The Role of Learnability in Morphological Change: A Computational Approach

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Previous work on acquisition-based computational modeling, including agent-based models and intergenerational learning (Hare and Elman, 1995; Kirby and Hurford, 2002; Cotterell et al., 2018) treats language change as a result of the difference in learnability of forms, where more learnable forms are better transmitted between generations of speakers and thus preserved. Such approaches have the benefits of offering quantitative results and making explicit modeling assumptions, but often minimize the complex social pressures and norms speakers encounter during their lifetimes. An alternative view emphasizes the social meaning of different forms (Hazen and Hamilton, 2008; Sankoff, 2018) (e.g., relative prestige) and has observed the importance of social and pragmatic factors such as location, register, and knowledge about interlocutor (Magner, 1978) in order to explain standardization or dialect loss. However, many such accounts don't provide clear independent reasoning for why certain linguistic variables acquire social meaning to start with. This work explores the correspondence between learnability as operationalized by computational modeling and observed human production data, and aims to identify the limits of a purely acquisition-based explanation.

The city of Split, Croatia is a site of dialect contact where the more prestigious standard Štokavian dialect is competing with the local Štokavian-Čakavian hybrid dialect. Jutronić (2001) examined four morphological variables that differ across dialects in their forms (dative/locative/instrumental plural nouns, genitive plural nouns, masculine singular past participle verbs, and present third person plural verbs) and observed that when prompted to produce the local forms, participants produced the two nominal forms less frequently than the two verbal forms, indicating a faster rate of standardization of nominal forms. Jutronić (2001) offers a socially-motivated explanation of this phenomenon from the perspective of salience and social stigmatization, arguing that the more quickly standardizing forms have higher perceptual prominence, which results in more pressure to change. However, it is unclear as to what makes a morphological variable perceptually prominent, which results in a potentially circular explanation of the observed human production data.

This work frames the learning of four morphological variables in the Croatian dialect of the city of Split as a supervised morphological inflection task (Durrett and DeNero, 2013) and trains a sequence-to-sequence neural network (Kann and Schütze, 2016) to map the orthographic sequence of a citation form to an inflected target form, given the morphosyntactic information and the dialect of the target form. This architecture has been shown to be able to learn the inflectional morphology of natural languages reasonably well (Kann and Schütze, 2016), making it a capable candidate for gauging the learnability of morphological variables based solely on distributional information present in the input. Standard Croatian dialect data comes from the Universal Dependencies Corpus (Agić and Ljubešić, 2015), based on which the data for the local dialect is generated by deterministically reinflecting the four variables of interest (see (1)-(4) for some examples). The reinflected corpus, despite its significant limitations in representing the dialect of Split, allows for focus on the four variables of interest while maintaining a realistic lexical distribution and avoiding other confounds.

(1) *ženama* → *ženan*
woman.F.DAT.PL woman.F.DAT.PL
'to the women' 'to the women'

(2) *kuća* → *kuć*
house.F.GEN.PL house.F.GEN.PL
'of the houses' 'of the houses'

(3) *radio* → *radija*
work.M.PST.PTCP work.M.PST.PTCP
'worked' 'worked'

(4) *puše* → *pušu*
smoke.3PL.PRS smoke.3PL.PRS
'they smoke' 'they smoke'

In order to represent learners with varying rates of exposure to the two dialects in a contact setting, five separate models are trained on varying proportions of the standard and local dialect corpora. The models are tested on held-out evaluation datasets, which contain no lemma present in training data. Target prediction accuracy is taken as a proxy of learnability, or how easy it is for the target forms to be learned from the distribution of the input (see Figure 1).

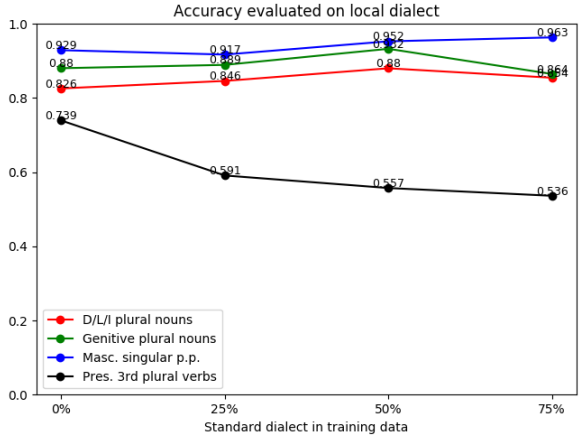

Figure 1: The model's accuracy on the four morphological variables on the local dialect evaluation set. The 100% standard dialect condition (not shown) resulted 0% accuracy on all four variables, likely due to untrained weights for the local dialect tag.

Results show that the local dialect forms of the masculine singular past participle were the easiest to learn and present third-person plural verbs were the most difficult to learn, with nominal forms in between. This learnability ranking does not coincide with production rates of the variables from Jutronić (2001), and therefore does not support a purely acquisition-based account that more learnable forms are more faithfully transmitted and persist over time. The most learnable masculine singular past participle is the most well-produced of the four forms, meaning that it has standardized the most slowly. While this could be interpreted as high learnability being correlated with low social significance and low rate of standardization, this relationship does not hold for the present third-person plural verbs, which are the least learnable but experiencing the second lowest rate of standardization according to Jutronić (2001).

Incorporating and explicitly modeling social stigma and perceptual prominence could be a way forward in further understanding the connection between learnability and dialect loss. While the current results do not offer a simple story about their relationship on their own, they provide a point of comparison to potential future work on the social and perceptual factors that could reasonably link the two and thereby provide a more complete picture of language change.

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