Input, intake, and sequence in syntactic development

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Recent investigations of language development in young Dutch-speaking children have revealed a highly invariant pattern of acquisition of verb types and clausal structures. Most developmental psycholinguists are familiar with such consistent sequential patterns. The crucial question of course is, how do we explain them? This paper outlines an approach to sequence in linguistic development based on the assumption that the set of linguistic data the child has access to expands over time in a deterministic way. However, it is not the *input* that changes in any relevant way, but the child's selection of data from the input, the *intake*. What is taken in is determined by a conspiracy of factors that affect the relative salience of parts of the language input. Distributional and prosodic features, as well as frequency, are among these, and they determine the initial stage. For all subsequent stages, however, the perception of the language input is also affected by what the child has acquired so far. In other words, what is already known will determine what is taken in and learned next. This approach meets with some success in accounting for the facts about Dutch syntax acquisition.

1. The logical and the empirical problem

The study of language acquisition can be approached from two angles. The first was defined by the research program of generative linguistics as conceived by Chomsky and his followers (see e.g. Chomsky 1986). The core question of this research program is the following: How is it possible, in principle, that children acquire language, given that, firstly, language (i.e., grammar, or I-language) is a rich and highly complex generative system, capable of generating an infinite number of sentences, and that, secondly, the primary linguistic data the learner has access to are impoverished and crucially underdetermine the syntactic

knowledge that grown-up language users possess. This has become known as the *logical* problem of language acquisition.

The second angle on language acquisition is connected, we may say, to the research program of developmental psychology. One of the striking features of language acquisition is that it is a *staged* process. Not only can we divide the developmental course into gross stages on the basis of relatively arbitrary criteria such as average utterance length, it is also possible to differentiate among various stages on the basis of specific grammatical criteria (e.g., the absence or optionality of particular formatives). Hence, it had been proposed that language development can be represented as a succession of grammars, each of which incorporates more aspects of the target system than its predecessor. Crucially, this sequence of grammars does not appear to be random. The order of stages and sub-stages is highly prototypical. There may be some variation, but this seems to be constrained. This constitutes the *empirical* problem: what determines the developmental sequence in language acquisition?

Over the past few years, we have seen the emergence of a number of highly interesting approaches to the empirical problem that are rooted in theories designed to solve the logical problem. A common and central assumption in most of these proposals with regard to the logical problem is that the language learner in its initial state is not a *tabula rasa*, but comes equipped with well-defined expectations about the possible structures in the target language. These expectations, which are pre-sumed to reflect aspects of grammatical structure common to all natural languages, supposedly derive from the structure and function of the human brain, as determined by the genome, and hence need not be acquired. Aspects of the architecture of grammar which vary across languages must be learned, but the learner is informed on the range of variance. Thus, the hypothesis space of the language learner is con-strained, and this is assumed to guarantee the eventual convergence of the learner on the target grammar. The 'aspects of grammatical structure common to all natural languages' have become known as the 'principles of universal grammar', and the variations which exist within this univer-sal scheme are standardly referred to as 'parameters'.

The idea that language acquisition entails a process of choosing among a restricted number of pre-defined variants of grammar seems appropriate enough for an abstract, idealized theory of acquisition, i.e., a theory which starts from the presupposition that language acquisition is instan-

taneous (e.g. Chomsky 1986). On this assumption, the language learner processes a large corpus of linguistic data in an infinitesimally small period of time, and uses the information to simultaneously set all parameters of Universal Grammar. Actual language acquisition in real children, however, obviously is not instantaneous. In principle, in order to explain the 'relative slowness' of the process, we may try to conceive of a 'stretched' version of the idealized theory of acquisition. However, such a theory would not be empirically adequate, unless it would involve constraints on the order of parameter setting. Otherwise, the steady state grammar is predicted to be reached by a 'random walk' through the parameter space.

Of course, acquisition theorists have acknowledged this problem, and have proposed developmental adaptations (or extensions) of the parameter setting framework. Each of these proposals is an attempt to formulate constraints on the possible interaction of primary linguistic data and the innate language knowledge, such that the series of intermediate grammars the acquisition device generates is correctly predicted. Three well-known proposals are 'maturation', 'ordered parameters', and 'lexical learning'. At this point, I will give just a rough and general sketch of these approaches. In section 3 I will single out and discuss specific hypotheses within each of these approaches.

