When dynamics conflict: Flap dynamics and palatalization in Japanese
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1. Introduction
Though palatalized rhotics are cross-linguistically rare (Hall & Hamann, 2010), Japanese rhotic taps can be palatalized. The rarity of palatalized rhotics has been associated with the observation that rhotics require tongue dorsum backing, while palatalization requires tongue dorsum fronting (Kavitskaya et al., 2009), implicating a possible conflict in articulatory place (see Gick & Wilson 2006). However, previous studies have indicated that Japanese taps do not have a tongue dorsum gesture, even though palatalized taps in Japanese still show a conflict between the tap and palatalization gesture (Yamane et al., 2015). The articulatory target of Japanese /ɾ/ is made with a tongue tip gesture only, but what the tongue tip gesture does in Japanese taps is understudied. In a study of North American taps and flaps, Derrick and Gick (2011) identify 4 subphonemic categories that could be viewed as resulting from the resolution of a conflict in articulatory dynamics (between the tap/flap and an adjacent rhotic) rather than in articulatory place. The present paper looks at Japanese palatalization, comparing taps to other coronal consonants, to test for a conflict in articulatory dynamics. Specifically, Japanese taps require a time-varying motion of the tongue tip that is constrained by palatalization; this conflict does not apply to the coronal nasal, although the two consonants share the same place.

2. Methods
Dynamic tongue contour graphs were made with SSANOVAs. The time frames included the closing gesture (4 frames before the primary contact), opening gesture (5 frames after the primary contact) (see Figure 1 for example), and for the contact event of /ara/, /arã/, /oro/, /orõ/, /uru/, /urû/ from the ultrasound (30 fps) recording of 6 native speakers of Japanese.

![Figure 1](image.png)
Figure 1. Timeframes 1-10 of /ara/ vs. /arã/. Frames are approximately 33 ms apart. SSANOVAs from 12 tokens for each time frame from one female speaker. Tongue tip is on the left hand side of the images. Time frame 5 is when the tongue tip gesture is raised highest for both /ara/ (red) and /arã/ (green). The maximum constriction of the palatalization of /arã/ happens at time frame 8.

In addition, one native speaker of Japanese producing different palatalized segments was also recorded using ultrasound. The items included geminates of palatalized nasal (anã:a), palatalized rhotic (arã:a), and alveolopalatal affricate (ate:a). These tokens were included to compare the gestural timing between the palatalization gesture and the coronal consonant gestures (tap or otherwise). 14 tokens of each item were produced in a randomized order. The timing of maximum constriction of palatal gesture and the beginning of the primary constriction was analyzed for each item.
3. Results
The results of our study demonstrate that palatalized tap has more dynamic complexity in its closing gesture compared to plain tap (Figure 2). The plain tap involves a simple tongue tip gesture to produce a brief tongue-palate contact. However, for the palatalized tap, the tongue body raises prior to the tongue-palate contact for the palatalized tap, and palatalization is fully achieved two frames after the contact has taken place (time frame 7, indicated by a green line on the rightmost graph), which is a delay of over 33 ms. This delay is much longer than in Russian palatalized rhotics, which Stoll et al. (2015) report averages at 10 ms.

Also, the palatalized tap behaves differently from palatalized nasal and alveopalatal affricate. While the palatal gesture in the (geminate) palatalized nasal and alveopalatal affricate occurs at around the mid-point of the entire duration of the constriction, in the palatalized tap, the palatal gesture occurs at the very end of the tap, indicating that speakers avoid producing (or are unable to produce) the tap and the palatalization gestures simultaneously. This is likely the result of difficulty timing the two gestures, as the tap is a quick bombastic movement and the palatalization gesture is a much longer, controlled movement.

4. Implications
This study reveals the importance of considering temporal dynamics of articulation when talking about how segments and environments interact. Phonologies need to consider not only place distinctions, but dynamic constraints in order to accurately describe how segments interact and coarticulate.

References