5.7 A Detailed Look into What Happens

Suppose that our learner is in the stage of the learning process that corresponds to having heard 400 data, and is presented with the adult surface form [aːp]. Tableau I shows the details of what happens.

/aːp/ 'monkey'	*COMPONS	*COMPCODA	ONSET	*CODA	FAITH
√ [aːp]			*!→	*→	
☞ [paː]					←**
[paːp]				*!	*
[aː]			*!		*

Tableau I. After 400 data.

The ranking values that can be read off Figure 2 (at 400 data) will probably give rise to the effective constraint ordering shown along the top row of Tableau I. On hearing the adult surface form [aːp], the child will recognize it as the underlying form /aːp/ 'monkey', which she then takes as an input to her own grammar, as shown in the top left cell of Tableau I. The tableau shows four relevant candidates for the child's output form. According to the temporary ranking in the tableau, the form [paː] will win, as is indicated by the pointing finger (☞). However, the child notices that the adult surface form is [aːp], and that this form is different from her own surface form. Since the adult form is available among the candidates, we can indicate this correct form with a check mark (√). Likewise, we indicate the incorrectness of the child's own form by putting two asterisks around the pointing finger.

Since the child's surface form is incorrect, the child will take action by raising the ranking values of all constraints violated in that form. In this case, only FAITH will have to be promoted, and this is indicated by the leftward arrow in Tableau I. But the child will take another action. Since the correct form occurs in the tableau, too, she will lower the ranking values of the constraints violated in that form (ONSET and *CODA), as indicated by the rightward arrows. If the child repeatedly says [paː] for /aːp/, she will eventually manage to rank FAITH above ONSET and *CODA, and become more likely to produce the adultlike form [aːp].

Having seen the details of the learning algorithm, we can return to the child's initial stage. In the beginning, the constraint ranking causes the child to produce CV syllables only. In 44.81 percent of the cases, the adult form will be CV as well, so nothing happens. In 49.95 percent of the cases, though, the adult form will contain one or more coda consonants. The child takes this as her underlying form, but still generates a CV surface form

herself, and notices the difference. As a result, she will lower *CODA and raise FAITH. After 400 data, *CODA has moved down the ranking scale by a distance of approximately 49.95% · 400 · 0.1 = 20.0, and FAITH has risen to about 72. At that time, the constraints will be ranked as in Tableau I.

After about 800 data, *CODA has fallen far below FAITH, so that the child will make few errors in pronouncing simple codas. Thus, there will be no differences between the number of *CODA violations in the adult and learner forms, so that *CODA will stop moving through the hierarchy. However, ONSET still outranks FAITH, so that the child may now produce /aːp/ with an epenthesized onset as [paːp], which is a form attested in one of the twelve live subjects. As Tableau II shows, this error will cause gradual demotion of ONSET, and further raising of FAITH.

/aːp/ ‘monkey’	*COMPONS	*COMPCODA	ONSET	FAITH	*CODA
√ [aːp]			*!→		*
[paːˑ]				**!	
☞ [paːp]				←*	*

Tableau II. After 800 data.

After 1200 data, ONSET is dominated most of the time, so the child begins to sound more adultlike again. She will still have trouble, however, with complex onsets and codas, as witnessed by her production of underlying /eːnt/ ‘duck’ as [eːt] (Tableau III). Again, [eːt] is a form attested in reality.

/eːnt/ ‘duck’	*COMPONS	*COMPCODA	FAITH	ONSET	*CODA
√ [eːnt]		*!→		*	*
☞ [eːt]			←*	*	*
[teːt]			**!		*

Tableau III. After 1200 data.

This proceeds until faithfulness has overtaken the constraints against complex onsets and codas. As can be guessed from Figure 2, however, the rankings will continue to diverge until FAITH is ranked by a distance of 10 above all the others. The cause of this *safety margin* is noisy evaluation: if FAITH is ranked above *COMPLEXCODA by a distance of only 4.0, the probability of /eːnt/ being produced as [eːt] is still 7.9 percent. The curves of the rankings as functions of time get gradually flatter, because the learner will produce fewer errors as her rankings approach the adult’s grammar.

6 Replicating the Acquisition Order

6.1 Predicted and attested learning curves

After every 100 data, we measured the performance of our learner by feeding her 10,000 underlying CVC syllables, having her stochastic grammar generate the corresponding surface forms, and seeing what percentage of these surfaced faithfully as CVC. We did the same for four other syllable types. The resulting learning curves are in Figure 3.

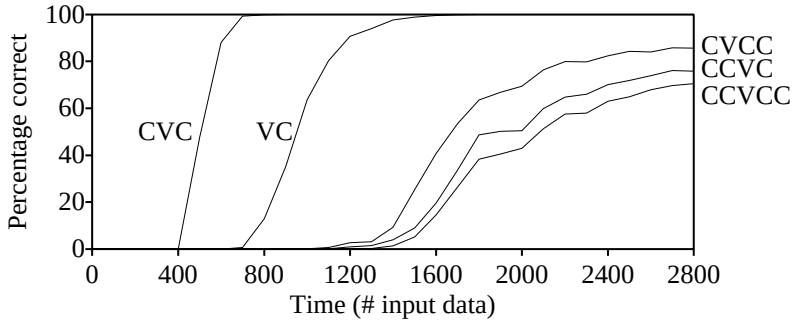

Figure 3. Five learning curves for our simulated learner.

Let us compare this to the behaviour of an actual child. Figure 4 shows the percentage of underlying CVC forms that he produced faithfully (we ignored forms with final liquids, which are often vocalized).

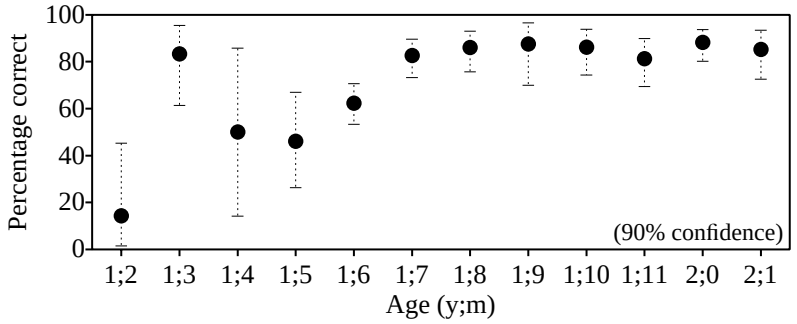

Figure 4. CVC learning curve for Tom.

Both the simulated learner and the actual child show gradual learning. For instance, Jarmo (at 1;9.9) pronounced /boːm/ 'tree' as [poː], [bɔ], [boːχ], [pɑ͡om], variably violating and satisfying *CODA during a single recording session. Such realistic modelling is not possible with learning algorithms based on ordinal ranking, like that by Tesar and Smolensky (1998).