Perceptual information from word *n*+2 does not affect the skipping of word *n*+1

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During reading, visual information is simultaneously available from the fixated word, and several parafoveal words. Recent research has focussed upon the extent to which a parafoveal word is assessed in terms of its fit into the prior sentence structure [1,2], showing that a parafoval word that does not legally fit into the preceding sentence frame (e.g. *surgeon* in *the admiral would not surgeon…*) is skipped less than one that fits into the preceding sentence frame (e.g. *confess* instead of *surgeon*). A separate body of research has focused upon whether information is extracted from the word to the right of fixation (word *n*+1) and the word beyond this (word *n*+2) [3], and whether information is extracted from each word simultaneously, or from each word one at a time in serial order[4,5]. One issue which is not often addressed in this debate is how visual information available from one word may affect the processing of other words in the perceptual span if these words are processed in parallel [6]. We investigated this issue, by examining whether salient visual information from word *n*+2 in the parafovea affects the skipping of word *n*+1, when this information affects word *n*+1's fit into the sentence frame. Specifically, we take advantage of the phonological convention in English for the form of the indefinite article *an*/*a* to be determined by whether the following word starts with a vowel or consonant sound.

We tracked the eye movements of sixty participants reading thirty sentences containing the indefinite article *an* followed by a proper noun (e.g. *African*), giving us ~900 observations per condition. We used proper nouns, because the initial capital maximizes the salience of the information affecting whether *an* is the correct form of the indefinite article. The boundary paradigm [7] was used to present participants with a correct preview of these words (e.g. *an African*) or a preview which violated the phonological conventions of English (e.g. *an Russian*; see Figure 1). As the eyes crossed an invisible boundary at the start of the space preceding *an* the preview always changed to the target word. We hypothesised that readers would spend less time fixated on the target noun given a correct as opposed to incorrect preview, in line with prior preview studies. More interestingly, we hypothesised that if readers rapidly extracted initial letter information from word *n*+2 while still processing word *n*+1, then it may have an effect on the skipping of *an*, due to this determining whether *an* is the correct form of the indefinite article.

We examined the effect of our manipulation on several measures of eye movement control. We were primarily interested in determining whether our phonological violation affected the skipping of the indefinite article *an*. Bayesian linear mixed-models (see Figure 2 for model posteriors) suggested that the skipping of *an* was unaffected by whether participants were given a correct preview (skipping probability of 0.68) as opposed to a violation preview (SP of 0.69). However, there were effects in single fixation duration, gaze duration, and go-past time on the previewed noun, with fixations being shorter given a correct as opposed to incorrect preview, showing that readers were extracting information from the false preview while fixated prior to the boundary.

Our findings offer no evidence that readers extract perceptual information from all words in the parafovea in parallel. In the current study, relatively low-level information from word *n*+2 (i.e. an initial letter indicating the word's first phoneme)—which should have been extracted in the early stages of processing this word—may have been expected to alter the fit of *an* into the sentence. Despite this, the initial letter of the word *n*+2 preview had no effect on the skipping of *an*, unlike manipulations of how well a word fits the prior sentence context. Thus, assuming that syntactic fit affects skipping of *an* in the same way as verbs/nouns, our data suggests participants do not extract information from word *n*+2 prior to identifying word *n*+1. This was clearly not due to participants failing to extract information from word *n*+2, with clear effects of our preview manipulation on how long this word was fixated. Thus, we favour an account of our findings in which information is only extracted from word *n*+2 once word *n*+1 has been fully identified.

The zoo had adopted* | an African elephant that could not live in the wild.

The zoo had adopted | an Russian elephant that could not live in the wild.

The zoo had adopted | an* African elephant that could not live in the wild.

The zoo had adopted | an African elephant that could not live in the wild.

Figure 1. An example of one our sentences, presented using the boundary paradigm. The boundary was always located at the start of the space prior to *an*. Before the eye (represented by an asterisk) crossed this boundary there was either a correct preview of the noun following *an* (*African*) or an incorrect preview which violated the morpho-phonological conventions of English (*Russian*). As the eye crossed the boundary the preview changed to the target word.

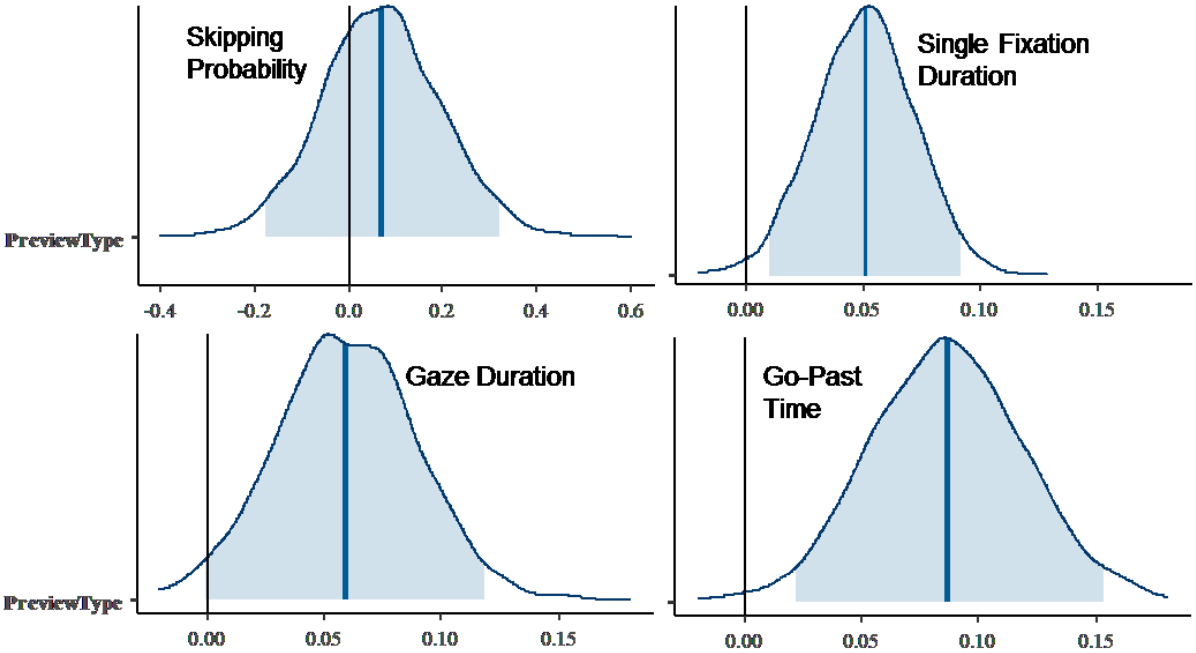

Figure 2. Posterior estimates of the preview effect from our Bayesian LMMs. Effect estimate is plotted on the x-axis in log space (reading time measures) or log-odds space (skipping), with probability density on the y-axis. The skipping data is for the article *an*, while the fixation time data is for the following proper noun. The median estimate is represented by the dark blue bar, and the 95% credible interval by the light blue shaded area. In skipping probability the median effect estimate of our preview manipulation was 0.07 (which translates to a skipping effect of 1.5%); however, the 95% credible interval spreads from -0.18 to 0.32 (which translates to an effect between -4% and 7%) and contains 0, suggesting a lack of effect of our manipulation on this measure. In contrast, in the three fixation time measures an effect size of 0 is not contained in the 95% credible interval, suggesting that there is a reliable effect of our preview manipulation in these measures, with median effect estimates of 11ms, 16ms, 28ms in single fixation duration, gaze duration, and go-past time respectively.

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