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The elimination of positive priming with increasing prime duration reflects a transition from perceptual fluency to disfluency rather than bias against primed words

Kevin W. Potter[a,*], Chris Donkin[b], David E. Huber[a]

[a] University of Massachusetts Amherst, Amherst, 01003 MA, USA
[b] University of New South Wales, Sydney, 2052 New South Wales, Australia

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ABSTRACT

With immediate repetition priming of forced choice perceptual identification, short prime durations produce positive priming (i.e., priming the target leads to higher accuracy, while priming the foil leads to lower accuracy). Many theories explain positive priming following short duration primes as reflecting increased perceptual fluency for the primed target (i.e., decreased identification latency). However, most studies only examine either accuracy or response times, rather than considering the joint constraints of response times and accuracy to properly address the role of decision biases and response caution. This is a critical oversight because several theories propose that the transition to negative priming following a long duration prime reflects a decision strategy to compensate for the effect of increased perceptual fluency. In contrast, the nROUSE model of Huber and O'Reilly (2003) explains this transition as reflecting perceptual habituation, and thus a change to perceptual disfluency. We confirmed this prediction by applying a sequential sampling model (the diffusion race model) to accuracy and response time distributions from a new single item same-different version of the priming task. In this way, we measured strategic biases and perceptual fluency in each condition for each subject. The nROUSE model was only applied to accuracy from the original forced-choice version of the priming task. This application of nROUSE produced separate predictions for each subject regarding the degree of fluency and disfluency in each condition, and these predictions were confirmed by the drift rate parameters (i.e., fluency) from the response time model in contrast to the threshold parameters (i.e., bias).

1. Introduction

Fluency, the ease/speed with which we process information, can strongly influence our judgments and decisions (Alter & Oppenheimer, 2009). In other words, people can base their decisions not only on the content of a set of information, but also on the evaluation of how easily and/or quickly they processed that information. Research indicates that fluency provides an adaptive heuristic for judgments, capturing relevant statistics from the environment (e.g., Hertwig, Herzog, Schooler, & Reimer, 2008). Indeed, decisions can often be based predominantly on fluency rather than cognitive content (Schwarz et al., 1991). In this article, we focus on perceptual fluency, an internal measure of the time taken to process perceptual stimuli. We examine the role perceptual fluency plays in a word identification task, in particular its role in explaining priming benefits following short duration primes and the

* Corresponding author.
E-mail address: kevin.w.potter@gmail.com (K.W. Potter).

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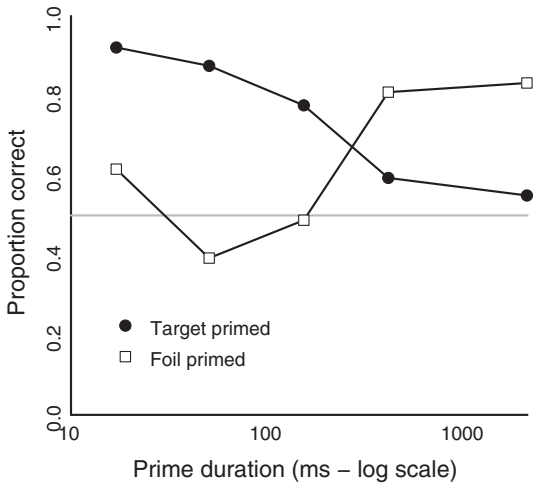

Fig. 1. Proportion correct in a forced-choice perceptual identification task (Huber, 2008). Filled points represent conditions for which the target word was primed; Empty points represent conditions for which the foil word was primed. The x-axis shows the duration for which the prime was displayed. Prime durations ranged from 17 to 2000 ms.

elimination of these benefits following longer duration primes.

Jacoby and Whitehouse (1989) provided one of the first demonstrations of this prime duration effect. After studying a list of words, subjects performed a yes/no episodic recognition task. Subliminal presentation of the test word immediately prior to a test trial produced a "memory illusion", with priming increasing both hits and false alarms. This effect was explained as an attribution error: subliminal priming increasing the perceptual fluency of the test word, and this fluency was mistakenly attributed to a sense of episodic familiarity. Support for this conclusion was found by examining a condition with a long duration easily seen prime, which produced decreased hits and false alarms (i.e., negative priming rather than positive priming). Jacoby and White argued that when subjects were aware of the potential source of perceptual fluency, decision processes were able to correct for this misattribution (the fluency was attributed to the prime rather than episodic familiarity). Subsequent work demonstrated that this prime duration effect can be found even when people are aware of the short duration prime (Huber, Clark, Curran, & Winkielman, 2008). However, despite attributions to perceptual fluency, decision biases, and response caution, the aforementioned studies did not directly measure these constructs.

Immediate word priming in perceptual identification also produces differing effects based on the duration of the prime. For instance, Huber, Shiffrin, Lyle, and Ruys (2001) used perceptual identification with forced-choice testing, comparing a condition where the target word was primed versus a condition where the foil word was primed. The authors found that short duration primes produced positive priming, as priming the target word improved accuracy and priming the foil word worsened accuracy. However, longer prime durations led to negative priming, as priming the target worsened performance and priming the foil improved performance.

This crossover interaction has been replicated many times; Fig. 1 presents an example from a study by Huber (2008). The y-axis denotes average proportion correct, and the x-axis indicates the duration (in log ms) that the prime was shown. The filled points show performance when the target word was primed, whereas the empty points show performance when the foil word was primed. The study demonstrates that as prime durations exceed 150 ms, accuracy performance improves substantially for the foil-primed condition, yet dips almost to chance performance for the target-word condition. The transition is distinctly non-linear as well.

The nROUSE model (Huber & O'Reilly, 2003) is a dynamic neural network that successfully accounts for this transition from positive to negative priming with increasing prime duration. The nROUSE model captures the time course of activation in early visual processing for the representations underlying the target and foil choice words. The model tracks the time it takes to process the onscreen choice alternatives, providing an explicit measure of perceptual fluency for each alternative. The subject choses the most quickly processed alternative (i.e., the alternative whose neural representation reaches its peak activation soonest). Psychologically, this represents a decision process in which an observer uses a heuristic, picking the more fluent choice. This is a rational heuristic in a situation where the target is not overtly identified: the briefly flashed target imparts lingering activation for the target choice, reducing the perceptual identification latency of that item at the time when it reappears as a choice alternative.

In the case of the nROUSE model, perceptual fluency is an effective heuristic, but this opens the door for priming effects, with the prime influencing decisions in either direction depending on whether the prime provides lingering activation or lingering habituation. Lingering activation from short duration primes makes the primed choice more fluent, boosting accuracy when the target is primed, but reducing accuracy when the foil is primed. In contrast, after presentation of a long duration prime, lingering habituation makes it difficult to perceptually identify the primed choice. This disfluency has the opposite effect, reducing accuracy when the target is primed, but boosting accuracy when the foil is primed.

The nROUSE model is relevant across multiple domains of psychology, providing insights into how neural mechanisms like inhibition and synaptic depression produce priming effects, how meta-cognitive evaluations of speed of processing can drive