Don’t buy, recycle? Acquiring new features versus feature redeployment in L2 speech perception

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Background

- An old struggle: feature-based approaches (phonological, abstract) versus phonetic approaches (based on acoustic similarity)
  - Theory 1: Presence/absence of phonological features in the L1 as predictors for acquisition of L2 sounds (Brown 1998, 2000)
  - Theory 2: L2 sounds that are perceived as similar to L1 sounds are predicted to be more difficult to acquire, but they can always be acquired
    - Acoustic/phonetic approach (i.e. SLM/SLM-r)
    - Articulatory gestures (i.e. PAM/PAM-L2)
- The evidence seems to widely favor phonetic approaches

Feature-based approach to L2 sound acquisition

- Brown (1998, 2000): (a) Features that are present in the L1 can transfer to the L2, even if they are in a different natural class, and *therefore* (b) if they are not present in the L1, there won't be acquisition (access to UG constrained by the L1)
    - A "weaker" version supports mainly (a) (Archibald 2005, 2009)
- Supporting studies (e.g. LaCharité and Prévost 1999, Ćavar and Hamann 2011, Pajak and Levy 2014) are varied in terms of method, learning state, objective and target structures
    - Some studies take an acoustic/phonetic approach but still relate to the idea of "if you have it, you can transfer it": Bohn 1995 (perceptual cues - but conflicting results), McAllister, Flege & Piske 2002 (duration).

Acoustic/phonetic similarity approaches

- Flege (1995), Flege & Bohn (2021): L2 sounds that are perceived as phonetically similar are more likely to be perceived as an L1 category, following patterns predicted by PAM-L2 (Best & Tyler 2007)
  - But this **does not** mean they won't be discerned
- Studies that do not support the deficit hypothesis (among others)
  - L1 Spanish and Catalan speakers using duration as cue in order to distinguish tense/lax vowels (Escudero & Boersma 2004, Cebrian 2006) ***
  - Barrios, Jiang & Idsardi 2016: Neither acoustic nor phonological similarity make good predictions about L2 learning of /æ-a/ and /i-ɪ/ by L1 Spanish learners

Question

- L1 Spanish learners of L2 German: acquisition of /ɪ/ versus /y/
  - Spanish has a 5-vowel system (/i-e-a-o-u/) where back vowels /o-u/ are also [+round]
  - German has a much larger vowel system with front rounded vowels and the tense/lax (long/short?) distinction
  - German /ɪ/ perceptually assimilated to Spanish /i/: the learner task is to **acquire** a new phonological feature [+/-tense]
  - German /y/ perceptually assimilated to Spanish /u/: the learner task is to **redeploy** the existing feature [+round] to a front vowel
- Question: is one of these tasks easier than the other?
  - What are the implications of this in terms of the **level of representation** at which learning takes place?

