Locality, Boundary Strength, and Variability in External Sandhi: Experimental Evidence from Czech Clitics

Background. Phonological processes across word boundaries (external sandhi) operate locally, affecting two adjacent words (W1-W2). However, while linear adjacency is a necessary condition for locality, it is often not sufficient on its own. The literature provides numerous examples demonstrating that the locality between W1 and W2, which governs external sandhi, can depend on syntactic structure (Selkirk 2011). For example, Gribanova & Blumenfeld (2013) examine vowel epenthesis in Russian prepositions. They demonstrate that, although prepositions are proclitics leaning on the following prosodic host, their phonological behavior regarding epenthetic vowels is influenced by syntax. A key factor is whether the preposition (W1) and its prosodic host (W2) form a head-complement relationship—that is, whether they are syntactically local. Similarly, Fried (1999) observed that syntactic locality governs the phonological behavior proclitic prepositions in Czech.

Hypothesis. In this paper, we investigate mirror structures where a prosodic host (W1) precedes the clitic (W2). Our aim is to determine whether external sandhi across the enclitic boundary is similarly sensitive to syntactic locality. We test this hypothesis using short pronominal forms such as *ho* 'him.ACC,' which are characterized as inherent enclitics in Czech (Fried 1994; Lenertová 2004). These enclitics are position-dependent, with their default position being immediately after the first syntactic constituent, a pattern common to other Slavic languages. A key prediction to be tested is that external sandhi functions differently with verbal hosts compared to non-verbal hosts, as only the former establish syntactic locality with the pronominal enclitic (that serves as a verb complement).

Experiment. We test the locality hypothesis by measuring the strength of the boundary between the enclitic and its host. We run a production experiment when 47 Czech native speakers read sentences like those in (1) in which the enclitic *ho* follows a single-word host.

(1a) [Pích]$_{V}$ *ho* do ruky. (1b) [Mráz]$_{N}$ *ho* spálil. (1c) [Snáz]$_{ADV}$ *ho* obváže.
he.poked *him* in arm frost *him* he.burnt easily *him* he.bandage

We obtained 47*11=517 recordings, which were analyzed using Praat to extract acoustic measures of three phonological phenomena indicating the boundary strength. First, we tested the initial strengthening effect (Keating 2006). This effect was examined by measuring the duration of the consonant cluster (C+*ɦ*), formed by the final consonant of the host and the initial consonant of the enclitic /ɦo/. We hypothesize that a longer cluster duration (measured in ms) indicates the initial strengthening effect which, in turn, signals the relative strength of the boundary separating the enclitic and its host. The remaining two phenomena involve voice-related processes reported to be productive in Czech: word-final devoicing and regressive voicing assimilation (Palková 1997). In this experiment, we measured the pitch values of the C+*ɦ* cluster (Bjorndahl 2022). We propose two complementary hypotheses regarding boundary strength, building on Booij's (1996) analysis of Dutch clitics. The boundary strength is indicated by (i) the presence of devoicing of a lexically voiced obstruent at the end of the enclitic's host, and (ii) the absence of regressive voicing assimilation between the enclitic's voiced fricative [ɦ] and the host's final voiceless obstruent.

Results. The results of the experiment are summarized in Tables 1–3. Table 1 shows a statistically significant difference in cluster length, distinguishing between verbal and non-verbal hosts. Tables 2 and 3 demonstrate that (i) voicing assimilation occurs more frequently with verbal hosts, whereas (ii) final devoicing is more productive with non-verbal hosts. In sum, the experimental data support the hypothesis that external sandhi is sensitive to syntax, being more productive with syntactically local verbal hosts.

