. The probe is neither the same color nor shares its identity with any of the letters that comprise the target and its temporal neighbors. The target letter could appear in positions 6, 7 or 8. There were always ten letters presented after the distractor letter, followed by the probe letter (the last letter in the stream)

presented (i.e., $T - 2$, $T - 1$, $T + 1$, and $T + 2$). Thus, there were five conditions: Repeated $T - 2$, Repeated $T - 1$, Repeated $T + 1$, Repeated $T + 2$, and Unrepeated.

The experiment consisted of 288 trials. Half of those were Repeated trials and the other half were Unrepeated trials. The Repeated trials were further divided into four conditions of 36 trials each, corresponding to the position of the distractor letter being probed, i.e., $T - 2$, $T - 1$, $T + 1$, and $T + 2$.

On every trial, target and probe report accuracy were recorded, as was response time (RT) to the probe. Of special interest were trials when the participant substituted the identity (or color) of one of the two letters presented before or after, for that of the target. For each participant, the number of errors originating from each position (e.g., $T - 2$, $T - 1$, $T + 1$, and $T + 2$) was recorded.

Results and discussion

Individual participant RT data were summarized using median response time to the probe letter. RTs were only included in the analysis if the participant correctly identified the target and probe letters on that trial. Data from the three target positions (6–8) were collapsed for analysis. For each participant, the mean response time to the probe stimulus in each Repeated condition (i.e., Repeated $T - 2$, $T - 1$, $T + 1$, and $T + 2$) was subtracted from the mean of the Unrepeated condition to obtain a priming score for each distractor position (see Table 1). A positive priming score indicates that the distractor stimulus was facilitated whereas a negative score indicates retardation or negative priming. Error scores were the number of errors originating from each distractor position and were included in the analysis regardless of whether or not the participant correctly responded to the probe stimulus. A higher score indicates that more intrusion errors originated from that position (i.e., a high score at $T - 1$ indicates that the identity of the $T - 1$ distractor was often substituted for the target). Both priming and error scores were then converted into z -scores so that the two could be compared directly.

Table 1 Mean priming and error scores at each position relative to the target (prior to conversion to z -scores)

	Position of distractor			
	$T - 2$	$T - 1$	$T + 1$	$T + 2$
Exp. 1: Identity				
Priming score	-16.11	12.24	17.79	-1.66
Errors	12.74	16.21	16.63	14.05
Exp. 2: Color				
Priming score	-20.18	1.29	19.03	22.55
Errors	20.89	25.74	36.26	24.00

Experiment 1

The standardized data were entered into a 2×4 Repeated measures ANOVA test comparing the two measures, priming and error z -scores, with the four positions, $T - 2$, $T - 1$, $T + 1$, and $T + 2$. There was a significant main effect of position [$F(3,54) = 5.82$, $P < 0.01$] with no interaction between measure and position [$F(3,54) = 0.12$, $P = 0.94$]. The lack of an interaction between measure and position is in accordance with the hypothesis that the temporal spread of priming mirrors the pattern of intrusion errors.

Figure 2 shows that the pattern of priming corresponds very closely with the pattern of intrusion errors. Referring to Table 1, positive priming at a given distractor position resulted in a greater number of intrusion errors originating from that position. In contrast, negative priming at a given distractor position resulted in fewer intrusion errors.

This is the first RSVP study to demonstrate that pre-target distractors prime related probe stimuli presented at the end of the stimulus stream. The authors would argue that upon detection of the target, representations associated with pre-target distractors can be more active than those of the target with the result that they may be erroneously selected and substituted for the target in the ensuing binding process.

On the other hand, it could be argued that the distribution of pre- and post-target errors, along with the pattern of priming, has nothing to do with any target selection mechanism. For example, perhaps the errors originating from the $T - 1$ and $T - 2$ positions result from the premature opening of an attentional gate in an effort to anticipate the presentation of the target stimulus. Perhaps this gate is opened because the critical stimuli in this study (i.e., $T - 2$, $T - 1$, $T + 1$, and $T + 2$) are different in color from the filler items and cue the participant as to when to expect the target. The problem with this explanation is that opening a gate upon the onset of the critical items would mean that both pre-target distractors (i.e., $T - 2$ and $T - 1$) would

