Eye Movement Measures as Valid Indices for Capturing Priming Effects

Introduction

Priming studies have had a dramatic impact on understanding of language processing and continue to be critically important to furthering knowledge regarding a vast array of information processing phenomena, including those that are of paramount importance in aphasia. In tasks that have typically been used to study priming effects (Goldinger, 1996; Neely, 1991), participants are required to understand instructions, use verbal or motor responses, and engage in metalinguistic decisions (such as required for lexical decision) that may be considered unnatural. The validity of results from studies employing these tasks in investigating lexical organization in neurologically impaired patients, whose ability to comprehend instructions and use verbal and/or motor responses may be compromised, is questionable. As the study of priming effects continues to be of importance in arriving at a consolidated theory of language processing for language-normal individuals and individuals with linguistic deficits, consideration of alternative methods for the study of priming is needed. Eye tracking methods hold promise for valid alternatives in this important area.

The aim of this study was to investigate which spontaneous eye movement dependent measures best capture priming effects for words in a cross-format priming context, (written prime and picture targets for which semantic association to the prime is controlled). The study was focused on indexing semantic associative priming because it is the most well established of all priming effects (Neely, 1991). The term "spontaneous" refers to the notion that the participants are not instructed to "look at" anything in particular. Conscious planning of eye movements is avoided, making the method suitable for studying priming in neurologically

disordered patients with possible ocular motor apraxia, i.e., deficits in eye movement programming (Hallowell, 1999). The specific research questions were:

1) Do *fixation duration* and *fixation latency* measures capture semantic associative priming effects?

2) Are eye movement dependent measures related to traditional priming reaction time measures?

Method

Phase I.

The picture stimuli consisted of 260 grey scale pictures developed by Rossion and Pourtois (2004). A total of 100 adult language-normal native English speakers served as participants in assigning associated words to the pictures. The responses to each of the 260 picture stimuli presented were noted and tallied across participants. Responses occurring with the highest frequency for each picture were assigned as each associative word and were designated as semantically associated primes for the corresponding pictures. A total of 129 picture targets, along with their high frequency response words, were selected. Any words listed by 25% (1 *SD* below the mean) or fewer of respondents were excluded.

To decide which two pictures qualified as low association nontarget items to the prime, a list of five nontarget pictures corresponding to each prime word was given to a separate group of 20 language-normal adult native speakers of English. These participants rated the degree of association between the prime word and each of the five pictures selected as low association words on a six-point rating scale ranging from 0 (no association) to 5 (medium association). The two picture stimuli with the lowest ratings (2 or lower than 2) were designated as the two nontarget low association items for each prime word.

To ensure that the above pairs of related stimuli show semantic priming effects, a traditional semantic priming task was conducted using Media Lab software with another group of 20 adult language-normal native English speakers. Each of the 129 picture targets was preceded once by a related prime and then again by an unrelated prime in order to obtain a within-subject comparison for the related versus the unrelated trials. Participants were asked to name, as rapidly and accurately as possible, the depicted object when it appeared. Naming latencies were recorded by the computer. Item-wise analysis was conducted for each picture target wherein the response times across participants for naming each picture with the prime and with the unrelated word was compared using dependent t tests. A total of 34 picture targets for which significant reduction in naming time occurred in the related-prime condition in comparison with the unrelated-word condition were included for further experimentation.

Phase II.

A total of forty language-normal native speakers of English participated. The following instructions were given to the participants: "You will see words and picture sets on a computer screen. Read the words and look at the pictures on the screen in whichever way comes naturally to you. You do not have to remember any of the words or pictures." Every picture array was repeated twice. For each visually presented word prime in the center of the screen, a set of three pictures simultaneously appeared in three corners of the screen. One picture represented a high semantic associative relationship with the prime word, while the other two pictures represented a low association relationship with the prime word. The selection of sets of high association and low association pictures for each prime word were based on phase 1 results. In another set of trials, each picture array was preceded by a word unrelated to the target. For each trial, the word duration was 400 milliseconds and the picture array was displayed for a total of four seconds.

Eye movements of the participants were monitored by the ISCAN RK426 remote pupil center/corneal reflection system.

