

Appendix: Models

A. Duration

In duration models, non-lexical vowels are coded as <u> before /a/, <i> before /i/, and <u> before /o/.

duration.ICI.model = Duration of ICI, assuming harmony

Formula: $\text{vdur_ici} \sim \text{Cr/} * \text{v1} + \text{c} + \text{v2} + (1 \mid \text{subj}) + (1 \mid \text{target_word})$

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	62.275	3.171	19.660	19.638	2.20e-14 ***
/Cr/=TRUE	-9.102	2.740	21.060	-3.322	0.00323 **
v1=[i]	4.804	2.460	38.420	1.953	0.05815 .
v1=[u]	6.847	3.830	25.370	1.788	0.08580 .
c1=/b/	-4.971	1.866	22.050	-2.664	0.01415 *
c1=/g/	10.273	1.853	21.750	5.545	1.48e-05 ***
v2=/i/	11.201	3.013	23.680	3.717	0.00109 **
v2=/o/	3.164	3.562	21.380	0.888	0.38442
/Cr/=TRUE:v1=[i]	-12.193	3.530	22.030	-3.454	0.00226 **
/Cr/=TRUE:v1=[u]	-10.977	4.391	23.300	-2.500	0.01990 *

duration.vowel.model = Duration of vowel, assuming harmony

Formula: $\text{vdur} \sim \text{Cr} * \text{v1} + \text{c} + \text{v2} + (1 \mid \text{subj}) + (1 \mid \text{target_word})$

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	45.286	2.918	12.490	15.520	1.56e-09 ***
/Cr/=TRUE	-7.983	2.088	20.840	-3.823	0.001001 **
v1=[i]	1.883	1.935	33.010	0.973	0.337622
v1=[u]	3.164	2.952	24.510	1.072	0.294264
c1=/b/	-0.236	1.426	21.980	-0.165	0.870130
c1=/g/	4.541	1.415	21.550	3.209	0.004117 **
v2=/i/	9.195	2.312	22.750	3.977	0.000606 ***
v2=/o/	1.080	2.716	20.870	0.398	0.694940
/Cr/=TRUE:v1=[i]	-8.379	2.698	21.710	-3.106	0.005212 **
/Cr/=TRUE:v1=[u]	-7.093	3.370	23.410	-2.105	0.046264 *

duration.burst.model = Duration of burst + positive VOT, assuming harmony

Formula: $\text{vdur_burst} \sim \text{Cr} + \text{c} + \text{v1} + \text{v2} + (1 \mid \text{subj}) + (1 \mid \text{target_word})$

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	19.0594	2.2717	10.5200	8.390	5.57e-06 ***
/Cr/=TRUE	-3.8869	1.0230	24.1400	-3.800	0.000866 ***
c1=/b/	-4.8037	1.2469	22.6000	-3.852	0.000831 ***
c1=/g/	5.5225	1.2394	22.6000	4.456	0.000187 ***
v1=[i]	3.5997	1.4184	59.9300	2.538	0.013769 *
v1=[u]	2.7034	2.1611	27.6000	1.251	0.221453
v2=/i/	-0.8843	1.6381	34.7700	-0.540	0.592774
v2=/o/	0.3989	2.1423	24.6800	0.186	0.853793

B. F1 and F2, assuming backness and rounding harmony

In the first set of F1 and F2 models, non-lexical vowels are coded as <u> before /a/, <i> before /i/, and <u> before /o/.

harmony.F1.model1 = F1 of vowel, assuming backness and rounding harmony

Formula: vf1 ~ Cr * v1 + v2 + c + (1 subj) + (1 target_word)					
	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	398.771	21.301	6.100	18.721	1.29e-06 ***
/Cr/=TRUE	10.210	7.408	20.230	1.378	0.183200
v1=[i]	-56.473	6.717	35.360	-8.407	5.96e-10 ***
v1=[u]	-11.131	10.391	24.180	-1.071	0.294632
v2=/i/	-18.346	8.165	22.560	-2.247	0.034732 *
v2=/o/	-38.430	9.634	20.460	-3.989	0.000696 ***
c1=/b/	-4.417	5.049	21.230	-0.875	0.391477
c1=/g/	-18.425	5.012	20.900	-3.676	0.001415 **
/Cr/=TRUE:v1=[i]	20.050	9.553	21.140	2.099	0.048016 *
/Cr/=TRUE:v1=[u]	-0.844	11.896	22.480	-0.071	0.944068