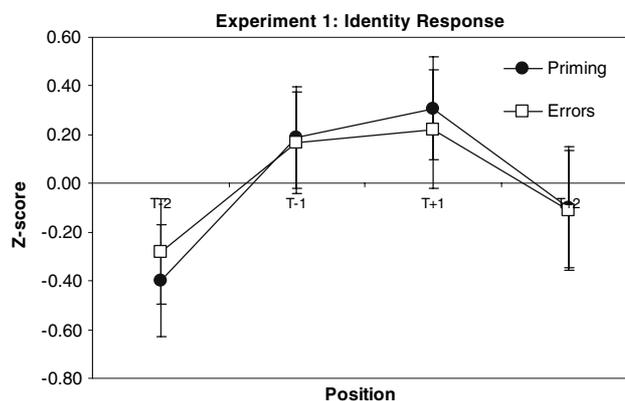


Fig. 2 Graph showing priming and error z -scores at each position relative to the target in Experiment 1

gain entry and receive attentional facilitation. Thus, one would expect closely similar numbers of $T - 1$ and $T - 2$ intrusion errors and/or equal priming at these positions¹. To refute this anticipatory explanation for pre-target errors, we conducted a paired samples t test which showed a significant difference between the number of intrusion errors originating from the $T - 2$ and $T - 1$ positions [$t(18) = -3.53$, $P < .01$, two-tailed]. Another paired samples t test revealed a significant difference between $T - 2$ and $T - 1$ priming scores [$t(18) = -2.23$, $P = 0.03$, two-tailed].

Though the simple opening of an attentional gate cannot explain the current data one could argue that attention is evoked upon the onset of the critical items in the RSVP stream, but takes a while (perhaps the duration of a single distractor stimulus) to engage and then disengage after the target. This delay would mean that the $T - 2$ and $T + 2$ distractor stimuli would not receive facilitatory processing because attention was either not engaged yet or had already been disengaged following processing of the target. But consider for a moment a simple AB study in which the position of T1 is varied randomly and participants are not forewarned as to its imminent presentation (as could be argued was the case in this study). We know that participants do report T1 in this case and yet T1 would no longer be on the screen by the time the *delayed engagement/disengagement hypothesis* predicts attention could be ready/engaged. One might continue to argue that in this example, attention is engaged well before the presentation of the target so the delay in its initiation is no longer relevant. But in this case one would expect equal numbers of $T - 2$ and $T - 1$ intrusion errors, which was not observed (see also, Botella et al., 2001). Thus, we can likely reject an attentional gate or delayed engagement explanation for the data in this study.

The results of Experiment 1 are in accordance with the prediction that the likelihood of committing a target error is bound up with the degree to which distractors in close temporal proximity are facilitated or inhibited. The logic behind Experiment 2 was to see whether the same relationship between priming and errors could be observed in another response dimension, that of color.

Experiment 2

In Experiment 2, participants were required to report the color of the uppercase letter. The pattern of binding errors

¹ As one reviewer pointed out, it could be argued that an attentional gate opens gradually which could explain the difference in priming and error scores between the $T - 2$ and $T - 1$ positions. A similar argument, i.e., a gradual closing of the gate, could be used to explain the differences in priming and error scores between the $T + 1$ and $T + 2$ positions.

in Experiment 2 was markedly different from that of the first experiment. It is clear there was a predominance of $T + 1$ intrusion errors in Experiment 2, compared to Experiment 1. This is consistent with the pattern of errors observed in Botella et al. (1992), who observed a predominance of post-target intrusion errors when the response feature in their RSVP stream was color (Fig. 3).

As in Experiment 1, the standardized data were entered into a 2×4 Repeated measures ANOVA test comparing the two *measures*, priming and error z -scores, with the four *positions*, $T - 2$, $T - 1$, $T + 1$, and $T + 2$. Again there was a significant main effect of *position* [$F(3,54) = 12.54$, $P < 0.01$] with no interaction between *measure* and *position* [$F(3,54) = 2.61$, $P = 0.08$]. The lack of an interaction here again supports the prediction that priming and error scores run essentially parallel to one another. There seems to be good correspondence between priming and error z -scores at the $T - 2$, $T - 1$, and $T + 1$ positions. However, at the $T + 2$ position, priming and error z -scores diverge. A paired samples t test confirmed the presence of a significant difference between priming and error z -scores at this position [$t(18) = 2.47$, $P = 0.02$]. This could mean that the relationship between errors and priming is not straightforward at post-target positions in the color domain.

Despite the difference at the $T + 2$ position, there is still evidence for the same relationship between priming and error scores at the other positions as was observed in Experiment 1. That is, (excluding position $T + 2$) a position with a high priming score produced many intrusion errors, whereas a position with a low or negative priming score produced fewer intrusion errors.