The common assumption in maturational hypotheses is that components (parameters, modules or principles) of Universal Grammar are not accessible during a certain period after the onset of language development. What this means is that the range of possible representations the learner can consider in trying to map the input data onto a grammar is restricted. Certain grammatical representations are simply 'out of reach', and can only be grasped after the necessary components of Universal Grammar have become available, as a result of maturation. Often, the rhetoric is that maturation of UG is a reflection of neurological maturation. It may be more appropriate, however, to interpret the term as a metaphor, referring to a hitherto unexplained developmental process, of any nature.

The main tenet of ordered parameters approaches is that particular parameter values cannot be set until certain others have been determined. The underlying assumption must be that Universal Grammar specifies dependency relations among parameters. The consequence for the acquisition process is that certain characteristics of the primary data

cannot be brought to bear on certain parameters during certain periods. In others words, a particular structure x in the input cannot act as a trigger for a parameter j, as long as another parameter i has not been set. Finally, lexical learning starts from the assumption that particular features or categories of UG are initially absent, and they are arise as a result of the discovery of specific (sets of) words or morphemes.

Are these proposals successful in accounting for the empirical problem, i.e., the stretched-out, stage-wise acquisition of grammar? In order to give an answer to this question, I will, in the next section, confront them with a very modest set of data, viz. data pertaining to acquisition by Dutch-speaking children of verb placement, in connection to morphology, and associated rules concerning the ordering of the principal NP arguments of the verb.

2. Infinitives and *verb second* in Dutch child language

An important characteristic of Dutch (morpho-)syntax, and a major motivation for studying verb placement in Dutch child language, is the verb second rule. In plain language, this rule refers to the fact that finite verbs in Dutch independent clauses must appear in second position, i.e., the position that is preceded by at most one other constituent (see examples 1). In addition to the second position, the sentence-final position is available for verbs (ignoring for now extraposition of prepositional phrases and the like). However, only nonfinite verbal elements, i.e., infinitives, participles and verb particles can appear here. By contrast, the dependent clause in Dutch has only one, clause-final position for both finite and nonfinite verbal elements, as the examples in (2) show. This asymmetry constitutes one of the arguments for the hypothesis that underlying word order in Dutch is SOV (Koster 1975), i.e., that the verb phrase is head final.

(1)	a	Jan zoent Marie.	(2)	a	Ik zag Jan Marie zoenen.
		John kiss_{3S} Mary			I saw John Mary kiss_{INF}.
		'John is kissing Mary'			'I saw John kiss Mary'
	b	Zoent Jan Marie?		b	Ik zag dat Jan Marie zoende.
		kiss_{3S} John Mary			I saw that John Mary kiss_{PAST}
		'Is John kissing Mary?'			'I saw than John kissed Mary.'
	c	Jan wil Marie zoenen.			
		John wants Mary kiss_{INF}			
		'John wants to kiss Mary'			

 d Jan heeft Marie gezoend.
    John has Mary kiss$_{PPT}$
    'John has kissed Mary.'

A classic transformational analysis of verb second is that the verb leaves its base position within the VP, and moves to the head of IP — to join with the inflectional features — and eventually proceeds to COMP (Den Besten 1983). Another constituent, not necessarily the subject NP, then moves to the specifier of CP. The jury is still out on the cause of the finite verb's movement to COMP. As a first approximation, we may say that COMP contains an operator related to finiteness, which has to be lexically bound. Note that in subordinate sentences the complementiser is supposed to take care of this, and hence the finite verb stays in situ (merged with Infl). More recent analyses, notably Zwart's (1993), assume that the verb is inserted in the derivation in fully inflected form. Since the inflectional features are 'strong', i.e., phonologically uninterpretable, they have to be eliminated by checking against corresponding features in the relevant functional head. Checking takes place by means of stepwise movement and adjunction.

