

Dynamo – Dynamic modelling of the relationship between language acquisition and language change

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1. Purpose

The purpose of this project is to build a precise model of language acquisition, taking the form of a network simulation, or some other kind of computer simulation. The model is intended to account for phenomena that language acquisition models normally do not account for:

- the fact that a normal outcome of language acquisition is language change;
- the fact that language acquisition does not stop at age four or five, but is a life-long process;
- the fact that language acquisition typically leads to a range of individual competences, rather than to initiation into some invariable Saussurean *langue*.

Finding a model of language acquisition which, on the one hand, is not excessively permissible, leading to acquisition of non-languages, and, on the other hand, does not exclude change, is recognized as an important problem in several domains of research, including theoretical linguistics, computational linguistics, psycholinguistics, cognitive science, and psychology. The problems of life-long acquisition and individual variation have barely begun to be recognized as problems, but we predict that they will soon be, particularly when sophisticated acquisition models begin to make contact with expert systems. The problems have a practical side, as well. A better model of language acquisition allows us to reconceptualize the very notion of language acquisition, something which has obvious implications for such important social activities as language teaching and language therapy, and computer implementations serving such activities. Since the model explicitly deals with adult acquisition and individual variation, it also has a bearing on such issues as vocational training and socialization.

2. General background

In much of modern linguistics, language acquisition has a key rôle in explaining the nature of language. Chomsky (1965, and later) holds that a linguistic theory has reached the level of explanatory adequacy only if it can derive adult linguistic competence from children's initial experience of language. In such a derivation, there are three components involved: the innate capacity of the child, the nature of the

linguistic experience, and the very process through which capacity and experience interact. In Chomsky's version of theoretical linguistics, it is of course the innate capacity that plays the leading part, while linguistic experience and the process of acquisition are idealized away as much as possible. But there are serious problems with this kind of model.

Viewed from an evolutionary perspective, a very rich innate language faculty would be something of an anomaly, because it would have no obvious precursors (Bickerton 1990). Moreover, recent biological theories of language and mind (Edelman 1992, Varela, Thompson & Rosch 1991) have made a convincing case that what could possibly be innate in humans is not any kind of software, but rather hardware (the capacity for growth of the brain and the nervous system, to be more precise) which makes possible a complex interaction between organism and environment.

A model which assumes a rich innate language faculty also has the considerable drawback that it models language acquisition as a deterministic process, simply because there are not enough degrees of freedom in the model to allow for an output that is different from the input. This means that change, individual variation and acquisition after initial exposure are in principle excluded by such a model. The trouble is, of course, that these phenomena are as much linguistic universals as are duality of patterning and other design features.

Within the Chomskyan tradition, there have been some attempts to work out a model of acquisition which allows for change (Lightfoot 1991, Clark & Roberts 1993). The common denominator in these attempts is a more sophisticated analysis of the notion that a certain linguistic experience triggers a particular setting of a parameter of Universal Grammar (the innate language faculty). In Lightfoot's theory, children are constrained in such a way that they can not bring their whole linguistic experience to bear on the task of parameter setting. Briefly put, children pay attention only to main clauses and have to infer subordinate clause structure from main clause evidence. This provides a needed source for mismatches between input and output, which in the end may lead to change. In Clark & Roberts' theory, triggering is not a one-to-one function. A certain experience may be compatible with several arrays of settings, which 'compete' for best fit with the original experience. Thus, in these versions of the Chomskyan model, experience plays a greater rôle than it normally does in that kind of model. However, the model is still deterministic. Once a parameter has been set, 'correctly' or not, it can not be altered by later evidence, and parameters are set in the same way for all learners with the same experience. In other words, acquisition after initial exposure and individual variation are still in principle excluded by the model.

What is needed to overcome these serious limitations is a model of language acquisition which brings the process component of language acquisition into focus. It is clearly no coincidence that language acquisition, despite all idealizations, is a process which takes time. If this elementary fact is respected and language acquisition is modelled as the outcome of a dynamic interaction between capacity and experience, which evolves over time and is governed by a range of activity contexts, where language resources are put to new uses, then change, life-long acquisition, and individual variation will fall out as natural consequences of the very process of language-acquisition. At least this is the hypothesis we want to put to the test. Initial support for this hypothesis comes from recent network simulations of language acquisition (Elman 1993, Plunkett & Markman 1993), where a dynamic interaction between capacity and experience extended over time is shown to provide the right results.