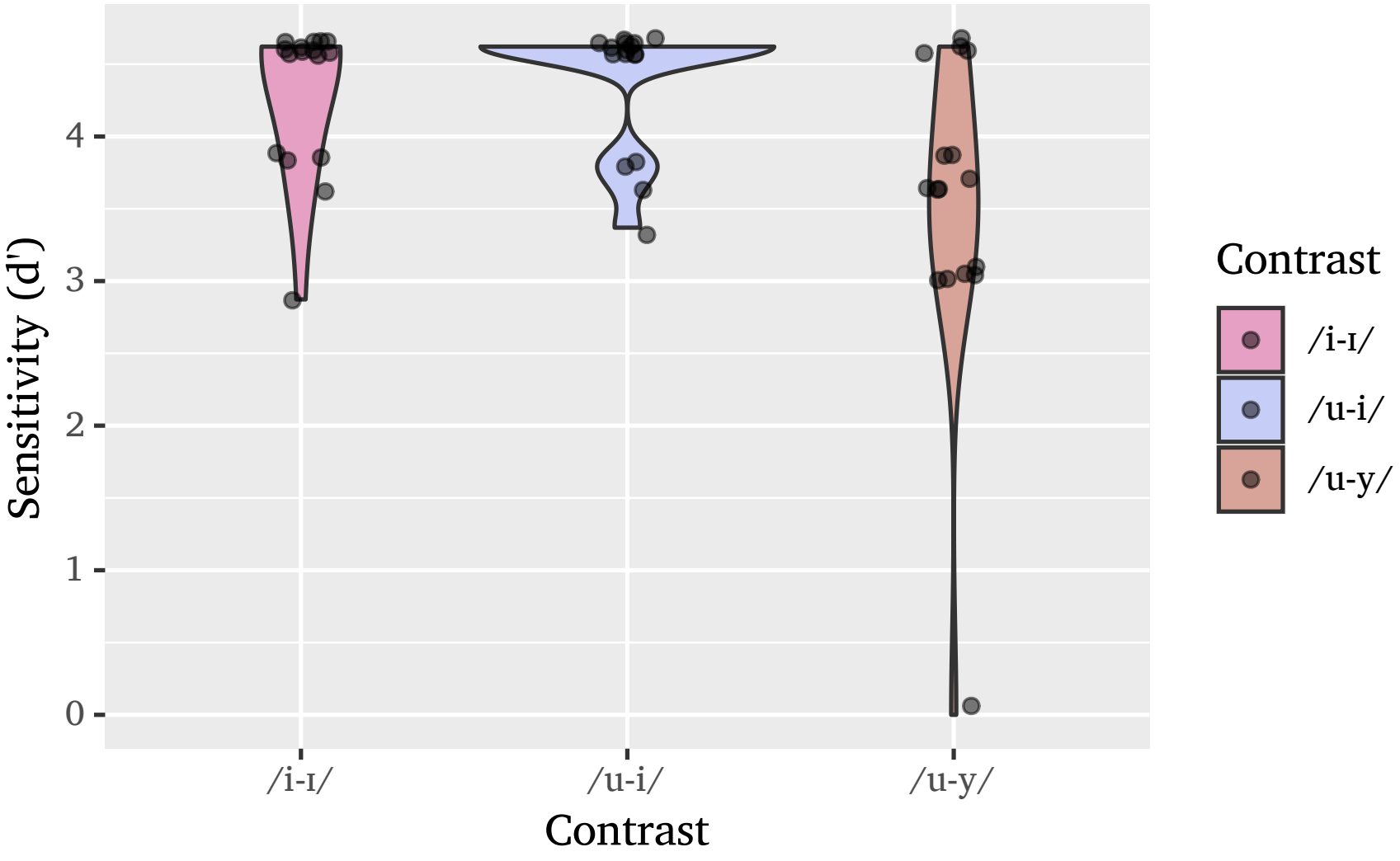
Experiment

- AX discrimination:
  - Subjects: N = 16, mean age: 35.9 years, native speakers of Spanish, most of whom (14) learned German after age 18.
  - Procedure: AX task with minimal pairs, contrasts /y/ – /u/, /i/ - /ɪ/, and /i/ – /u/, ISI of 1500 ms. Participants heard two words consisting of a minimal pair (e.g. *Blüten/bluten*, *Miete/Mitte*, *Tier/Tour*); duplicates of the same word were also included. Total of 36 randomized trials.
  - Materials: 18 German words containing the vowels /y/, /i/, /u/, and /ɪ/ were recorded by a trained female native speaker of German.
  - RTs were recorded.

Experiment

- Picture identification:
  - Subjects: same as above
  - Procedure: Perception of /y/ – /u/, /ɪ/ – /i/ and /i/ - /u/ with a picture identification task. Full words; responses were based on pictures. Total of 54 randomized trials.
  - Materials: same as above, but with the words presented in isolation while showing the participants two pictures (e.g. if the aural stimulus was *Blüten*, the pictures shown corresponded to *Blüten* and *bluten*)
  - RTs were recorded

Results: Discrimination - sensitivity (d')



Results: discrimination - sensitivity (d')