2.1 The pattern of development

The acquisition of verb placement has been studied quite extensively over the past 10 years or so, both cross-sectionally (Bol 1995, Bol & Kuiken 1988, Schlichting 1996, Wijnen & Bol 1993) and in longitudinal (case) studies (De Haan 1986, 1987, De Haan & Frijn 1992, De Haan, Frijn & De Haan 1995, Jordens 1990, Wijnen 1995a, 1995b, 1997a, 1997b). To my mind, it is safe to say that we now have a pretty clear view of the typical course of development in this domain. The acquisition of verb placement before the attainment of the mature state can be divided into three stages, which I have tentatively labeled the infinitive stage, the lexical-finite stage and the optional infinitive stage (the latter term was taken from Wexler 1994).

2.1.1 The infinitive stage
The onset of this stage coincides with the onset of combinatorial, i.e., multi-word, speech, and it may last a variable period of time, ranging from a few weeks to several months. The most important characteristic of this stage is that children virtually only use infinitive verbs, i.e., verb forms that are morphologically and syntactically identical to the infini-

tives of adult language (example 3). That is, they have a typical suffix-like schwa ending, and they quite systematically occur in utterance-final position. Due to the latter feature, the major arguments (particularly subject and object), as well as most other constituents, systematically precede the verb. The order of the primary arguments corresponds to the 'canonical' SOV order in Dutch, which is encountered in dependent clauses (see ex. 2a, b above) and main clauses with compound verb phrases (ex. 1c, d). This utterance type is often called 'root infinitive' (Rizzi 1992) or 'optional infinitive' (Wexler 1994). In some cases, a very limited number of finite forms can be observed, but there are sound indications that these mostly represent unanalyzed forms (see Wijnen 1995a, 1997b).

(3) a   thee drinken   (Niek, 2;7)[1]
          tea drink_INF

     b   die helemaal kapot maken   (Niek 2;7)
          that+one altogether broken make_INF

     c   ook ə paard stappen   (Peter 1;9.20)
          also horse step_INF

     d   mama radio aan doen   (Peter 2;0.7)
          mummy radio on put_INF

2.1.2 The lexical-finite stage

Usually starting some two months after the onset of multi-word speech, this stage is characterized by the appearance and productive use of (a limited number of) finite verbs, i.e. lexical items that are morphologically similar to finite elements in the adult language. It should be noted that the root infinitive remains the predominant structure. Importantly, the finite forms invariably constitute a set that is virtually completely disjunct from the set of infinitives. The infinitive verbs in Dutch-speaking children's early vocabularies usually denote actions, or more generally events. The first finite verbs, however, are almost without exception drawn from a set consisting of modal auxiliaries (e.g., *kan* 'can', *mag* 'may'), the copula *is*, as well as a limited number of lexical verbs that denote states (*past* 'fits'), or, more generally, non-dynamic eventualities (*zit* 'sit(s)', *slaapt* 'sleeps').

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[1] In the transcribed child language examples, 'ə' denotes a schwa-like sound, and '#' signifies a (hesitation) pause. Children's ages are in years; months. days.

(4) a   mag niet   (Niek 2;11.10)
          may not

     b   rode kan niet in   (Peter 2;1.13)
          red one can not in

     c   kan niet   (Matthijs 2;1.7)
          can not

     d   eh, past   (Matthijs; 2;1.21)
          eh… fits

The observation that finite forms and infinitives constitute disjunct sets of lemmas has been referred to as the no-overlap phenomenon (De Haan 1987, Poeppel & Wexler 1993). It has been established that usually the overlap between the sets of finite verbs and infinitive verbs remains virtually zero until the time at which children start to use compound predicates (see below). In view of the non-overlap during the early stages of the development of combinatorial speech, we may say that finiteness is a feature specific to certain lexical items, rather than a rule-based feature of morpho-syntax. Importantly, the early finite forms can be preceded by at most one constituent. In other words, they occupy the position that corresponds to the verb second position in the adult language. However, the very first finite constructions usually conform to the template $V_{FIN}+X$, in which X can be any constituent, but most often is an adverbial such as *niet* 'not' or *wel* (an affirmative particle). Subjects, too, are at first almost exclusively placed after the verb (which results in the so-called inversion order).

