Speech timing evidence on the (in)dependence of root and inflection access in production

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Do morphological features operate by themselves in sentence production? Number errors may provide a window into morphological computation and their timing. Recent research in language production suggests that speakers can override surface word order [contra 1] and plan linearly distant parts of the sentence together [2,3]. For example, [2] used an extended picture-word interference (ePWI) paradigm to show that speakers slowed down while uttering intransitive verbs' patient-like subjects (*unaccusative*) but not their agentive subjects (*unergative*), when confronted with a semantically related distractor verb. They interpreted the increased utterance onset time in unaccusatives as evidence for early verb planning. If true, this asymmetry in planning may provide a fruitful testing ground for understanding the planning of morpho-syntactic features, such as number. Meanwhile, using a picture description task, [4] found that people utter standard agreement attraction errors, such as *'The greeny below the pinkies are mimming,'* and show an increased gap likelihood before uttering the auxiliary *is* in their correct answers. However, the scenes in [4] only had unergative target verbs. The **CURRENT WORK** (N_{subj}*=80,* N_{item}*=12,* N_{trial}*=144*) aimed to use the verb type difference in planning in agreement attraction scenarios to answer whether *φs* may be planned independently of their host as suggested by [5]. The **TASK & ITEMS** were adapted from the scenes in [2] (Table1) with three within-subject manipulations: (i) verb type (*unaccusative/unergative*), (ii) semantic relatedness between the distractor and the verb (*related /unrelated*), and (iii) attractor number (*singular/plural*). Participants were asked to describe scenes with distractor verbs superimposed. If morphological features are planned together with verbs, we expect to see different effects of attractor number on both timing profiles and attraction error profiles, as speakers should only have access to the head noun, and not the attractor when planning unaccusatives [2]. Unergative verbs should be planned after features of both nouns are available [2], making them more prone to attraction. Our **RESULTS** present a surprising picture. Firstly, attraction errors were much rarer (Fig1) than in previous production studies [4,6]. The attenuated profile might reflect the experiment-wide pairing of animate heads with inanimate attractors, as previously observed [7]. Unlike [4], we found increased overall gap likelihood (Fig2); however, attractor number only had a substantial effect in unaccusative sentences with related distractors. Our **ONSET TIMING RESULTS** suggest a facilitation effect due to semantically related distractors only during the production of unaccusative subjects (Fig3). However, our maximal Bayesian GLM (Fig4) provides a clearer picture: strong evidence for a positive main effect of unaccusativity, suggesting a general slowdown in starting to utter sentences with patient-like subjects (*θ=0.02; CI=[0;0.04]; P(θ>0)=0.96*) and weak evidence for a negative main effect of semantic relatedness, i.e. participants were faster to start speaking when the distractor verb was semantically related to the verb they were going to utter (*θ=-0.02; CI=[-0.04;0.01]; P(θ<0)=0.89*). More importantly, there was no effect of attractor number. Length adjusted **PREVERB TIMING RESULTS** provide clear evidence for an attractor number effect only: participants slowed down preverbally when the attractor was plural but only in unaccusative verbs with related distractors (Fig5). Our Bayesian GLM (Fig6) verified this observation with a three-way interaction (*θ=-0.07; CI=[-0.01;0.16]; P(θ>0)=0.95*). We also found a positive main effect of relatedness (*θ=0.02; CI=[0;0.05]; P(θ>0)=.96*), i.e., participants slowed down preverbally independent of verb type. **TAKEN TOGETHER**, we were able to replicate the early commitment for unaccusatives reported in [2]; however, differently from [2] and previous ePWI findings we found semantic facilitation effects as big as 50ms. We suggest that participants used semantically related distractors to retrieve the target verb, a heuristic previously attested with phonological similarity, but not semantic similarity [8,9]. Similar to [4], we found an overall increased preverbal gap likelihood with mismatching numbers. This effect was more amplified in unaccusatives, suggesting that computation of morphological features was still active preverbally despite the much earlier unaccusative verb planning signaled by the onset delay.

Table1: *Target sentences and distractor words used in the experiment. The experiment was conducted in PCIbex [11]. In addition to Unaccusative and Unergative conditions, where the subject head is always singular, we included control trials with plural subjects to prevent participants from forming heuristics for auxiliary selection. Attractors are underlined.*

Condition	Target Sentence	Related	Unrelated
Unaccusative	[$_{t1}$ The octopus] below the [$_{t2}$spoon/spoons is] boiling.	melt	fall
Unergative	[$_{t1}$ The octopus] below the [$_{t2}$lemon/lemons is] swimming.	run	smile
Control	[$_{t1}$ The babies] below the [$_{t2}$waffle/waffles are] hiding.	find	consider

Figures: *Data preprocessed and visualized using R and the tidyverse packages and analyzed with the packages brms and cmdstanr to fit maximal Bayesian GLMs [12]. Error bars in Fig1,2,3,5 show means and adjusted 95% CrIs [13] as a function of experimental conditions. Posterior distribution plots (Figs4,6) shows the mode of the distributions and 95% HDIs.* ***Red coefficients (θ>0) suggest a slowdown, green coefficients (θ<0) suggest a facilitation effect.*** *P(θ>0) is our degree of evidence for a positive effect (1-P(θ>0) for a negative effect.)*