- Friedman test (non-parametric data): significant, but moderate, effect of contrast on d'

```
friedman.test(dprime ~ contrast | subj, data = dprimedf)
```

```
    Friedman rank sum test

data:  dprime and contrast and subj
Friedman chi-squared = 11.783, df = 2, p-value = 0.002763
```

```
friedman_effsize(dprime ~ contrast | subj, data = dprimedf)
```

```
# A tibble: 1 x 5
  .y.         n effsize method    magnitude
* <chr>   <int>   <dbl> <chr>     <ord>
1 dprime     16   0.368 Kendall W moderate
```

Results: discrimination - sensitivity (d')

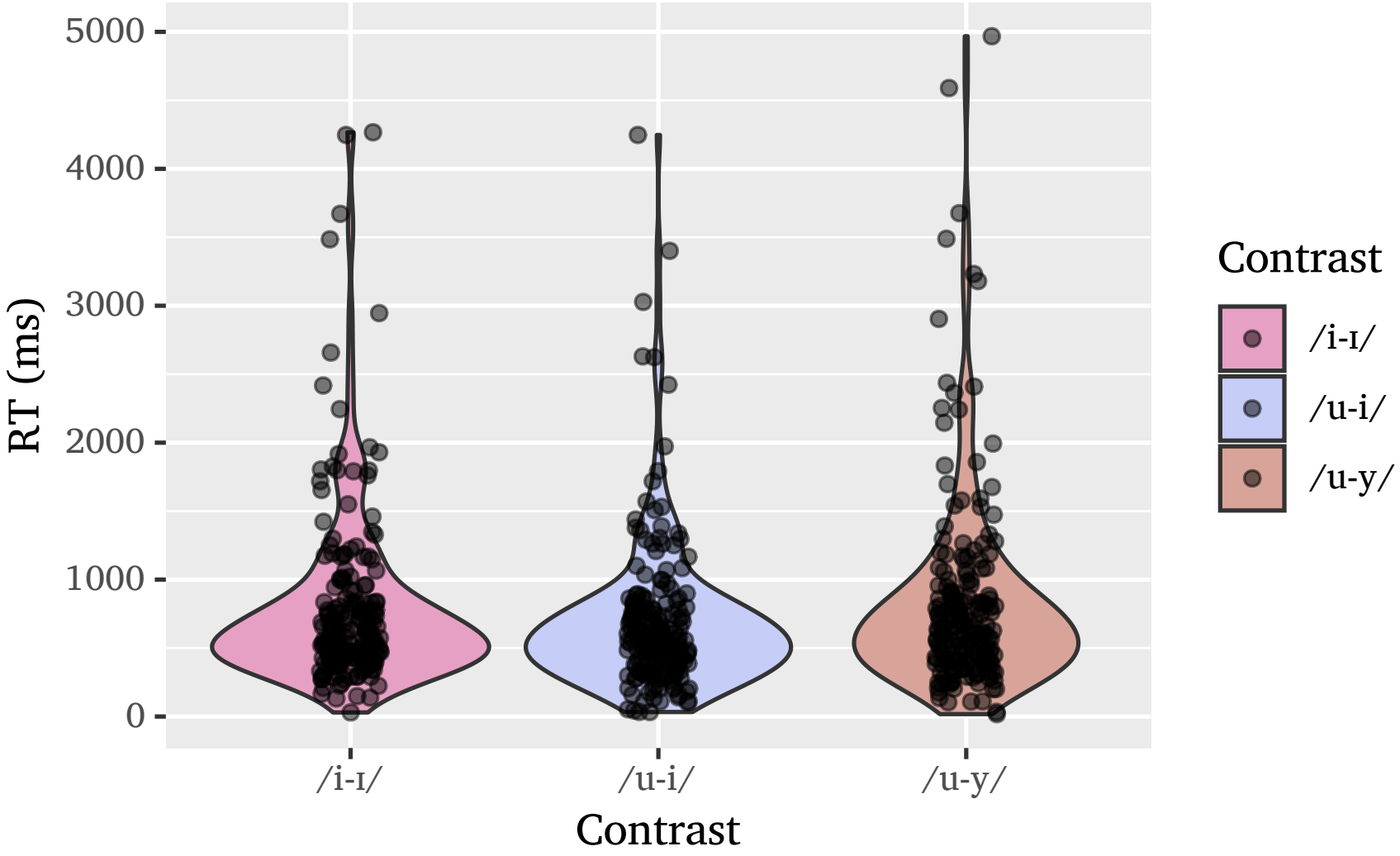
- Post-hoc Wilcoxon test: shows no significant difference between /i-u/ and /i-ɪ/, and a significant difference between /i-u/ and /u-y/ ($W = 86.0$, $p < 0.01$, two-sided, with Bonferroni correction).

```
wilcox_test(
    dprime ~ contrast, p.adjust.method = "bonferroni", paired = TRUE,
    data = dprimedf, ref.group = "/u-i/", detailed = F
)
```