2.1.3 The optional infinitive stage
The transition to this stage (usually some 3 months after the onset of combinatorial speech) is marked by the appearance of sentences that contain two verbal elements: a finite auxiliary and an infinitive lexical verb, as in examples (5). The positions of the verbal elements in these periphrastic predicates correspond to those dictated by Dutch syntax: the finite element (an auxiliary verb) is placed in first or second position, the infinitive occurs clause-finally. There are indications that the 'inversion' order of subject and finite verb (V_{FIN}-Subject) is initially preferred over the normal (Subject-V_{FIN}) order. Not very long after periphrastic predi-cates with infinitive lexical verbs have appeared, auxiliary-participle combinations start to show up as well (ex. 6). Before that time, partici-

ples were used in isolation, i.e., without an auxiliary, similarly to infinitives.

(5) a   mag ə ik trein zoeken   (Niek 3;0.10)
        may I train look+for

    b   moet op # staan   (Peter 1;11.10)
        must on stand

(6) a   ik heb die gevonden   (Niek 3;1.17)
        I have that+one found

    b   Jiska heef(t) stuk gemaakt   (Peter 2;0.28)
        Jiska has broken made

Next to the appearance of complex predicates, the frequency with which finite verbs (tokens) are used rises. Also, the number of different finite verbs (types) increases. In connection to this, the overlap between the sets of infinitive and finite verbs grows, which means that an increasing number of verbs (lemmas) occurs both as finite and nonfinite forms. This seems to indicate that the distinction between finite and infinitive is gradually being generalized, i.e., applied to all verbs in the child's repertoire. Since the same verbs (lemma's) can now occur both as finite forms and as root infinitives, we can speak of a true optionality of finiteness. Despite this progress, the child continues to use root infinitivals. There are indications, however, that the rate with which these constructions are used starts to drop markedly after the first periphrastic predicates (notably periphrastic predicates with a sentence-initial subject) have been produced.

Figure 1 gives a summary of the developmental pattern described in the preceding paragraphs. It depicts the relative frequencies of various types of verbal predicates (nonfinite, simple finite and periphrastic) in all verb-containing utterances of a Dutch boy (Peter), as recorded between the ages of 1;9.6 and 2;4.12. These data cover the period that started with the first recording session at which multi-word utterances were observed, and that ended when the subject's use of root infinitives was well within the adult range (approximately 5%). These data are representative of most Dutch-speaking children, although the pattern in this subject is remarkably neat and clear. The curve for the proportion of root infinitives has the shape of a stretched-out, inverted S, which is typical for natural learning curves. In the early samples, we observe a near 100% of root infinitives. This proportion declines gradually over the first 10 to 15

weeks. The infinitive stage covers approximately the first 8 weeks; all of the finite forms during this time were most likely frozen forms. The onset of the *lexical-finite* stage can be set around age 1;11.3 Approximately one month later, at age 2;0.7, the first subject-initial periphrastic predicates emerge, and the root infinitive curve steepens, which reflects the acceleration of the decline of root infinitives mentioned above. This marks the onset of the optional infinitive stage, which ends when an adult-like proportion of root infinitives is observed, at approximately age 2;3.7.
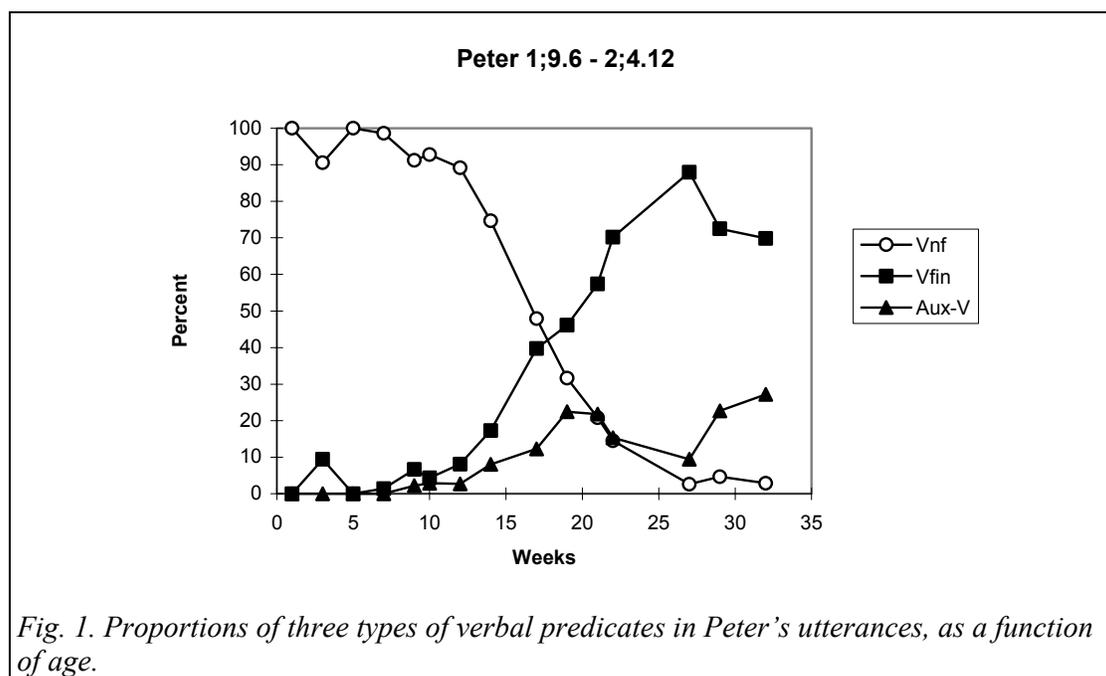
Peter 1;9.6 - 2;4.12

