

## Modeling Interactions in Morphosyntactic Changes (as presentation)

**Introduction:** In this paper, we show that in addition to the S-shaped curves produced by the logistic (Fig. 1a,b), another trajectory can be produced by the interaction of two logistic changes (Fig. 1c). Namely, when a new change bleeds the context of an earlier change, a parabolic trajectory is produced. Using data from the Parsed Corpora of Historical English (Kroch and Taylor, 2000; Taylor et al., 2003; Kroch et al., 2004; Taylor et al., 2006), we rely on the Constant Rate Effect (Kroch, 1989) to argue that the change seen in Fig. 1c should be modeled as the interaction between Fig. 1a and Fig. 1b.

**First Change:** McFadden (2002) showed that after the loss of morphological dative case in Early Middle English (c1100), ‘to’ began to be used to mark recipients. Unlike McFadden, we will analyse this as **the replacement of null dative case morphology with ‘to’**. This happened with full noun phrases<sup>1</sup> when the theme preceded the recipient (1a), and also when the recipient preceded the theme (1c), although to a lesser degree.

**Second Change:** Around 1400, however, when the rate at which recipients were marked with ‘to’ when they preceded the theme began to decline (Fig. 1c). We attribute this to **a reanalysis of recipients in these positions as accusative**. As a dative case marker, ‘to’ would not surface in accusative contexts. Another reflex of this reanalysis was the possibility for the recipient to raise to subject in the passive (1b), which was previously impossible.

**Model:** Both independent changes can be modelled by the logistic  $1/1+e^{-(a+bt)}$ , where t stands for time. The accusative reanalysis bleeds the contexts for the ‘to’ dative replacement to occur. This can be modelled by multiplying the probability of using ‘to’ in this context by the probability of still using dative case in this context. **If L1 is the model for the rise of ‘to’, and L2 is the model for the accusative reanalysis the intersection of them can be modelled as L1\*(1-L2)**. This gives three equations associated with the graphs in Fig. 1:<sup>2</sup>

$$a) 1/1+e^{-(a_1+b_1*t)} \quad b) 1/1+e^{-(a_2+b_2*t)} \quad c) (1/1+e^{-(a_3+b_3*t)})*(1-(heavy/1+e^{-(a_4+b_4*t)}))$$

If this analysis is correct, the Constant Rate Effect predicts that  $b_1$  should equal  $b_3$  and  $b_2$  should equal  $b_4$ .

**Results:** Kruschke (2010) shows that Markov chain Monte Carlo (MCMC) can be used to solve problems that cannot be solved analytically. This relies on Bayesian statistics which relates how much prior beliefs about a model's values should be updated by the data set to new posterior beliefs. The results of Bayesian reasoning can thus be best understood showing how the prior is updated to the posterior. Using the results of corpora searches, I generated a prior assumption by using logistic regression to solve for  $b_1$  and  $b_2$ . I then used those values to create a shallow belief that the mean of  $b_3$  and  $b_4$  would be the average of  $b_1$  and  $b_2$ . The standard deviation for  $b_3$  and  $b_4$  was generated so that any possible value of  $b_1$  or  $b_2$  were predicted to be one standard deviation away from either  $b_3$  and  $b_4$ 's means. Table 1 shows that the means for both  $b_3$  and  $b_4$  split, with  $b_3$  becoming close to  $b_1$  and  $b_4$  becoming close to  $b_2$  as predicted. The degree to which the standard deviations shrank shows how much the data increased our certainty in the new values.

<sup>1</sup>The interaction of ‘to’ with pronouns was a special situation that is not dealt with here

<sup>2</sup>Since heavy NP shift allows the surface form to be generated even after the change of accusative reanalysis has gone to completion, the denominator of the second equation for c is somewhat less than 1, which is represented by the variable heavy.

**Data:**

- (1) a. ‘I gave a book to John’ vs ‘I gave a book John’  
 b. ‘John was given a book’ vs ‘A book was given’  
 c. ‘I gave to John a book’ vs ‘I gave John a book’ John’

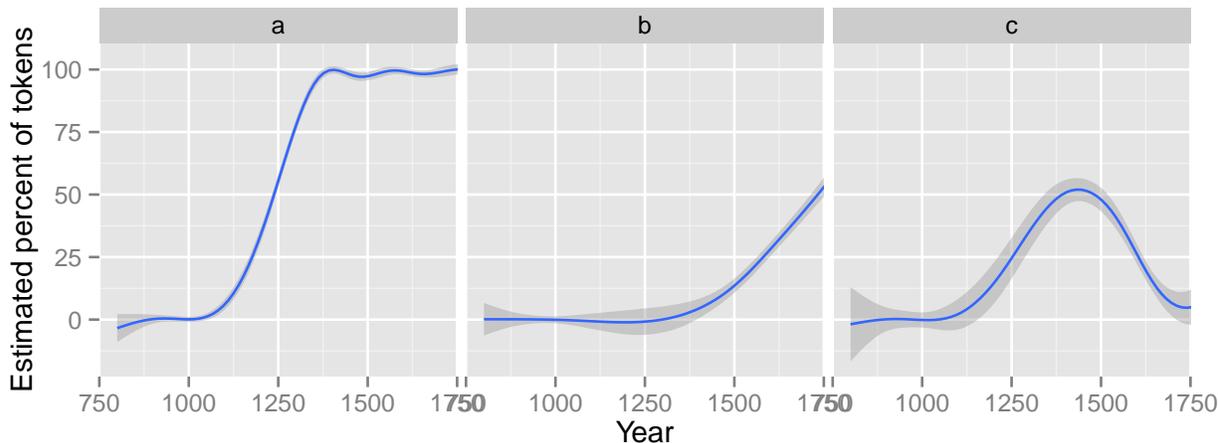


Figure 1: Trajectory of changes

	b1-Mean	b1-SD	b2-Mean	b2-SD	b3-Mean	b3-SD	b4-Mean	b4-SD
Prior	0.019	0.001	0.010	0.001	0.014	0.006	0.014	0.006
Posterior	0.020	0.001	0.010	0.001	0.019	0.001	0.011	0.001

Table 1: Results of Bayesian Modeling

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