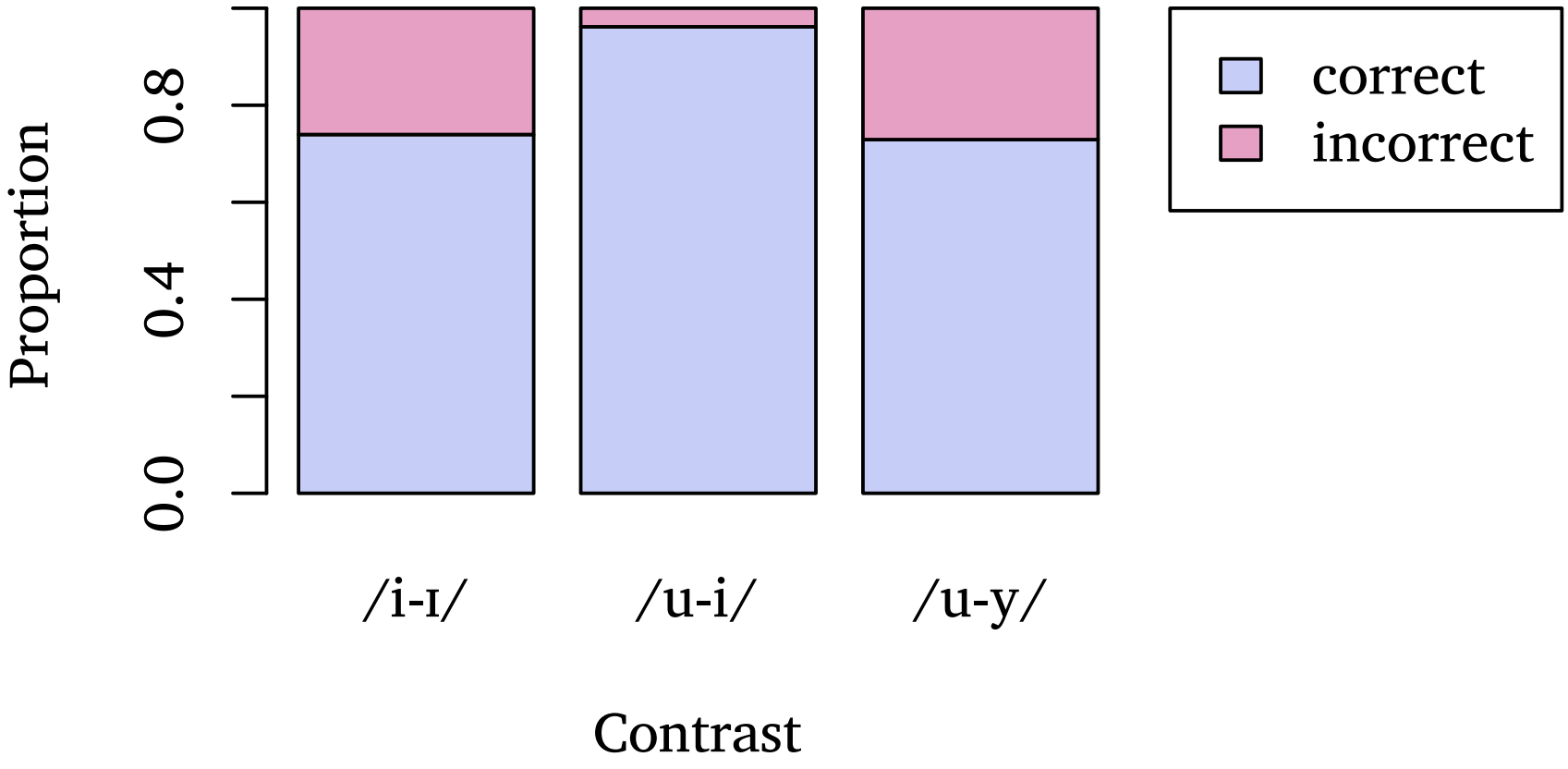
```
# A tibble: 2 x 9
  .y.    group1 group2    n1    n2 statistic     p p.adj p.adj.signif
* <chr>  <chr>  <chr>  <int> <int>     <dbl> <dbl> <dbl> <chr>
1 dprime /u-i/  /i- /     16    16      18.5 0.495 0.99  ns
2 dprime /u-i/  /u-y/     16    16      86   0.005 0.009 **
```