Results

All the fixation duration measures, the proportion of fixation time (t (39) = 15.82, $p < 0.001$), the average fixation duration (t 39) = 9.35, $p < 0.001$), and the first pass fixation duration (t (39) = 12.37, $p < 0.001$), allotted to the target item were significantly greater in the related condition than in the unrelated condition. All the above duration measures were significantly greater for the target item than the nontarget foils in the related condition. The latency of fixation to the target was significantly shorter in the related condition than in the unrelated condition (t (14) = -4.10, $p = 0.001$). Additionally, significant correlation between the traditional priming reaction time difference measure and the fixation duration difference measures were found. This suggests that eye movement fixation duration measures can be used for within-item comparisons and interpreted similarly to reaction time measures indicating that both sets of measures may reveal similar (if not the same) underlying semantic processes.

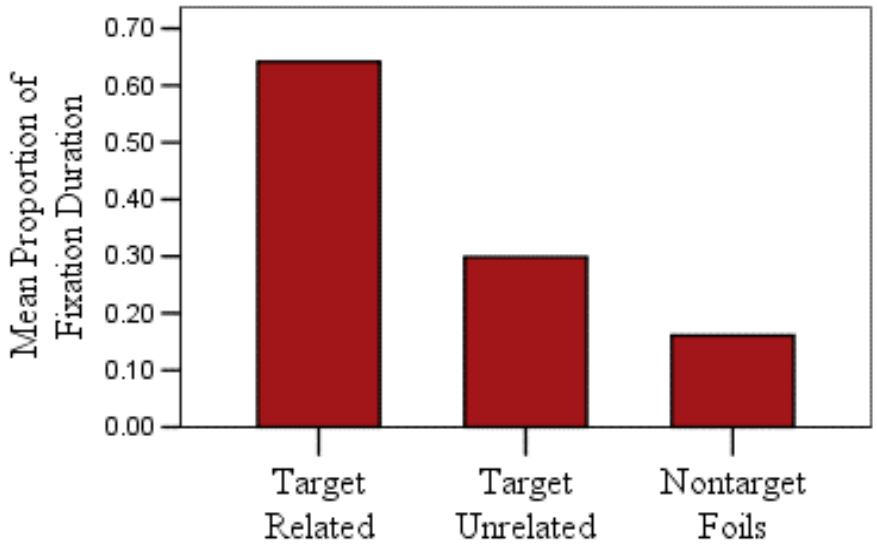

Figure 1. Proportion of fixation duration (PFD) for related and unrelated conditions for target picture, t (39) = 15.82, $p < 0.001$ and for nontarget foils in the related condition, t (39) = 16.35, $p < 0.001$.

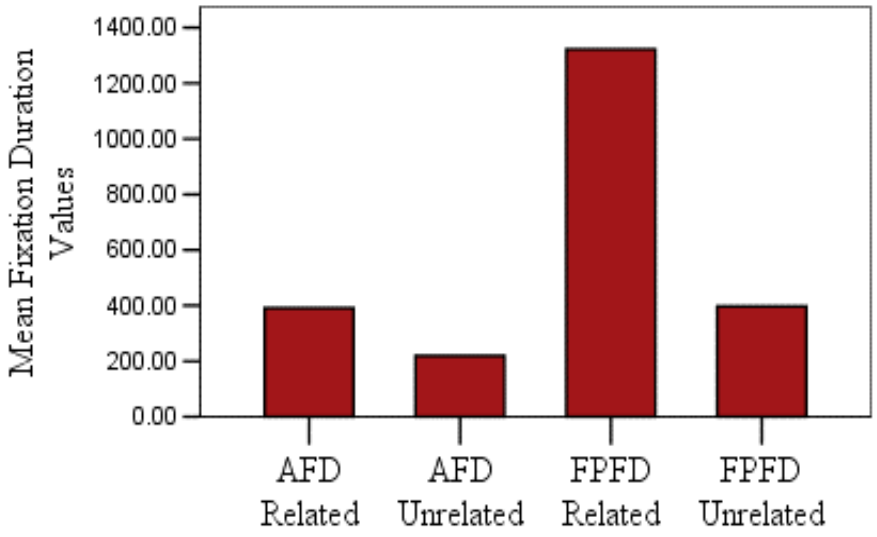

Figure 2. Average fixation duration (AFD, t (39) = 9.35, $p < 0.001$) and first pass fixation duration (FPFD, t (39) = 12.37, $p < 0.001$) for target picture in related and unrelated conditions.