Fig. 1. Proportions of three types of verbal predicates in Peter's utterances, as a function of age.

3. Can the UG-inspired hypotheses explain the developmental sequence?

3.1 Maturation

I will concentrate on the maturational hypothesis proposed by Radford (1988, 1990), since it appears to yield predictions that are directly relevant to the linguistic domain discussed here. Radford contends that functional categories, such as *Comp* and *Infl* are absent from the child's initial grammatical representation. Functional categories depend on a module of Universal Grammar, viz., the Case Module, which is assumed

to mature some time after the child has started to produced multi-word sentences. Hence, small children's sentences are 'small clauses', elementary connections of a subject and a predicate, without a grammatical 'superstructure'. The hypothesis predicts, among other things, that verbs will not be marked for tense and agreement, and that verb second does not occur.

To a large extent, the Dutch developmental data are compatible with this hypothesis. We have seen that there is an infinitive stage, in which productive (generalized) use of finite verb forms is not attested, and that this phase is followed by a stage in which verb second arises and becomes productive. However, the data also pose a problem for Radford's hypothesis. If functional categories mature at some point, we would expect that all clause types that depend on the availability of these categories would appear at roughly the same time. The data indicate however that different types of finite structures come in at disparate points in time. The order of appearance is roughly: (1) simple finite structures (X-V_{FIN}-Y), either without subject, or with a post-verbal subject; (2) subject-initial simple finite structures; (3) compound predicates (X-Aux-Y-V_{INF}) without a sentence-initial subject; (4) subject-initial compound finite structures. Moreover, it has been shown elsewhere that functional elements in the nominal domain and functional elements in the verbal domain show different patterns of development (Ingham 1994, Ruhland, Wijnen & Van Geert 1995).

3.2 Ordered parameters

Gibson and Wexler (1994) assume that three parameters determine the major variations across languages with regard to the positioning of verbs, subjects and complements: (1) the head-complement parameter, which specifies, roughly, whether basic word order is Object-Verb or Verb-Object; (2) the Specifier-Head parameter, which determines the order of subject (specifier) and verb (head): SV or VS; and (3) the V2-parameter, which determines whether the language has *verb second* or not.

Within the parameter setting framework it is generally assumed that particular sentences in the input point directly to a correct parameter setting. Such sentences (structures) are called triggers. Furthermore, it is assumed that even though the learner does not know which structures trigger which parameters, eventual convergence on the target grammar is

guaranteed (in the limit). This means that irrespective of the parameter values that determine the current grammar, there will be a (series of) trigger(s) that enables the learner to reach the target grammar. Gibson and Wexler (1994) argue however that this assumption is incorrect. The discovery of the correct definition of the vector constituted by specifier-head, head-complement, and V2 parameters is highly problematic, given the usual assumptions, such as the subset principle, the single value constraint and the absence of negative evidence. Starting from the idea that development is continuous and involves only setting and resetting parameters, the authors point out that learners may be 'misled' to assume parameter settings from which 'pathways' to the parameter settings of the target grammar are not available (these are called local maxima). A pathway, in this context, refers to an ordered series of triggers.