A further interesting consequence of such a model of language acquisition is that the innate component of acquisition can be considerably reduced, making linguistic theory better compatible with an evolutionary perspective on language. This is one of the principal results of the project 'Part-of-speech systems - a typological investigation', supported by HSNR (Anward 1994).

3. Special background

This project brings together several strands of research carried out by the members of the project group. Anward has been concerned with working out interesting models of language acquisition and language change and using such models to explain basic features of language design. A substantial part of this research has been devoted to Swedish. Källgren has a solid background in Swedish grammar and computational linguistics, having worked for years with morphological and syntactic analysis of large text corpora. Eriksson has a solid programming experience and have worked in several projects with computer analyses of Swedish morphology and syntax. Eriksson also has a background in historical linguistics. Swedenmark is at present engaged in analyses of definiteness in Swedish and Icelandic case. A characteristic feature of Anward's and Källgren's research is an attempt to place linguistic generalizations in activity and genre contexts, and a research interest in conversational analysis and text linguistics, respectively. Swedenmark has also a background in literary studies.

4. Object of inquiry

We have chosen to investigate two fairly straightforward features of modern Swedish: definiteness marking and case marking in noun phrases. All Swedish noun phrases are marked for definiteness, distinguishing definite ones from indefinite ones. 'Definite' is marked by a suffix on nouns, a definite article and a suffix on adjectives:

<i>Stol-en</i>	(Chair-DEF; 'The chair')
<i>Den stor-a stol-en</i>	(The big-DEF chair-DEF; 'The big chair')
<i>Stol-ar-na</i>	(Chair-PL-DEF; 'The chairs')
<i>De stor-a stol-ar-na</i>	(The.PL big-PL-DEF chair-PL-DEF; 'The big chairs')

'Indefinite' is unmarked, signalled by the absence of definiteness suffixes and by an indefinite article in the singular:

<i>En stol</i>	(A big chair)
<i>En stor stol</i>	(A big chair)
<i>Stol-ar</i>	(Chair-PL; 'Chairs')
<i>Stor-a stol-ar</i>	(Big-PL chair-PL; 'Big chairs')

Accusative case is marked only on pronouns: on first person, second person, and third person animate pronouns, while genitive case is marked on all noun phrases. First and second person pronouns have special possessive forms, though, which agree in number and gender with possessed nouns.

What is particularly interesting with definiteness marking and case marking in Swedish is that Swedish, on its way from Proto-Germanic to modern Swedish, has changed from being only case-marking, employing the standard Germanic model of nominative, genitive, dative, and accusative, which can be found in modern German and modern Icelandic, to being almost exclusively definiteness marking. Thus, we have before us a process of change where case-marked demonstratives are grammaticalized into definite suffixes and articles, and where case marking is lost on nouns, demonstratives, and adjectives.

Definiteness marking and case marking are furthermore distributed in different ways in various spoken and written genres, depending essentially on the ways pronouns and nouns are used in such genres. In early narratives, for example, subjects are normally animate pronouns and nouns are used only in object position. This means that evidence for a definiteness contrast is lacking in subject position. Yet when a language learner encounters other genres, (s)he must be prepared to extend this contrast to subject position, as well. On the other end of the stylistic range, we find modernistic poetry (Sjöberg, Björling, and others) which has a very high frequency of articleless noun phrases.

The challenge we wish to take on is to work out a computer simulation, preferably a network simulation, that will model the acquisition of definiteness marking and case marking in Swedish in such a way that long-range change and genre-dependent variation is not only not excluded, but in fact predicted, given varying conditions of language use.

5. Framework

A fundamental assumption is that language acquisition is an ongoing and embedded accomplishment, crucially driven by a desire of being-inside various social activities. The details of this fundamental assumption are spelled out in the following 'language acquisition story' (Anward 1983: ch. 6, 1993):

A language acquisition story

1. Language acquisition and development is a consequence of the acquisition of a repertoire of rôles in social activities.
2. Learning a rôle in a social activity is learning how to contribute in a specific way to the texts produced and/or reproduced within that activity. This means learning what can be said, how it can be said, who can say it, and who you are, as a function of what you can say and how you can say it.
3. To enter a new activity you may have to learn a new variety of your language, or even a new language. You may also have to enter a new group. Membership in the new group may be incompatible with membership in a group you already belong to.
4. To enter a new activity, you have to find a model inside that activity and then follow that model, but with a difference, which secures both your own individuality and the individuality of your model. And this following with a difference must be accepted by ratified participants in the activity as a valid means of contribution to that activity.

A *linguistic rôle* in a social activity is determined by the activity's *genre* and its *division of saying*.

