The acquisition of phonological variation: Evidence from artificial language learning

Children are often faced with inconsistent input for language learning: in the koineization of new dialects from multiple dialect inputs (Kerswill 2003), during the emergence of new languages such as Nicaraguan Sign Language (Senghas & Coppola 2001), or the acquisition of a native language from parents who are themselves late learners of the language (Singleton & Newport 2004). In these circumstances, children are master 'generalizers' and produce regular syntactic and phonological rules despite the inconsistencies in their input. However, natural languages also contain variability. If children are great regularizers, how do they acquire a language's variation and its conditioning? Some sociolinguistic work on children's acquisition of first language (L1) variation suggests that children successfully acquire L1 phonological variation as young as age 3 (Smith, Durham, & Fortune 2007; Roberts 1997). Miller (2013) found mixed results, with some of her youngest speakers (ages 2 and 3) producing regularization and older children (ages 3 to 8) producing variation in word-final /s/-lenition, suggesting that increased exposure (Hendricks, Miller, & Jackson) and/or increased age and cognitive development may play a role in children's ability to learn and produce variation.

Here we present an artificial language study designed to test the role of age and cognitive development in the acquisition of phonological variation. 8 participants in each of three age groups (6-7, 8-9, adult) for each condition heard and then produced words and sentences in a miniature artificial language. In the exposure phase, participants heard a stem ending in -p (such as *gep*), followed by 6 full sentences, each paired with either a singular or plural image. Each sentence consisted of a nonsense word (*lessi*) meaning 'here is,' followed by the stem with a meaningless suffix *-en*. The phonological variable in all conditions is stem-final *p* → *f*. That is, the stem *gep* sometimes is produced as *lessi geppen* and sometimes *lessi geffen*. The circumstances under which this phonological variation occurs differs across conditions in the experiment. After the exposure phase, participants perform a "wug test" (Berko 1958) that elicits their production of the language: they are given a novel stem, then shown a novel image (either plural or singular) and are asked to produce the sentence describing the image.

In the Grammatical Conditioning condition (Figure 1), *p* → *f* variation is perfectly conditioned by plurality; singular images always occur with *p* and plural images always occur with *f*. In this condition, we find that adults as well as 8-9 year olds reproduce that conditioned variation, but 6-7 year olds show a strong tendency to regularize to the stem form (*p*) for the plural. In the Unconditioned Variation condition (Figure 2), the exposure contains 67% *f* sentences in both singular and plural. Here again we find adult participants reproducing their input while 6-7 year olds regularize to the stem form (*p*). The 8-9 year olds in this condition show mixed results, with some individuals regularizing and others producing variation. In the Grammatical Variation condition (Figure 3), variation is probabilistically conditioned by plurality, with 33% *f* for singular images and 67% *f* for plural images. Here we again see adults reproducing their input while 6-7 year olds regularize to the stem form (*p*). For the 8-9 year olds, the proportion of *f* produced is lower than in the input, but they do exhibit both variation and grammatical conditioning, with a higher proportion of *f* sentences produced for plurals.

Overall, then, we find strong evidence that, for this amount of exposure to a novel language with variation, younger children regularize across all conditions, in line with previous findings (Hudson Kam & Newport 2005, 2009). We also see that while older children may not perfectly match the proportion of variation in the input, they are attuned to probabilistic conditioning on variation, suggesting that the conditioning of variation is acquired concurrently with the variation itself. These findings suggest that variable phonology may not be acquired in the earliest stages of acquisition but that age and cognitive development may play an important role in the acquisition of variation.

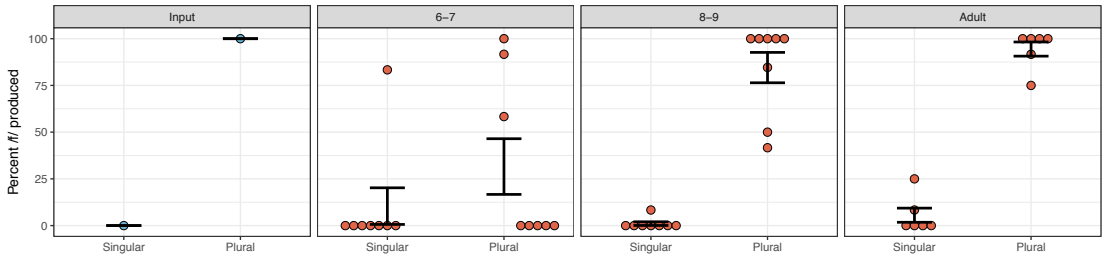

Figure 1: Grammatically Conditioned variation. 6-7 year olds regularize to the stem form; 8-9 year olds and adults acquire the input grammatical conditioning and its proportions (p=0.003).

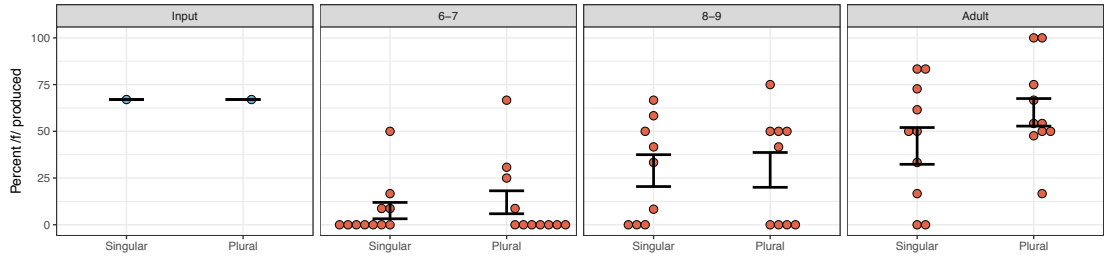

Figure 2: Unconditioned Variation. 6-7 year olds regularize to the stem form (p<0.001 for both singular and plural; 8-9 year olds and adults acquire the input conditioning and its proportions (no difference between proportion *f* in singular and plural for the adults, p=0.3).

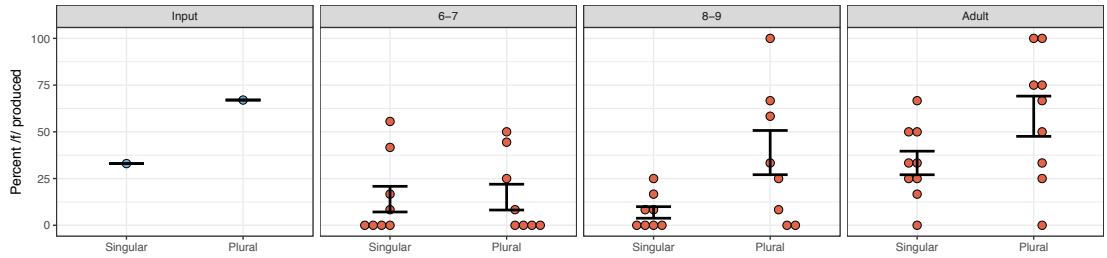

Figure 3: Grammatical Variation. 6-7 year olds regularize to the stem form (p=0.05 for singular, p<0.001 for plural) and no conditioning across singular and plural (p<0.001). 8-9 year olds produce lower rates of *f* than in the input(p=0.002 for singular, p=0.005 for plural) but follow the conditioning of the input, with higher rates of *f* in the plural. Adults match the input proportion and conditioning.

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