The solution Gibson and Wexler propose is that during particular phases in the acquisition process, certain parameter values cannot be set or reset. The learner, in other words, does not consider a particular (set of) parameter(s) in trying to account for the structure of the input language. Specifically, in the initial stage of syntactic acquisition, learners will not consider the V2-parameter, but try to account for the input structures in terms of the specifier-head and head-complement parameters only. In other words, the language learner postpones setting the V2 parameter until after the other two parameter values have been triggered.

Gibson and Wexler show that this constraint guarantees convergence on the target grammar, and does not lead to local maxima. They go on to suggest that their — computationally motivated — proposal has empirical ramifications. The proposal is claimed to predict an early stage in the development of verb second languages in which verb-second patterns are infrequent or even non-existent. We have seen that such a stage occurs in the acquisition of Dutch syntax. We have also seen that during this stage children use the canonical order of verb arguments, SOV. Consequently, Gibson and Wexler's proposal appears, at first sight, to hold water.

However, on second thought, matters are not as straightforward as they seem. Recall that the input to a child acquiring Dutch contains every possible word order, SVO, as well as SOV and OVS (Kempen, Gillis & Wijnen 1997). There is nothing (under Gibson and Wexler's assumptions) to prevent the learner in the initial stage of syntactic acquisition from misinterpreting the data. Particularly, V2 structures may be (mis)taken to signify the VO-setting of the head-complement parameter.

The assumption of the existence of a specific trigger for the V2 parameter does not seem to bring relief, since on Gibson and Wexler's assumptions, this parameter cannot be set. In conclusion, it appears that the predominance of nonfinite (non-V2) constructions in early Dutch and German does not follow from Gibson and Wexler's proposal.

3.3 Lexical learning

The general idea is that functional projections necessary to apply the verb second operation become available ('are triggered') as a result of acquiring words and morphemes and their grammatical features:

> "… phrase structure positions are said to emerge gradually in children's grammars, and the creation of new positions and features in phrase structure is driven by the child's learning of words and morphemes." (Clahsen, Kursawe & Penke 1996: 6).

Clahsen (1990) has proposed that the functional category *AgrS* (which hosts subject-verb agreement features and can be considered to be a component of the *Infl*-complex) is triggered by the acquisition of inflectional paradigm. In the initial stages of the acquisition of German (phases II and III in Clahsen's scheme), children only use *0* (stem), *-n* (infinitive) and incidentally *-t* verbal suffixes. According to Clahsen, these suffixes do not yet signify agreement, and the host position for verb second is underspecified. The agreement paradigm is completed when in a later stage (phase IV) the second person singular suffix *-st* becomes productive. This gives rise to the emergence of the AgrS category.

Clahsen's proposal was based on German child language data, which appear to be highly similar to the observations for Dutch. The overview in section 2 showed that children have no mastery of the agreement system during the initial stages of syntactic development. At some point (the 'lexical-finite stage'), the verb second pattern arises, but it is restricted at first to a limited range of elements (mainly modals). This is suggestive of an 'underspecified' V2 position. It is not clear, however, whether the onset of the optional infinitive stage, during which verb second is generalized and root infinitivals rapidly vanish from the child's repertoire, coincides with the mastery of the agreement paradigm. In fact, the available evidence suggests that Dutch-speaking children have not yet mastered it at this particular point (Wijnen 1993, De Haan, Frijn & De Haan 1995).

A more principled problem with Clahsen's proposal, and with lexical learning in general, is that it appears to be unable to account for the highly stereotypical developmental sequence in Dutch- and German-speaking children (and, by assumption, in all children). The acquisition (or emergence) of syntactic structure is assumed to depend on the acquisition of lexical items. However, the acquisition of the vocabulary, as we now understand it, is essentially an unordered, random process. Particularly, the discovery of the agreement system depends on the acquisition and morphological analysis of finite verbs. The point is that we have no clue as yet as to why finite verb forms — more specifically, the agreement markers that are associated with them — are acquired later than infinitives.

4. The *output-as-input* approach

We have seen that the three developmental hypotheses rooted in the parameter-setting approach to language acquisition are, at best, only partially successful in accounting for the empirical problem at hand, viz. the acquisition of Dutch verb placement patterns. Most notably, these hypotheses show various shortcomings in accounting for the stereotypical and highly invariant sequence of stages Dutch-speaking children pass through en route to the mastery of the rules of verb placement.

