Phonology **38** (2021). Supplementary materials

Articulatory coordination distinguishes complex segments from segment sequences

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Supplementary materials

Appendix A

Different measures of G_1 duration

Our main analysis defines G_1 duration as the temporal interval from the onset to the offset of phonologically controlled movement. However, this measure of gesture duration is not uncontroversial; see note 2. In Fig. 11 we report the correlation between G_1 duration and onset lag based on two additional measures of G_1 duration: (i) gesture onset to gesture target, and (ii) gesture onset to gesture release. The same basic pattern persists, regardless of how G_1 duration is defined. The correlation between G_1 duration and onset lag for English is much stronger than for Russian.

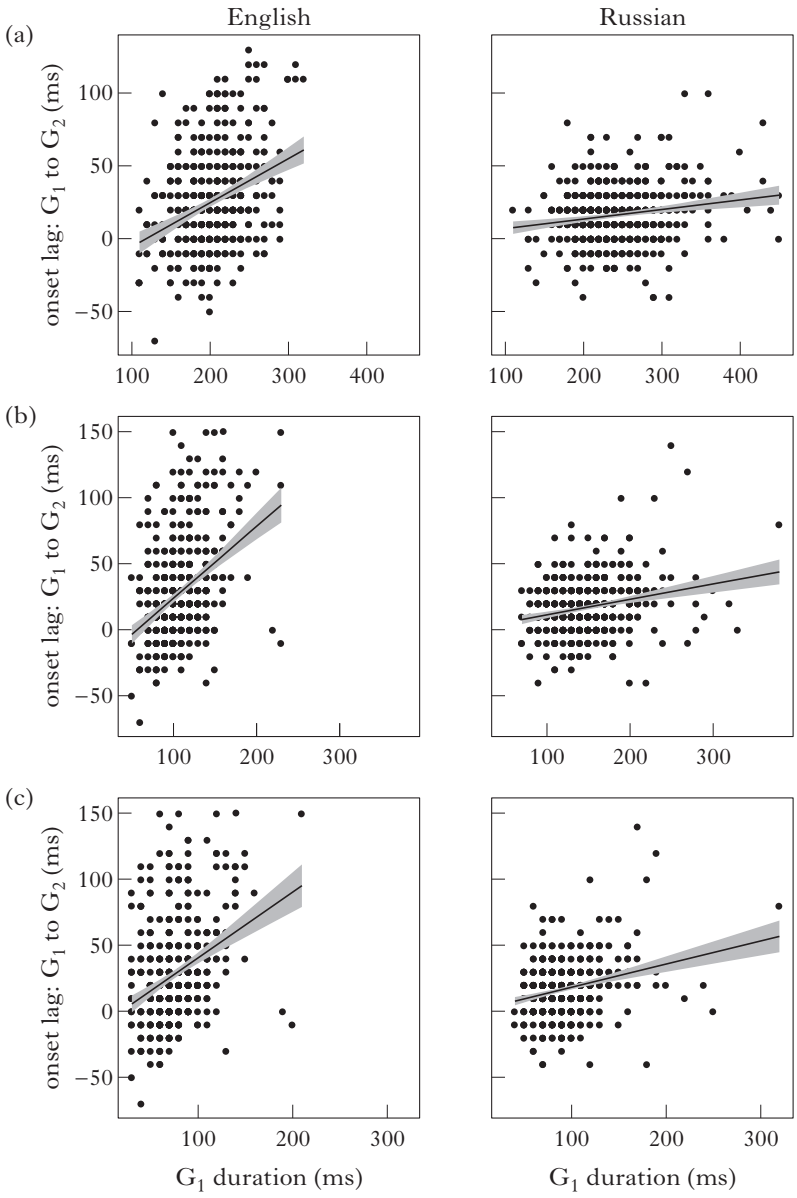

Figure 11

Results based on different definitions of G_1 duration: (a) onset to offset (original): $R^2 = 0.10$; 0.04; (b) onset to release: $R^2 = 0.17$; 0.05; (c) onset to target: $R^2 = 0.12$; 0.07.