General discussion

The results of Experiment 1 show that the temporal pattern of intrusion errors mirrored the pattern of priming. This is

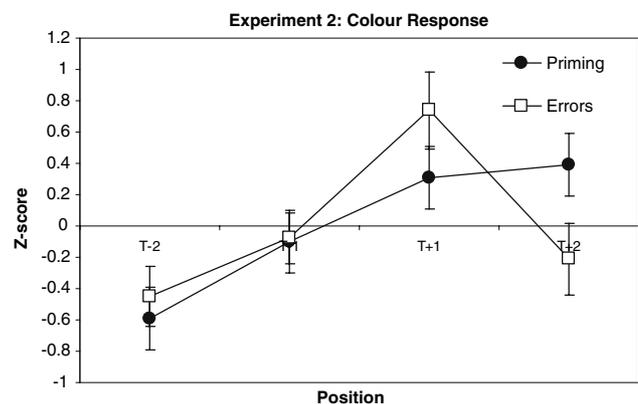


Fig. 3 Graph showing priming and error z -scores at each position relative to the target in Experiment 2

true to a lesser extent of the results of Experiment 2. In order to elucidate the link between the priming of distractors in close temporal proximity to a target and the likelihood of committing a temporal binding error we would do well to consider attentional selection in another domain, that of space. In the spatial domain, attention had been considered analogous to a spotlight (Eriksen & Hoffman, 1973; Posner, Snyder, & Davidson, 1980) or zoom lens (Eriksen & St James, 1986; Eriksen & Yeh, 1985) traveling over the visual field, facilitating the information processing of objects caught in the beam. However, recent findings have shown that spatial attention has an inhibitory component. For example, Cutzu and Tsotsos (2003) had participants make a forced choice as to whether two letters, presented at various spatial distances from one another, were the same or different. The location of one of the letters was pre-cued. They found that participants performed less well when the two letters were presented close to one another compared to when they were presented farther apart. This suggests an inhibitory surround in space centered on the pre-cued location. Similar findings to this one have been reported elsewhere (Caputo & Guerra, 1998; Muller & Kleinschmidt, 2004) in the literature and researchers are beginning to recognize the role that inhibition plays in attentional selection.

The concept of an inhibitory annulus around a facilitatory center has some utility in explaining the current results if we extend the concept from the spatial domain to the temporal domain. An inhibitory surround is one consequence of selection occurring between features (or clusters of neurons which code for those features) linked to one another via lateral inhibitory connections. Indeed, in Experiments 1 and 2 the higher priming scores at positions $T - 1$ and $T + 1$ support the notion that response features belonging to letters presented in close temporal proximity to the target are facilitated whilst those further away may be inhibited.

We suggest that the same attentional mechanism can account for inhibitory surrounds in both time and space. It is worthwhile briefly explaining some terminology that has been used in studies of temporal binding errors (see, Botella & Eriksen, 1992). The target's *key dimension* is the dimension on which the target may be identified. For example, in a task where a participant is required to identify a red letter amongst black letters in an RSVP stream, the *key dimension* is COLOR. The *key feature* that allows identification of the target is RED. The *response dimension* is the dimension of the target that should be reported. In this example, the participant is required to report the identity of the red letter, so the *response dimension* is IDENTITY. The identity of that letter is the *response feature*, e.g., the letter "X".

The basis for the attentional mechanism we propose is mutual inhibitory competition between currently main-

tained features (belonging to targets and distractors). This mechanism is very similar to that proposed by Bowman and Wyble (2007) to account for the AB. The response feature with the highest activation stands the best chance of being bound to the target's key feature. This will likely belong to the target or its immediate neighbors ($T - 1$, $T + 1$). Depending on the speed with which the key and response features are processed, different patterns of intrusion errors will emerge (Botella et al., 2001). For example, in Experiment 2 of this study, the key feature was *Uppercase* and the response feature was COLOR. It is reasonable to assume that color is a feature that would be detected almost immediately after onset. Thus, color response features with the highest activations (and consequently the best chance to win out once mutual inhibition ensues) will belong to the target, or those letters presented immediately afterwards ($T + 1$). This will produce a predominance of post-target intrusion errors, which is exactly what was observed in Experiment 2 and Botella et al. (1992). In other words, the temporal inhibitory surround we propose may be asymmetrical around the target depending on the speed with which response features are processed. In line with the finding of Di Lollo et al. (2005), we would suggest that selection via mutual inhibition is only initiated once the potential for committing a binding error exists, that is, once a distractor stimulus has been presented.

