

Evidence for the contribution of semantic factors to speeded cloze production times

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The dominant account of lexical production states that cascading spreading activation from semantic features activates multiple words, which are thought to compete with each other for selection [1], with most evidence coming from the picture word interference paradigm. Indeed, analyses of responses to the cloze task [2], which elicits different responses to complete a given linguistic context or preamble, assume this is the case, since the response probabilities of all words sum to one. However, cloze probabilities are an imperfect reflection of linguistic expectations, which may be syntactic, semantic, or lexical [4]. To probe these expectations more directly, [3] inspected production times in a *speeded* cloze task in English. These results show cloze responses are *independently* selected based on their fit to the context, regardless of possible alternatives, thus posing a challenge to competition-based accounts. However, in a non-speeded cloze task, [6] showed that lexical production times were facilitated by probable semantics, but negatively impacted by the presence of semantic neighbors. Here we present strong evidence that the timing of cloze responses is affected by the presence of semantically related alternatives, even when participants are under time pressure.

We re-visit [3]’s speeded cloze data from a semantic perspective by empirically identifying related completions. We extracted vector representations of the Staub et al. cloze responses from the language model RoBERTa, and clustered responses over the entire dataset using a Bayesian Gaussian Mixture model, an approach shown by [6] to produce coherent clusters of cloze responses. Table 1 shows examples of clusters.

Media cluster	Occupation cluster
book, film, movie, play, song, novel, album, musical	artist, officer, writer, scientist, babysitter, spy, poet, clerk

Table 1: Items from clusters that contain semantically related cloze responses.

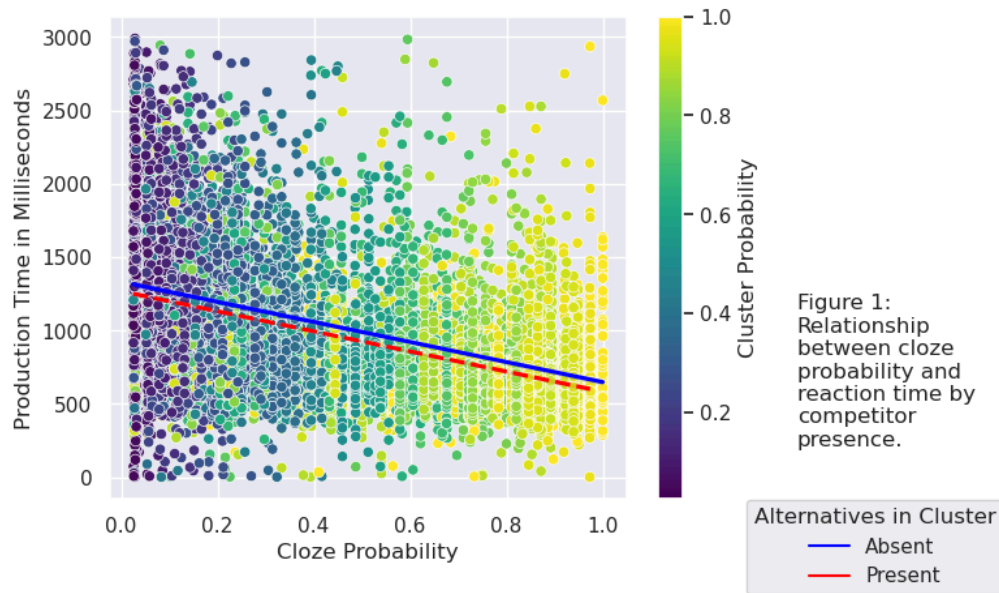
In addition to cloze probability, we considered the effect of responses sharing semantic features in two ways. First, for each cloze response, we computed the cluster-level probability for the cluster it belongs to, to show effects over and above lexically specific information. As an illustrative example, Table 2 shows different cloze responses falling in the same clusters. Second, we added a binary feature for *whether* multiple different responses within the same cluster were produced to show effects on RT from related completions. We then fit a linear mixed-effects regression model predicting each RT based on cloze probability, cluster probability, and presence of an alternative completion within the same cluster as the actual response, with random intercepts for stimulus, participant, and word (Table 3). Null results would mean RTs are not affected by other completions. Probabilities and RTs were scaled and log transformed, and the presence of cluster alternatives was mean-centered. We find significant main effects for all these predictors and an interaction for cloze probability and cluster probability. Figure 1 shows faster responses were also associated with words from high-probability clusters.

We find evidence for the contribution of a word’s semantic features to its selection as a cloze response and a slowdown in response times when multiple items from a cluster are produced, contrary to analysis showing responses are generated independently [3]. This experiment also replicated the findings of [6] in a real-time task that is not complicated by conscious reflection, thus tying their results more explicitly to real-time processing. This is evidence for higher-level semantic properties governing cloze responses over and above lexically specific information, even in a task with time pressure. Our results also support [5]’s findings on semantically related alternatives facilitating production in Hebrew, as well as demonstrating a more robust effect over all completions. Overall, these results suggest a distinct role for semantic processing when generating linguistic expectations based on context, over and above lexically specific information.

Clusters of responses to "The internet review trashed the..."

- A. artist, celebrity, author, actress, writer (25.8%)
- B. book, movie (12.9%)
- C. restaurant, campus, website (16.1%)
- D. article, story (16.1%)

Table 2. Responses in the same color are also in the same cluster, cluster probabilities are in parentheses



	Estimate	Std. Error	t	p
(Intercept)	0.08	0.05	1.57	0.12
Cloze Probability	-0.20	0.02	-11.52	< 0.001
Cluster Probability	-0.20	0.02	-8.52	< 0.001
Alternatives Present	0.03	0.01	2.65	< 0.01
Cloze Probability * Cluster Probability	-0.09	0.01	-6.23	< 0.001

Table 3. Regression coefficients for predictors of cloze RT, with random effects for stimulus, word type, and participant.

References: [1] Levelt, Roelofs, & Meyer (1999). A theory of lexical access in speech production. *BBS*. [2] Taylor (1953). "Cloze procedure": A new tool for measuring readability. *Journalism Quarterly*. [3] Staub, Grant, Astheimer, & Cohen (2015). The influence of cloze probability and item constraint on cloze task response time. *JML*. [4] Smith & Levy (2011). Cloze but no cigar: The complex relationship between cloze, corpus, and subjective probabilities in language processing. *Cog Sci Proceedings*. [5] Ness & Meltzer-Asscher (2021). Love thy neighbor: Facilitation and inhibition in the competition between parallel predictions. *Cognition*. [6] Jacobs, Hubbard, Federmeier & Grobol (2024). Uncovering patterns of semantic predictability in sentence processing. *PsyArxiv*.