The influence of *verb-specific featural restrictions*, *word associations*, and *production-based mechanisms* on language-mediated anticipatory eye movements

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Why is language comprehension so fast? One answer to this question might be: Because humans can predict upcoming language input. While there is a growing body of literature on experimental studies exploring the contents of the comprehenders' predictions, empirical evidence for proposed mechanisms underlying anticipation in language processing is sparse. One proposal is that listeners or readers imagine what they would say next as a speaker, using their language production system cf. [1]. Those theories essentially suggest that predicting a word is like producing a word. Alternatively, some theoretical frameworks propose that prediction happens on the basis of simple word associations [2]. That is, on processing a given word, activation of that mental representation automatically spreads to associated concepts. Lastly, priming experiments have shown that verbs, for example, activate typical patient nouns but only if those meet verb-specific featural restrictions [3]. Crucially, the latter two accounts predict that differences in association strength between concepts or differences in the fit of featural restrictions modulate the degree of anticipation.

This study investigated the relative contribution of those three mechanisms to language-mediated anticipatory eye movements. In a visual world experiment, participants (Exp 1 = 61, Exp 2 = 60, Exp 3 = 60) looked at sets of four objects and listened to predictive sentences (N = 40) such as "The man peels an apple*"* or non-predictive sentences such as "The man draws an apple". The sentences varied in verb-noun association strength (mean = .37, range .09 to .77) as assessed in a free association task. Moreover, we quantified verb-specific featural restrictions using a typicality rating (e.g., "How common is it for an apple to be peeled?"). On predictive trials, only the target object fitted the semantic constraints of the verb. When the objects were presented before the verb was heard (Experiments 1 and 2), participants, as expected, looked at the target object before it was mentioned. In both experiments, the likelihood of predictive looks correlated positively with participants' production fluency (Exp 1: $r = .332$, $p = .011$; Exp 2: $r = .187$, $p = .16$) as measured in a separate verbal fluency task (categories: animals, professions; letters: L, M). When participants were given only a short preview of the display (after the verb was heard, Experiment 3), the correlation between the likelihood of predictive looks and participants' production fluency was absent ($r = -.061$, $p = .645$). In all three experiments, anticipatory fixations of the target objects correlated positively with the items' typicality rating (residualized for association strength; Exp 1: $r = .451$, $p = .004$; Exp 2: $r = .352$, $p = .028$; Exp 3: $r = .366$; $p = .022$). Verb-noun association strength did not modulate anticipatory eye movements in any of the experiments.

We conclude that verb-specific featural restrictions are a robust contributor to language-mediated anticipatory eye movements. The involvement of production-based mechanisms seems to be constrained to situations where visual input is present when predictions are made. We conjecture that the presence of visual objects stimulates the engagement of the production system as comprehenders might be more inclined to imagine how they would finish the sentence given the visual objects. Word associations, did not influence anticipation in our experiments, but may do so in other settings. We suggest that the different mechanisms (e.g., featural restrictions and production-based mechanisms) play different roles depending on the situational context. Theories of prediction have to take *situational context* (e.g., the amount of visual input) into account.

References: [1] Pickering, M.J. & Garrod, S. (2013). An integrated theory of language production and comprehension. *Behavioral and Brain Sciences*, 36, 329-347. [2] Kukona, A., Fang, S.-Y., Aicher, K. A., Chen, H., & Magnuson, J. S. (2011). The time course of anticipatory constraint integration. *Cognition*, 119, 23–42. [3] Ferretti, T. R., McRae, K., & Hatherell, A. (2001). Integrating verbs, situation schemas, and thematic role concepts. *Journal of Memory and Language*, 44, 516–547.