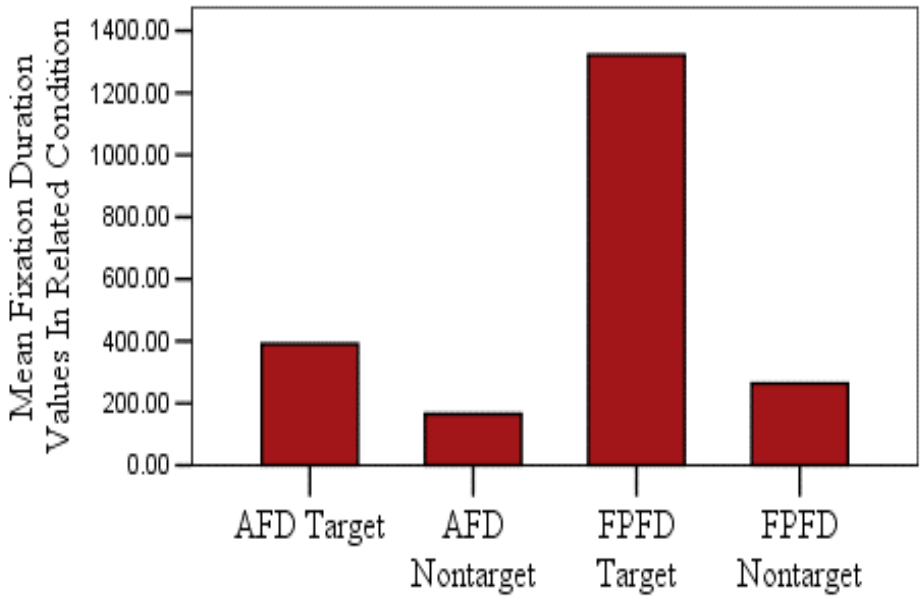

Figure 3. Comparison of target and nontarget foils for the AFD (t (39) = 9.99, $p < 0.001$) and FPFD (t (39) = 12.11, $p < 0.001$) in the related condition.

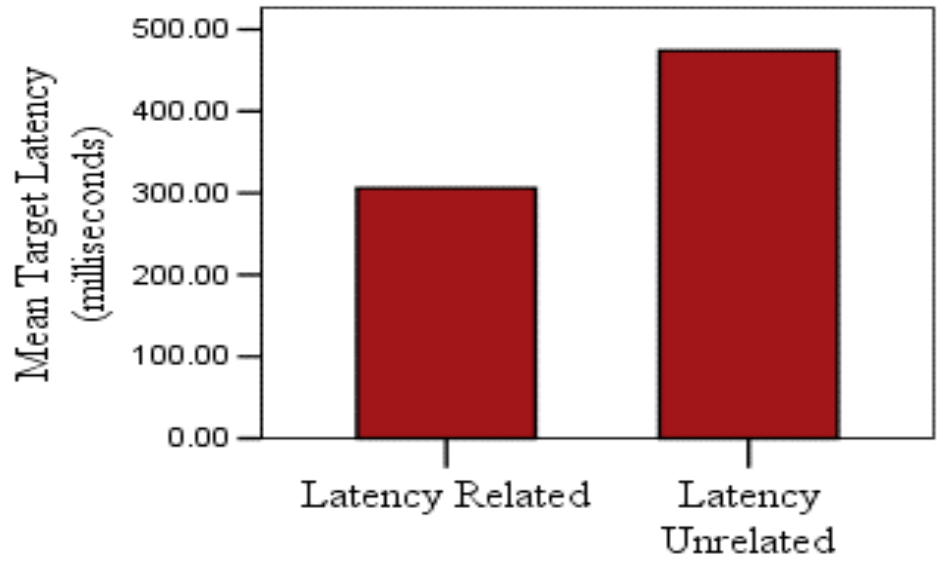

Figure 4. Comparison of latency of target fixation in the related and unrelated condition, (t (14) = -4.10, p = 0.001).

Table 1

Correlation between Reaction Time and Fixation Duration Measures for 4-second Analyses

Fixation Duration Measures	Reaction Time Measure	
	r	*p*
Proportion of Fixation Duration	-0.41*	.02
Average Fixation Duration	-0.38*	.03
First pass Fixation Duration	-0.39*	.02

Note. *Significant at alpha = 0.05, number of cases = 34.

Clinical Research Implications

Results indicate that fixation duration measures and latency measures hold promise as valid indicators of semantic priming effects in a multiple-choice priming format. Additionally similar eye movement measures may be useful for investigation of priming effects that are less well established, such as form, morphological, and syntactic priming, in normal populations as well as in individuals with neurogenic communication disorders.

References:

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