Results: discrimination - reaction times

- No significant difference



Results: Identification - correct/incorrect



Results: identification - correct/incorrect

- Significant effect of vowel contrast on the count of correct responses

```
logreg <- glmer(
    correct ~ vowelcontrast + (1 | subject), family = binomial,
    data = pictask
)
Anova(logreg, type = "III")
```

```
Analysis of Deviance Table (Type III Wald chisquare tests)

Response: correct
               Chisq Df Pr(>Chisq)
(Intercept)   20.858  1  4.946e-06 ***
vowelcontrast 51.737  2  5.828e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Results: identification - correct/incorrect

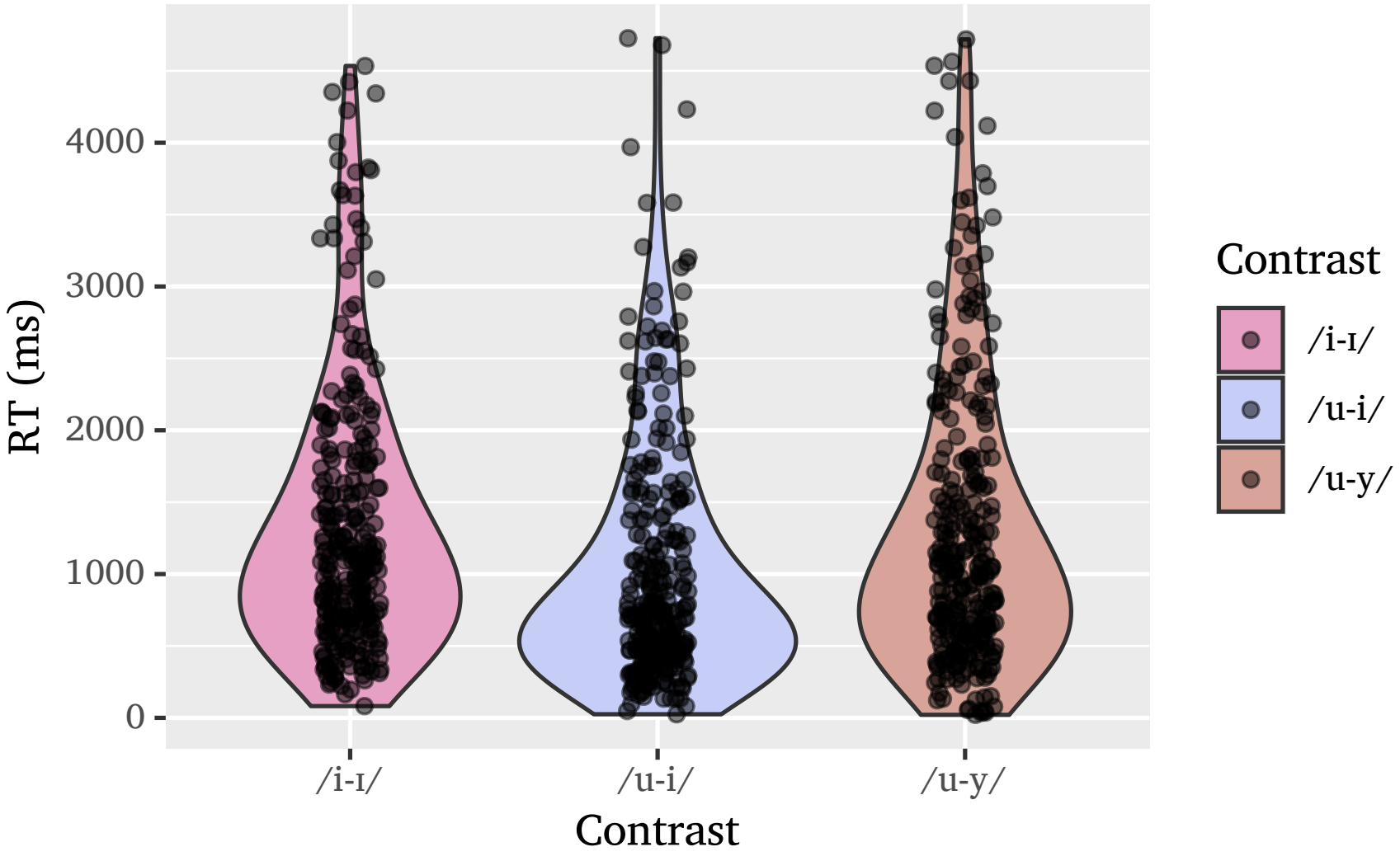
- Post-hoc test: native /u-i/ has significantly more correct counts than the other nonnative contrasts.