In the simplest case, a *genre* unconceals (Heidegger 1927, Pöggeler 1989) the topic of a social activity as a small set of referents involved in certain typical events and relations (Anward 1972, 1994). At the same it provides a frame for relating these events, relations, and referents to the speech event (Anward 1983: ch. 6, 1994). Consider the following example, a text printed on a box of detergent:

Använd skopan för att dosera rätt mängd
(se doseringstabellen) Via MICRO PLUS!

(Use the scoop to dose correct amount (see the dosage table) VMM!)

This text concerns the very activity in which the detergent is used. The text unconceals the activity as an activity involving a *user* and a number of *tools*. At the same time, the text adopts a narrative perspective on the activity. The activity is described from a participant-perspective, as it unfolds to the user. Thus, the author of the text describes the activity from the perspective of the user, which is reflected in a genre-specific *thematic hierarchy*, which ranks the user above any tool for the purpose of subject selection. Finally, the text uses the speech event as a resource: referents at hand in that situation (the scoop packed in the box, the table printed at the back of the box) need not be explicitly introduced, but are referred to by definite noun phrases.

Compare now the following opening of a Grimm brothers fairy tale ('The seven ravens'):

1. Det var en gång en man
som ø hade sju söner.
(Once upon a time there was a man
who had seven sons.)
2. Både han och hans hustru önskade sig livligt en liten dotter,
och äntligen blev deras önskan uppfylld.
(Both he and his wife wished very much for a little daughter,
and finally their wish was fulfilled.)
3. Den lilla flickan var emellertid från födelsen sjuklig och klen
och ø måste ha nöddop.
(The little girl was however from birth sickly and weak
and had to have an emergency baptism.)
4. Fadern skickade skyndsamt en av sönerna till källan
för att ø hämta dopvatten.
(The father sent hurriedly one of the sons to the spring
to fetch water.)

Here we have a text that concerns a fictive series of events. In the short extract above, this series of events is unconcealed as involving a man, his wife, their seven sons, and their little daughter. Although it is not apparent from the extract above, the first part of the tale contrasts two actions: the father keeps the little girl, and sends the sons away. Clearly there is a narrative perspective, and the events in this part of the tale are told from the perspective of the father, which is reflected in the following thematic hierarchy: father (& wife) > children > tools. In contrast to the instruction on the box of detergent, the text is self-contained. Its referents are not shared with the speech event, and are all properly introduced into the narrated series of events.

A careful analysis of language use along these lines has the important consequence that language acquisition can always be modelled as composed of acquisition of a genre within an activity, thereby considerably reducing the scope of the task at hand. Within a genre-in-an-activity, referents will come 'pre-packaged', for example as

protagonist; human; definite; thematic role 1
prop; inanimate; indefinite; thematic role 2

and linguistic resources, such as \emptyset vs. pronoun vs. noun, definiteness marking, case marking, agreement, and word order will be analysed as means of distinguishing such pre-packaged referents.

This means that generalizations about such linguistic resources may look slightly different in different genres. In the first part of 'The seven ravens', we find the following distribution of NP:s:

	Subject	Object
\emptyset	13	0
Pronoun	12	0
Proper name	0	0
Definite noun	9	2
Indefinite noun	1	8
Σ	35	10

As we can see, this distribution supports more or less strongly a number of generalizations, which appear spurious, when placed in the context of the 'whole' of Swedish grammar. For example:

- a. Pronouns are only used as subjects (Exception rate: 0%)
- b. Proper names are only used as subjects (Exception rate: 0%)
- c. Definite nouns are only used as subjects (Exception rate: 18%)
- d. Indefinite nouns are only used as objects (Exception rate: 11%)

Compare the following figures from Lange & Larsson (1973: 31, 34), which report the distribution of NP:s in the Swedish girl Embla's speech between 20 and 24 months of age (Embla 6-10; we have no idea why the total numbers of subjects and objects are different in the two tables):

	Subject	Object
Pronoun	16	5
Proper name	46	0
Definite noun	14	5
Indefinite noun	0	14
Σ	76	24

	Subject	Object
Human	67	4
Animate	3	1
Inanimate	3	25
Σ	73	30

Generalizations a and c are not as strong here (exception rates are 24% and 26%, respectively), but b and d are exceptionless. Furthermore, the following two generalizations can be added:

- e. Animates are only subjects (Exception rate 7%)
 f. Inanimates are only objects (Exception rate 11%)

Compare also the following figures, which report the distribution NP:s in an article on transportation of fluids in plants from a Swedish encyclopedia:

	Subject	Object
∅	2	0
Pronoun	1	0
Proper name	0	0
Definite noun	6	1
Indefinite noun	3	1
Σ	12	2

What is particularly interesting here, although the figures are very small, is that generalization d is not at all supported.