I will now present a developmental hypothesis, which in contrast to the ones discussed above is not based on theoretical solutions to the logical problem of acquisition. My proposal is specifically aimed at accounting for the actual, observable course of language development. It is a hypothesis about a psychological process crucially involved in language acquisition, rather than a theory which specifies the computational preconditions needed to get from knowledge state X to knowledge state Y. The hypothesis, in the form presented here, was inspired by, and in fact grew out of the ideas put forth by Loekie Elbers (1995, 1996, to appear) in the framework of her output-as-input model of language acquisition. One of the main claims of this model is that the primary data for language acquisition are not the utterances as adult speakers produce them, but rather children's own incomplete and partially analyzed versions of these sentences. In the hypothesis to be described here, it is assumed that children's own production affects perception and analysis of the language input. Obviously, there are also overlaps between this

approach and various other proposals on the alterations of the child's perception of the language input in connection with the development of grammar, as it is reflected by production data (e.g. White 1982).

With Corder (1967) and many others, I draw a distinction between language input (in principle, all utterances the child can perceive) and language intake (the child's selection from the input). I assume that the data base children use to derive hypotheses on the structure of the target grammar is to be equated with the intake, rather than the input. The language learner's selection of data from the input is determined by *relative salience*. What is salient to the learner depends on two factors. The first of these relates to the conglomerate of physical and distributional characteristics of spoken utterances that affect perceptual processing. The acquisition literature is replete with suggestions that constituents in stressed positions, as well as those at phrase or clause boundaries (which are also prosodically marked) are more easily perceived and processed than unstressed or clause-internal elements (Slobin 1973, Peters 1983, Gleitman, Gleitman, Landau & Wanner 1988, Echols & Newport 1992). I would re-state this observation by saying that, all other things being equal, intake is determined by (prosodic) stress, and position.

The second factor that co-determines the relative salience of (parts of) utterances in the input is constituted by the knowledge the language-learning child has already acquired. This 'current knowledge' affects the selection of language data from the input in several interconnected ways. (a) It directs attention to (parts of) utterances that contain elements the language learner has already learned (Pinker 1984). (b) It directs attention to (parts of) utterances that are slightly deviant from what the learner already knows. This derives from a general principle of human attention, viz. that it is attracted by that which is slightly, but not too much different from expectation (Kagan 1984). (c) In connection to (a) and (b), it is hypothesized that attention is primarily focused on parts of utterances that surround elements that are familiar to the learner (the 'island hypothesis').

The first factor supposedly has a constant, non-evolving impact. At any time during the developmental course, prosodic and distributional features will affect the relative prominence of certain parts of the input utterances in the same manner. The second factor, current knowledge, introduces variability. It is obvious that knowledge of language, or

familiarity with particular linguistic elements and structures, is constantly changing in the developing child. I assume a mutual interaction of knowledge state and selection of data from the input. Language acquisition is assumed to involve a recurrent, iterative and incremental process in which attained knowledge *X* determines intake *X+1*, which results in knowledge *Y*, which causes intake to include *Y+1*, and so on, until the learner's knowledge converges at the target grammar.

Within this framework, 'knowledge of language' refers to the representations that enable the language learner to produce structured utterances. In other words, language knowledge can be evaluated by what the child is actually producing. Consequently, what is taken in (i.e., selected from the input), is determined by what the child himself is capable of producing, hence 'output-as-input'.

5. Can *output-as-input* explain the developmental pattern in Dutch children?

In the following discussion, I will apply the assumptions outlined above to the Dutch acquisition data presented in section 2.1. The goal will be to demonstrate the viability of the output-as-input approach. I hope to show that the child's own productions during a certain stage predict what his or her progress in the next stage will be. Also, I intend to highlight the importance of knowing what the actual linguistic input is. The output-as-input hypothesis (as well as, I think, any other developmental hypothesis) will fail to make accurate predictions in the absence of accurate information on the kind of data the learner is confronted with.