```
emmeans(logreg, list(pairwise ~ vowelcontrast))[2]
```

```
$`pairwise differences of vowelcontrast`
 1              estimate    SE  df z.ratio p.value
 (i/I) - (i/u)  -2.3009 0.339 Inf  -6.781  <.0001
 (i/I) - (y/u)   0.0594 0.198 Inf   0.300  0.9515
 (i/u) - (y/u)   2.3604 0.339 Inf   6.966  <.0001

Results are given on the log odds ratio (not the response) scale.
P value adjustment: tukey method for comparing a family of 3 estimates
```

Results: Identification - reaction times



Results: Identification - reaction times

- This time we have significantly different RTs by contrast…

```
rtreg <- lmer(rt ~ vowelcontrast + (1 | subject), data = pictask)
Anova(rtreg, type = "III")
```

```
Analysis of Deviance Table (Type III Wald chisquare tests)

Response: rt
                Chisq Df Pr(>Chisq)
(Intercept)   194.663  1  < 2.2e-16 ***
vowelcontrast  20.809  2  3.029e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Results: Identification - reaction times

- … of which the native /i-u/ is the one with shortest RTs

```
emmeans(rtreg, list(pairwise ~ vowelcontrast))[2]
```

```
$`pairwise differences of vowelcontrast`
 1             estimate   SE  df t.ratio p.value
 (i/I) - (i/u)    313.1 74.5 825   4.205  0.0001
 (i/I) - (y/u)     44.8 74.5 825   0.602  0.8192
 (i/u) - (y/u)   -268.3 74.0 825  -3.624  0.0009

Degrees-of-freedom method: kenward-roger
P value adjustment: tukey method for comparing a family of 3 estimates
```

Discussion

- How do we explain the different results by task?
  - Differences in cue saliency
    - The /i-ɪ/ contrast offers two cues, one of them not in the L1 but very salient
    - /u-y/ offers a cue that the L1 does use but not very salient
  - Potential problems recognizing lexical items in the task
  - Since many L1 Spanish speakers also have some knowledge of English, there might be a familiarity effect with /i-ɪ/

Discussion

- Regarding feature-based approaches to L2 phonology:
  - This study **does not** support FBM as-is
  - However, before we completely rule it out:
    - Check for equally salient perceptual cues first
- Conclusion: if FBM is not predicting properly, then maybe L2 learning takes place at a phonetic level and does not reach more abstract levels of representation. Thus,
  - FBM may still be right, in that the L1 offers a limit to learning
  - However, the limitations are not in terms of the absence of features; rather, it may be that L2 learning is encoded at a surface level.

Thank you / Gracias / Gràcies / Danke

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