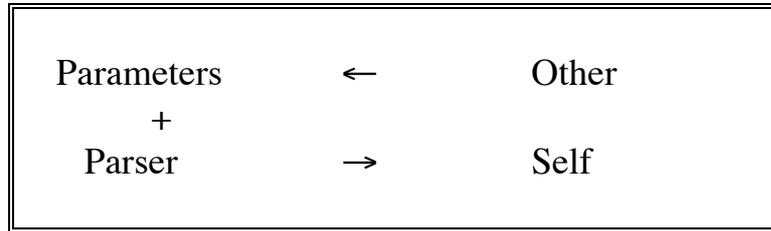
Our task is now to see under what conditions a model will learn various spurious and real generalizations. In particular, we are interested in seeing whether the move from one genre to another necessitates a new process of acquisition or whether initial learning can be modified to deal successfully also with later genres.

This question has important consequences for our view of change. If each genre calls for a new process of acquisition, then maybe change is driven by introduction of new genres. It is worth noting that a number of new genres, both written and spoken were introduced in Swedish from the 14th century on. Otherwise, change is more realistically modelled as a slow drift towards new generalizations.

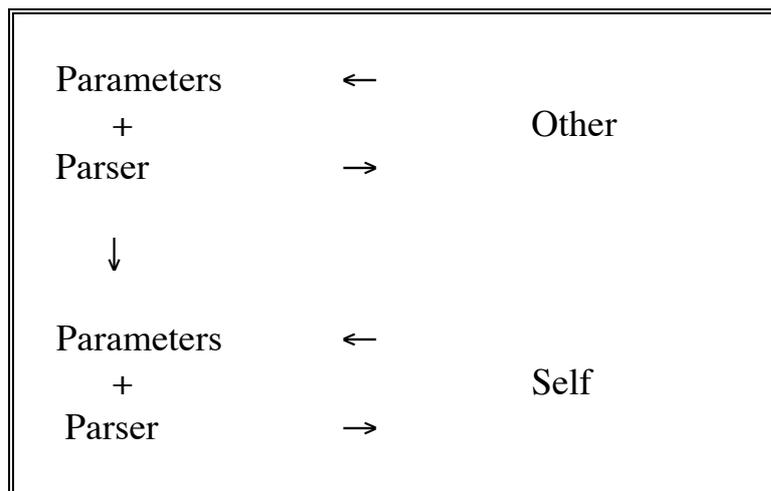
A further important feature of an activity perspective on acquisition is that language acquisition is always accomplished within a specific *division of saying*, which determines the expressive space of the learner.

Anward (1997) uses an extension of Goffman's notion of *principal* (Goffman 1981: 144-145, 226) to explicate this aspect of linguistic activities. For Goffman, the principal of an utterance is the one whose position is expressed by the utterance. This means, among other things, that the principal of an utterance is answerable to the adequacy of that utterance, its truth, ethical value, correctness, appropriateness, beauty, etc. This notion of principal of X, as the one answerable to the adequacy of X, can now be extended to the three dimensions of linguistic activities isolated in Anward (1997): the activity itself, the topics of the activity, and the texts produced about these topics within the activity. The principal of an activity is thus the one answerable to the adequacy of that activity; the principal of a topic is the one answerable to the adequacy of what is said about that topic; and the principal of a text is the one answerable to the adequacy of that text.

In a symmetric dialogue, all participants are principals of activity, topics, and texts, while in an asymmetric dialogue, there is one participant which is the exclusive principal of at least activity and texts. Language acquisition, at least in its early stages, in Western middle class cultures, often takes place within asymmetric dialogues, which has an important consequence for models of language acquisition. While traditional models of language acquisition only emphasize the reproduction of Other's utterances by Self, as in the model below:

Acquisition: Old

an explicit recognition of division of sayings leads one to realize that not all Other utterances are meant to be reproduced by Self. Thus, instead we get a more sophisticated model:

Acquisition: New

with the consequences listed below:

1. Self Output \neq Other Input
2. Self Output changes over time
3. Other Input changes over time
4. Self Output not necessarily adjusted to match Other Input

This aspect of the acquisition model also has important consequences for the modelling of change. In particular, we can assume that in situations where social change is rapid and social control is weak, there may be more room for change.

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