Appendix B

Analysis of Russian incorporating local speech rate

Our main analysis shows a strong positive correlation between G1 duration and onset-to-onset lag for English, and a weak positive correlation between these same variables for Russian. For Russian, we speculate in the main text that the weak positive correlation could be due to the joint influences of speech rate on both G1 duration and onset-to-onset lag. To evaluate this possibility, we conducted another statistical analysis of Russian, in which we factor in a measure of local speech rate.

We operationalised local speech rate as the interval between the onset of the labial gesture to the offset of the palatal gesture. This measure of Speech rate, included as a fixed factor, provides significant improvement over a baseline model with only random intercepts for Subject and Item. Adding G1 duration to the model that already includes local speech rate does not result in further improvement. A summary of the model comparison is provided in Table III. For English, in contrast, addition of G1 duration provides substantial improvement, even with local speech rate included in the model.

	df	AIC	log-likelihood	χ^2	$p(>\|\chi^2\|)$
1 + (1 | Subject) + (1 | Item)	4	4900.8	−2446.39	*n/a*	*n/a*
1 + Speech rate + (1 | Item)	5	4887.6	−2438.81	15.15	<0.00001
1 + G_1 duration + Speech rate + (1 | Subject) + (1 | Item)	6	4888.6	−2438.29	1.04	0.307

Table III

Comparison of nested linear mixed-effects models of onset lag in Russian. Each model is compared pairwise with a progressively more complex model, i.e. one additional degree of freedom. The addition of Speech rate leads to significant improvement and lowered AIC. The addition of G_1 duration does not lead to further significant improvement.

Appendix C

Simulations using the coupled oscillator model

To evaluate whether in-phase and anti-phase coupling in the coupled oscillator model, as implemented in TADA (Nam *et al.* 2006), can also generate the patterns we have hypothesised for complex segments and segment sequences, we ran a series of TADA simulations. We simulated the gestures based on /b/ and /j/ segments with the gestures timed anti-phase (to approximate English) and in-phase (to approximate Russian). In both cases, the /b/ and /j/ gestures were followed by a vowel /u/, which was timed in-phase to both consonantal gestures. To introduce variation in G_1 gesture duration, we scaled the natural frequency of the oscillators from 0.5 to 3 in steps of 0.1. We then simulated the kinematic trajectories and parsed gestural landmarks using the same procedure applied to our EMA data. Figure 12 plots the onset lag, the difference in gestural onset times, against the duration of the first consonant gesture, as defined in the main body of the paper. The correlation between these variables resembles our experimental data, in that, as G_1 duration increases, the onset lag also increases when the gestures are timed anti-phase but not when they are timed in-phase.

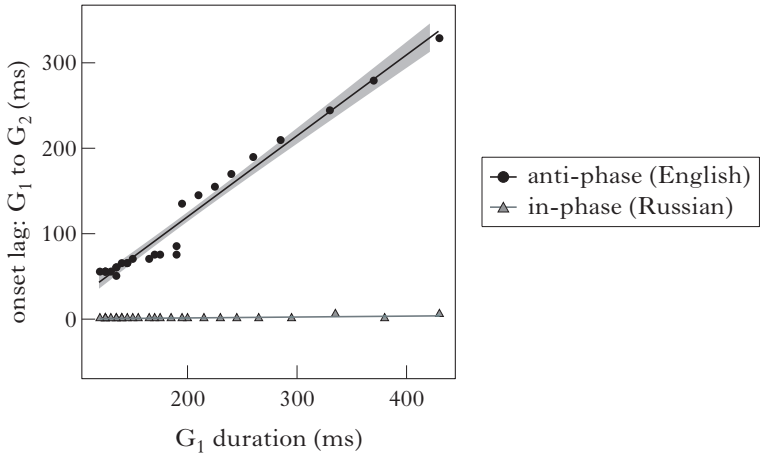

Figure 12
The relation between G_1 duration and onset lag for data simulated with TADA using in-phase coupling and anti-phase coupling.