Anticipatory Planning in Hindi Spontaneous Speech: Evidence from Hesitation

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Language production in spontaneous speech is rapid and often disfluent, with speakers frequently producing disfluencies such as *um* or *er* [1]. These disfluencies are linked to difficulties in linguistic processing [2–5]. Corpus-based studies have also shown that disfluencies tend to occur before words that are less predictable in terms of frequency [6, 7], lexical surprisal, and memory-based measures such as storage/integration cost [8].

Recent work on Hindi demonstrates that both preceding and upcoming planning difficulties (e.g., word frequency, integration cost, etc.) predict hesitations (filled pauses) [9]. This suggests that hesitations are susceptible to future planning demands. However, the scope of this planning demand is still unclear. This study investigates the scope of planning in Hindi by examining the effect of planning-related processing load on hesitations.

We operationalized the processing load due to planning using storage cost (SC), a forward-looking cost [10], which reflects the number of unresolved syntactic dependencies maintained in memory. We computed SC as the sum of all active and unmet dependencies held in memory at a given token. Additional predictors included lexical frequency, sentence length (reflecting utterance complexity), SC slope (change from SC value at *n-2* to *n*), SC local max (whether SC is maximum locally within ±2 tokens), and window-based SC averages (w = ±2, ±3, ±4 tokens) as measures of planning scope. We analyzed hesitation contexts using a Hindi dialog corpus [11], matching hesitation sentences with fluent controls by sentence length and the index of hesitation token (*n*). We predict that hesitations would arise from infrequent words, higher SCs, longer sentences, at peak difficulty, with increased average planning load.

We fit a series of mixed-effects logistic regression models with hesitation as the binary outcome variable. Results showed that frequent upcoming words (*n*+1) reduced hesitation likelihood ($p < .01$), whereas a higher upcoming planning load (SC at *n*+1) increased it ($p < .01$). Interestingly, higher preceding planning load (SC at *n*-1) and longer sentences reduced the likelihood of hesitation ($p < .01$), and hesitations are less likely to appear at local peak load ($p = .01$).

Window-based analysis revealed asymmetric planning effects. Higher preceding SC averages were associated with reduced hesitation likelihood, whereas higher upcoming SC averages increased hesitation likelihood. Crucially, anticipatory effects were limited to smaller upcoming windows (up to +3). AIC-based model comparison indicated that the two-word window provided the best fit among the three models. This pattern is consistent with limited planning.

Sentence length further modulated this pattern. The effects of SC averages were stronger in longer sentences than in shorter sentences. Likelihood-ratio tests showed that adding sentence length and its interactions with the preceding and upcoming SC averages to the window-based analysis significantly improved model fit across all window sizes. This suggests that planning-related processing load has a greater influence on hesitation production in longer sentences.

Overall, the results suggest that hesitations are tied to upcoming structural planning load, but are suppressed under sustained or peak planning demands. Broadly, our findings suggest anticipatory planning in Hindi spontaneous speech extends to approximately three upcoming tokens.

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Figures and Tables

Figure 1: Window-based Analysis Schematic

Index	Token	Head	Unmet Dependency	SC	Deprel
1	वही	4	(1 → 4)	1	Dep
2	**यार**	**4**	**(1 → 4), (2 → 4)**	**2**	***Vocative***
3	अम	4	(1 → 4), (2 → 4), (3 → 4)	3	Dep
4	**जाएँगे**	**0**	**RESOLVED**	**0**	**Root**
5	आयोवा	6	(5 → 6)	1	Compund
6	सिटी	4	RESOLVED: (5 → 6), (6 → 4)	0	*Obl*

Figure 2: SC Calculation

Optional Supplemental Information

Example:

Hesitation:

वही	यार	अम	जाएँगे	आयोवा	सिटी
that	friend	FP	go.FUT	Iowa	City

"We'll, um, go to Iowa City."

Fluent:

चलो	फिर	भी	देखते	हैं	अभी
let's	still	even	see-IPFV.PL	be.PRS.PL	now

"Let's see anyway for now."