It is important to differentiate between the attentional mechanism we have proposed, i.e., mutual inhibition of response features and the concomitant behavioral effect. The latter may be the presence of negative priming, indicating inhibition (e.g., at the $T - 2$ and $T + 2$ positions), or it may be reduced positive priming. In other words, the outcome of this attentional mechanism is not necessarily negative priming but rather a reduction in priming (*towards* negative) in the temporal surround (i.e., $T - 2$ and $T + 2$) when compared to the center (i.e., the target, $T - 1$, and $T + 1$).

It should be noted that the results of this study differ somewhat from those reported by Loach and Marí-Beffa (2003) which showed negative priming at the $T + 1$ position, whereas the present results show positive priming (a positive z -score). In the AB literature, performance at reporting T2 is sometimes unimpaired if it appears directly after T1. Bowman and Wyble (2007) claim that this "Lag-1 sparing" is contingent upon the temporal proximity of T2 to T1; if T2 occurs very close in time to T1 then it can benefit from the pulse of activity in the system that was evoked by the presentation of T1. We would make a similar argument to explain the current results. If a pre- or post-target distractor is presented in very close temporal proximity to the target, then there is a chance that their activations partially reinforce one another before mutual inhibition has had a chance to build between their respective response features.

In this case, the criterion activation necessary for the target's response feature to be bound to the target's key feature would be reached quickly. The early conclusion of the binding process associated with the target would be such that the activation of certain distractor response features, i.e., $T - 1$ and $T + 1$ (or T_2 in the case of an AB study), would remain relatively high. Of course having two or more response features simultaneously highly activated (as a consequence of inhibition not having had time to build) would lead to an increased likelihood that the target key feature would be bound to the response feature of a distractor stimulus, i.e., a binding error. This is supported by the high number of intrusion errors we observed from temporally proximal positions in this study. Similarly, in the AB literature, it has been shown that in cases where T_1 and T_2 occur very close in time to one another, participants are less likely to successfully report T_1 (Potter, Staub, & O'Connor, 2002).

The Bowman and Wyble (2007) model, which has successfully reproduced behavioral AB data, predicts that report of T_2 will be unimpaired even at Lag-2 if the SOA of items in the RSVP stream is around 50 ms. Certainly, the SOA of 66 ms in this study is close to this interval, which could account for the presence of positive priming at the $T - 1$ and $T + 1$ positions with a trend towards negative priming at positions further away in time from the target (i.e., $T - 2$ and $T + 2$) in Experiment 1. In contrast, the SOA of stimuli in Loach and Marí-Beffa (2003) was 90 ms, which would account for the lack of Lag-1 sparing in their study.

The results of these experiments may benefit our understanding of post-target response deficits such as the AB. On an AB trial where the participant is unable to report T_2 , we would argue that the binding of T_1 's response feature to the T_1 key feature is accomplished via the mutual inhibition of other currently maintained response features; the same process as occurs in a single target paradigm such as the one we have utilized in this paper. We propose that this binding phase lasts approximately 200–500 ms (the length of the AB). If a second key feature is detected during this window, that belongs to T_2 , another mutual inhibitory competition is initiated. Unfortunately, T_2 is not liable to win this competition due to its inhibition during T_1 's binding phase. It is more likely that another response feature currently maintained in the system will have a higher activation and be bound to T_2 's key feature. These might belong to a distractor stimulus presented immediately before or after T_2 . In line with this prediction, Chun (1997) observed that when participants fail to report T_2 in an AB experiment, they often substitute the identity of a post- T_2 distractor.

There are distinct differences between the methodologies employed in this study and a typical AB experiment. For example, in this study the distractor and target stimuli were

both drawn from a small set of letters (i.e., B, D, F, H, K, and T) and were thus distinguishable from the teal and olive filler letters. In contrast, pre- and post-target distractors in an AB study are not from the target set or if they are, they are drawn from the entire alphabet and are indistinguishable from other filler items. Also, there is no second target (T_2) in our experiments and the stimulus durations we chose are somewhat shorter than typical AB studies. These methodological differences mean that we should not generalize these results too far with regards to the AB.

Conclusions

Our results have demonstrated a link between the temporal spread of priming around a target and the distribution of binding errors. Until now, the mechanism by which response features are selected has been understood as a simple function of their activation at the point of key feature detection. We have outlined a more sophisticated selection process based on mutual inhibitory competition between currently maintained response features. The nature of this competition is such that the winner is bound to the target's key feature resulting in a correct response or temporal binding error.

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