TABLE 1	BOUNDARY-LENGTH: *t*-test for the length of the ***C+ɦ*** cluster (length/duration measured in *milliseconds*)									
what do we compare	MEAN		STAND. DEV.	MEAN		STAND. DEV.	ν	t	$t_{CRITICAL}$ for $\alpha = 5\ \%$	statistically relevant difference
V+*ho* vs Adv+*ho*	V1	106	26	Adv1	148	34	87	**6,485**	1,986	strong
	V2	114	27	Adv2	129	28	86	**3,840**	1,986	strong
	V3	158	37	Adv3	134	33	82	**3,214**	1,986	strong
V+*ho* vs N+*ho*	V1	106	26	N1	123	29	87	**2,907**	1,986	strong
	V2	114	27	N2	111	23	85	**0,535**	1,986	---
	V3	158	37	N3	139	41	82	**2,188**	1,986	strong
	V4	117	24	N4	136	29	85	**3,823**	1,986	strong

TABLE 2	VOICING ASSIMILATION: χ^2-test for the voicing patterns of ***C+ɦ*** (based on the presence of voicelessness /-voiced/ in *C+ɦ*)							
what do we compare	ABS. FREQ. *C+ɦ* is fully voiced	ABS. FREQ. /-voiced/ appears in *C+ɦ*	ABS. FREQ. *C+ɦ* is fully voiced	ABS. FREQ. /-voiced/ appears in *C+ɦ*	ν	χ^2	χ^2 *CRITICAL* for $\alpha = 5\ \%$	statistically relevant difference
V vs Adv	60	24	44	45	1	**9,412**	3,840	strong
V vs N	60	24	50	39	1	**5,389**	3,840	strong
N vs Adv	50	39	44	45	1	**0,812**	3,840	---

TABLE 3	WORD FINAL DEVOICING: χ^2-test for the voicing patterns of the ***C+ɦ*** cluster (based on the presence of voicelessness /-voiced/ in the cluster)								
what do we compare	ABS. FREQ. *C+ɦ* is fully voiced	ABS. FREQ. /-voiced/ appears in *C+ɦ*	ABS. FREQ. *C+ɦ* is fully voiced	ABS. FREQ. /-voiced/ appears in *C+ɦ*	ν	χ^2	χ^2 *CRITICAL*		statistically relevant difference
							$\alpha = 10\ \%$	$\alpha = 5\ \%$	
V vs Adv	68	22	25	22	1	**7,083**	2,706	3,840	strong
V vs N	68	22	59	35	1	**3,517**	2,706	3,840	weak
N vs Adv	59	35	25	22	1	**1,193**	2,706	3,840	---

Discussion. Although the experimental results reveal statistically significant differences between verbal and non-verbal hosts of enclitics across all three observed phenomena, these results are not categorical. Instead, they exhibit gradience, where a given sandhi process is more or less frequent in particular syntactic contexts rather than being entirely absent or present. Our findings, therefore, suggest that external sandhi is variable and cannot be solely attributed to syntactic locality. This observation aligns with cross-linguistic findings and may be explained by *production planning* (Wagner 2012; Kilbourn-Ceron 2017; Scheer 2024). Furthermore, the experimental data confirm that clitics vary between behaving as full words and as affixes, a phenomenon noted in the literature (Anderson 1993). This dual status is illustrated in table 4, which compares the two voice-related processes across the enclitic boundary with two control structures involving full words and suffixes. The comparison reveals a statistically significant pattern: the enclitic /ɦo/ alternates between suffix-like and word-like behavior, depending on its syntactic proximity to the host. Suffix-like behavior is observed with syntactically closest verbal hosts, whereas syntactically more distant adverbial hosts show phonological behavior of the enclitic akin to that of a full word.

TABLE 4	CONTROL WORDS: RESULTS		
what do we compare	control full word (FW) vs clitic *ho* (CL) vs control suffix (SUF)		
	phenomenon	*t*-test comparison	χ^2-test comparison
V	VOICING ASSIMILATION	FW > CL > SUF	FW > CL ≥ SUF
	FINAL DEVOICING	FW > CL ≥ SUF	FW > CL ≥ SUF
N	VOICING ASSIMILATION	FW > CL > SUF	FW > CL > SUF
	FINAL DEVOICING	FW > CL > SUF	FW > CL ≥ SUF
Adv	VOICING ASSIMILATION	FW ≥ CL > SUF	FW ≥ CL > SUF
	FINAL DEVOICING	FW ≥ CL > SUF	FW ≥ CL > SUF

* yellow color and sign ">" manifest that compared items are statistically different, green color and sign "≥" manifest that items are not statistically different