harmony.F2.model1 = F2 of vowel, assuming backness and rounding harmony

Formula: vf2 ~ Cr * v1 + v2 + c + (1 subj) + (1 target_word)					
	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	1477.53	71.56	18.96	20.646	1.87e-14 ***
/Cr/=TRUE	11.75	59.35	21.83	0.198	0.844837
v1=[i]	393.70	42.44	99.48	9.277	4.00e-15 ***
v1=[u]	-202.93	76.70	34.42	-2.646	0.012202 *
v2=/i/	162.94	62.35	26.55	2.613	0.014575 *
v2=/o/	-141.07	76.11	23.79	-1.854	0.076240 .
c1=/b/	-70.54	39.96	22.64	-1.765	0.091022 .
c1=/g/	81.68	39.72	22.79	2.057	0.051333 .
/Cr/=TRUE:v1=[i]	-320.52	75.33	23.09	-4.255	0.000296 ***
/Cr/=TRUE:v1=[u]	14.57	92.78	23.81	0.157	0.876536

C. F1 and F2, assuming backness harmony

In the second set of F1 and F2 models, non-lexical vowels are coded as <u> before /a/ and /o/, and as <i> before /i/.

harmony.F1.model2 = F1 of vowel, assuming backness harmony but not rounding harmony

Formula: vf1 ~ Cr * v1 + v2 + c + (1 subj) + (1 target_word)					
	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	399.489	21.146	5.660	18.892	2.49e-06 ***
/Cr/=TRUE	8.934	5.274	21.862	1.694	0.104473
v1=[i]	-55.827	6.130	31.303	-9.108	2.60e-10 ***
v2=/i/	-19.450	6.835	22.797	-2.846	0.009207 **
v2=/o/	-39.261	5.523	25.429	-7.109	1.71e-07 ***
c1=/b/	-2.754	4.571	21.130	-0.603	0.553246
c1=/g/	-20.085	4.530	20.647	-4.434	0.000238 ***
/Cr/=TRUE:v1=[i]	21.028	7.556	21.925	2.783	0.010865 *

harmony.F2.model2 = F2 of vowel, assuming backness harmony but not rounding harmony

Formula: $vf2 \sim Cr * v1 + v2 + c + (1 | subj) + (1 | target_word)$

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	1522.80	73.96	15.67	20.589	9.16e-13	***
/Cr/=TRUE	-55.87	50.08	22.13	-1.116	0.27656	
v1=[i]	378.82	42.38	132.05	8.938	3.11e-15	***
v2=/i/	126.67	60.75	28.05	2.085	0.04629	*
v2=/o/	-249.10	50.59	23.03	-4.924	5.61e-05	***
c1=/b/	-74.78	43.45	22.66	-1.721	0.09888	.
c1=/g/	85.18	43.13	22.92	1.975	0.06045	.
/Cr/=TRUE:v1=[i]	-248.63	70.49	23.65	-3.527	0.00175	**

D. F1 and F2, assuming no harmony

In these models, all non-lexical vowels are coded as <u>, regardless of V2.

noharmony.F1.model = F1 of vowel, assuming all non-lexical vowels are [u] (no harmony)

Formula: $vf1 \sim Cr * v2 + c + (1 | subj) + (1 | target_word)$

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	397.074	22.277	5.841	17.825	2.58e-06	***
/Cr/=TRUE	10.784	6.772	12.049	1.593	0.137148	
v2=/i/	-17.954	7.459	12.988	-2.407	0.031689	*
v2=/o/	-38.790	8.840	11.714	-4.388	0.000935	***
c1=/b/	3.222	5.446	14.724	0.592	0.563091	
c1=/g/	-20.487	5.303	14.091	-3.863	0.001703	**
/Cr/=TRUE:v2=/i/	-34.037	9.415	13.528	-3.615	0.002959	**
/Cr/=TRUE:v2=/o/	-4.518	11.187	13.978	-0.404	0.692435	

noharmony.F2.model = F2 of vowel, assuming all non-lexical vowels are [u] (no harmony)

Formula: $vf2 \sim Cr * v2 + c + (1 | subj) + (1 | target_word)$

	Estimate	Std. Error	df	t value	Pr(> t)	
(Intercept)	1525.806	53.215	8.989	28.672	3.80e-10	***
/Cr/=TRUE	16.697	30.244	13.469	0.552	0.58994	
v2=/i/	122.929	32.997	15.074	3.725	0.00202	**
v2=/o/	-110.282	39.590	13.157	-2.786	0.01530	*
c1=/b/	-176.019	23.878	15.991	-7.372	1.58e-06	***
c1=/g/	41.953	23.317	15.766	1.799	0.09115	.
/Cr/=TRUE:v2=/i/	71.535	41.550	15.211	1.722	0.10540	
/Cr/=TRUE:v2=/o/	-158.133	49.339	14.926	-3.205	0.00593	**