

# Does GLA predict response times in a stem completion task?

Sascha Tamm, Florian Klonek, Markus Hofmann, & Arthur M. Jacobs  
Arbeitsbereich Allgemeine und Neurokognitive Psychologie, Freie Universität Berlin

## Introduction

In a word stem completion task participants have to complete a series of letters to the first word that comes to their minds (see Fig. 1). By means of computer simulations Botvinick et al. (2001) showed that words in comparison to their stems lead to lower activation of Hopfield Energy, a measure directly related to the extent of conflict in a cognitive system (see Fig. 2). It is concluded that stems with SEVERAL completions constitute a condition of underdetermined responding and are therefore associated with more conflict than stems with only ONE candidate. The occurrence of conflict is usually indicated by increased response times (RTs), as well as ACC activation.

In contrast, the Multiple Read Out Model (MROM, Grainger and Jacobs, 1996), predicts decreased RTs in a lexical decision task for words with a high number of activated candidate representations (based on Global Lexical Activation, GLA).

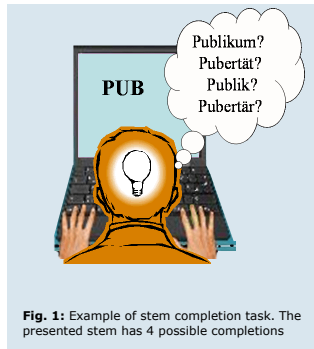


Fig. 1: Example of stem completion task. The presented stem has 4 possible completions

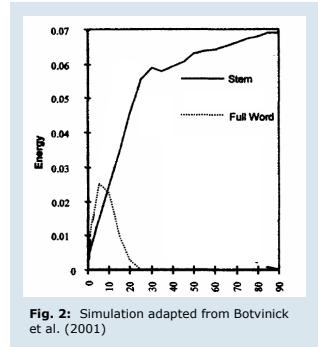


Fig. 2: Simulation adapted from Botvinick et al. (2001)

The aim of the present study was to test whether GLA predicts RTs in a stem completion task

## Simulation & Experimental Design

Figure 3 shows the experimental design. For each stem we calculated a number of possible completions for all 5-8 letter words by means of the CELEX word frequency corpus (Baayen et al., 1995). Three stem categories were built upon these criteria: 1, 3-5, more than 8 completions. GLA was calculated for each stem category by means of the MROM-P. The activation curves in Fig. 4 show that stems with several completions usually have a larger GLA.

To determine an index of preference for one completion amongst competitors, a frequency strength ratio between the most frequent word and the second most frequent word was calculated. A large ratio represents conditions in which conflict should be low, whereas low ratios represent conditions in which at least two candidates are activated equally. Participants (N=17) gave responses to 90 three-letter word stems. RTs and responses were recorded.

FREQUENCY STRENGTH RATIO	NUMBER OF COMPLETIONS			
	HIGH	LOW	OBG	>8
			HIM	KLE
			GIP	FOL

Fig. 3: Experimental design

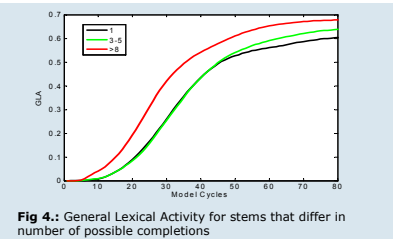


Fig. 4: General Lexical Activity for stems that differ in number of possible completions

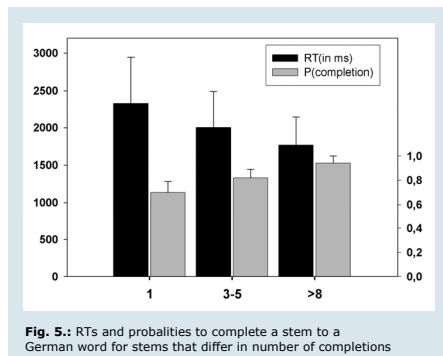


Fig. 5.: RTs and probabilities to complete a stem to a German word for stems that differ in number of completions

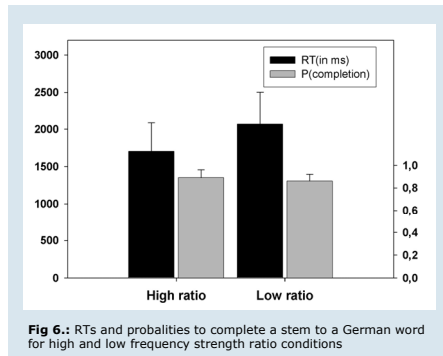


Fig 6.: RTs and probabilities to complete a stem to a German word for high and low frequency strength ratio conditions

## Results

Subjects showed longer RTs for stems with few candidates compared to stems with several ones ( $F(2)=13.3, p<0.01, \eta^2=0.45$ ). The probabilities to complete a stem are affected by number of possible completions, too ( $F(2)=73.7, p<0.01, \eta^2=0.82$ ; see Fig. 5).

**Strength Ratio:** In the low ratio condition response latencies were significantly increased ( $t(16) = -5.165; p<0.01$ ) while there was no change in probability to complete a stem across conditions ( $t(16) = 1.74; p>0.5$ ; see Fig. 6).

## Conclusion

The more completions a stem was compatible with, the shorter were the RTs. This result seems at odds with the hypothesis derived from Botvinick et al. (2001). MROM predicts greater GLA for stems with several activations, which is in accordance with the present findings.

It remains a question for future research whether ACC activation is also increased in these conditions, and whether computational models can accurately simulate both ACC activation and behavioural results.

## Data Analysis

Response accuracy was checked via wortschatz.uni-leipzig.de and orthographically corrected by means of google.de. A total of 203 out of 1448 responses had to be excluded or modified. The probability to complete a stem was calculated according to Meier & Eckstein (1998). To test corpus validity we correlated the number of different responses given to a stem with the number of possible CELEX completions. We obtained a Pearson-Correlation of 0.73 ( $p<0.01$ ). Similar correlations of 0.63 and 0.77 were found in other studies (Graf & Williams, 1987, Shaw, 1997).

## References

- Baayen, R.H., Piepenbrock, R., & Gulikers, L. (1995). The CELEX lexical database [CD-ROM] (2.5 Ed.). Philadelphia: Linguistic Data Consortium.
- Botvinick, M.M., Braver T.S., Barch D.M., Carter C.S., & Cohen J.D. (2001). Conflict Monitoring and Cognitive Control. *Psychological Review*, 108 (3), 624-652.
- Graf, P. & Williams, D. (1987). Completion norms for 40 three-letter word stems. *Behavior Research Methods, Instruments, & Computers*, 19, 422-445.
- Grainger, J. & Jacobs, A.M. (1996). Orthographic processing in visual word recognition: A multiple read-out model. *Psychological Review*, 103, 518-565.
- Meier, B. & Eckstein, D.J. (1998). Experimentiermaterial für die Untersuchung impliziter und expliziter Gedächtniseffekte mit der Wortanfangsergänzungsaufgabe. *Sprache und Kognition*, 17 (1-2), 89-105.
- Shaw, R.J. (1997). Unprimed stem completion is only moderately predicted by word frequency and length. *Behavior Research Methods, Instruments, & Computers*, 29 (3), 401-424.