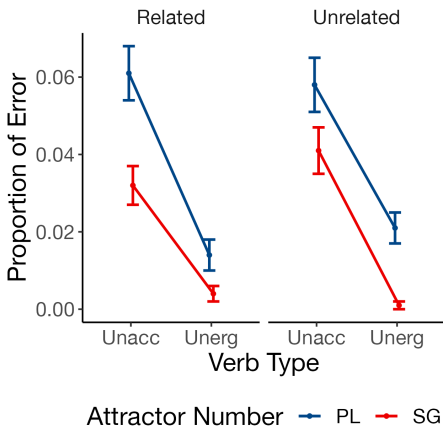

Fig1. Percentage of agreement error.

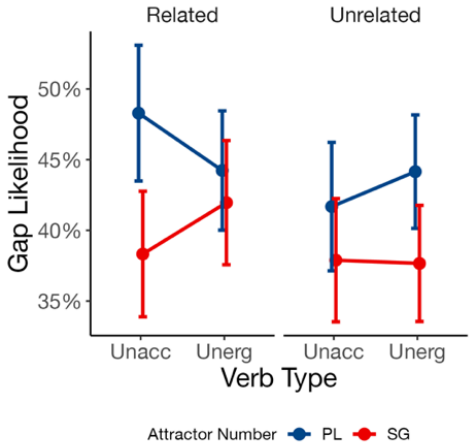

Fig2. GAP likelihood between the second NP and the auxiliary is.

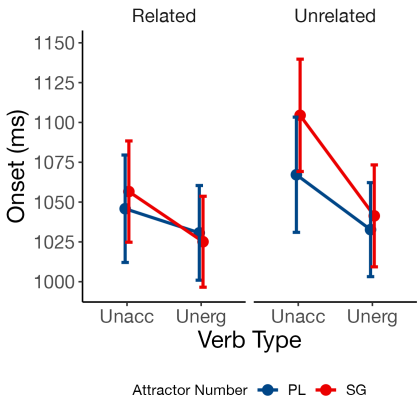

Fig3. ONSET LATENCY (t_1) from the start of the recording to onset of the first noun in the recalled sentence.

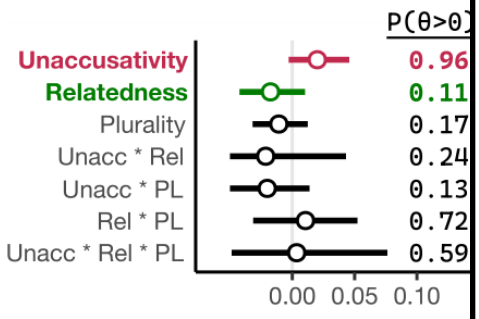

Fig4. Log estimates and 95% CrIs for the regression coefs for the model of ONSET LATENCY

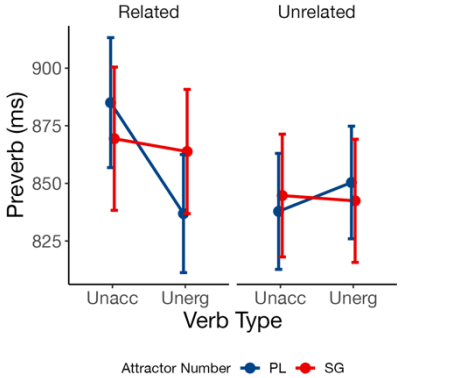

Fig5. PRE-VERB (t_2) Production Time from the onset of the attractor to onset of the verb, adjusted for the number of phonemes

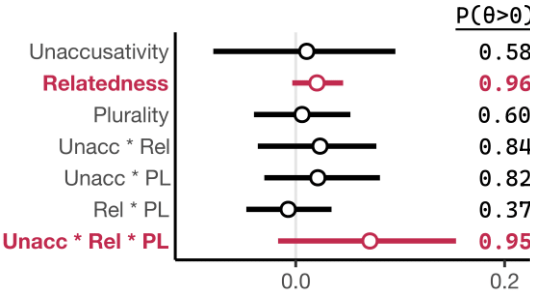

Fig6. Log estimates and 95% CrIs for the regression coefs for the model of PRE-VERB Production Time

References: **[1]** Levelt 1989 **[2]** Momma & Ferreira 2019 **[3]** Momma & Yoshida 2023 **[4]** Kandel & Phillips 2022 **[5]** Caramazza & Miozzo 1997 **[6]** Eberhard et al. 2005 **[7]** Bock & Miller 1991 **[8]** Jescheniak & Schriefers, 1998 **[9]** Jescheniak & Schriefers, 1999 **[10]** Jescheniak & Schriefers, 1997 **[11]** Zehr & Schwarz 2018 [12] Cousineau 2005 [13] Gelman & Hill 2007