5.1 The infinitive stage

Due to the rules of verb-placement in Dutch, infinitive verb forms occur predominantly at sentence-final positions. Kempen, Gillis and Wijnen (1997) show that, on average, around 50% of all utterances in child-addressed speech which contain at least one verb have a final infinitive. The child's processing and storage of infinitives may be facilitated by something analogous to the 'recency effect', well-known from investigations into short-term memory, as well as the raised salience which results from co-occurrence with prosodic markers typical of clause-final boundaries. Moreover, the sentence-final infinitives that caregivers use in talking to their children are semantically salient. Virtually all of them

refer to actions (or dynamic events), which means that they have relatively transparent referents. By contrast, around 50 percent of the finite verbs in child-addressed language are (modal) auxiliaries or copula's, which do not have any concrete referents at all. Of the remaining lexical finite verbs, about 42% refer to states or otherwise non-dynamic eventualities (Kempen et al. 1997). Kempen et al. (1997) also report that the type-token ratio of sentence-final infinitives is considerably higher than that of the left-peripheral finite verbs. While the number of different verb types in both positions is approximately equal, the numbers of tokens are markedly different. Kempen et al. take this to indicate that — in the long run— sentence-final verbs contribute more to the difference in meaning between sentences than finite verbs do (in this particular register). An immature language learner who is eager to use his limited processing resources as efficiently as possible had better focus on the sentence-final words.

On the basis of the above observations, the prediction that the first verb forms Dutch children acquire are infinitives is almost self-evident. And indeed, an inventory of the words most frequently represented in children's early (pre-syntactic) vocabulary compiled by Schlichting (1996), supports this prediction. She found that all of the verbs children use in the single-word stage are infinitives.

One of the assumptions of the output-as-input hypothesis is that what children already know (i.e., are capable of producing) co-determines their selection of materials from the input data, by directing their attention to utterances that contain familiar elements (Pinker 1984). We have seen that infinitives, as a result of their prosodic and distributional attributes, as well as their semantic and informational features have a head-start over finite verb forms. The consequent intake and reproduction of infinitives further boosts their salience in the input language. Because children have learned to produce infinitive forms, their attention will be drawn (even more strongly) to those input utterances that contain these forms, i.e., utterances which involve a compound verbal predicate (X-Aux-Y-V_{INF}).

Of course, the child's early vocabulary not only contains infinitive verb forms, but also a number of other content words, notably nouns (words referring to objects and people). As a result of this, the child is able to detect the canonical order of the verb and its major arguments (SOV), as

it is reflected in the structure of the periphrastic predicate (Aux-V$_{INF}$) constructions that adult speakers use so abundantly.

5.2 The lexical-finite stage

Recall that the main characteristic of this stage is the appearance of simple finite structures, which correspond to the template (X)-V$_{FIN}$-(Y). The initial finite verbs are most often modal auxiliaries, and are followed by a limited number of lexical verbs, notably statives. In contrast to English, Dutch grammar allows the use of modal auxiliaries as autonomous predicates, i.e., without an infinitival complement, as exemplified in (6). Another attribute of Dutch grammar that is relevant in this respect is that constituents preceding the finite verb can be dropped ('topic drop'). In colloquial speech this happens very often, so that utterances with a single modal auxiliary in clause-initial position, such as kan niet (can not, i.e. 'that's impossible) or mag wel (may AFF, i.e., 'that's allowed' or 'that's okay') occur quite regularly. It does not come as a total surprise, then, that the first simple finite utterances that Dutch-speaking children produce are of this type.

(6) (dat) kan niet   (that) can not   'it's impossible'
     jij mag morgen   you may tomorrow   'tomorrow you're allowed to ...'
     ik wil wel   I want AFF   'I want to ...'

Kagan's discrepancy principle gives rise to the expectation that when the child starts using (X)-Aux-(Y) structures, the existence of other finite verb forms, which adults use in a structural context similar to that in which modals occur (e.g. past niet 'it doesn't fit'), will be highlighted. As noted above, the various classes of lexical verbs differ in their distributional properties in colloquial Dutch language use (Schlichting 1996, Kempen et al. 1997). Transitive action verbs, for instance, tend to occur in sentence-final position, with the appropriate (infinitival) morphology. State verbs (e.g. *past* 'fits') and non-dynamic verbs (*lig* 'lies'), on the other hand, are more often used as finite forms in left-peripheral position. Thus, the prediction is that the first lexical verbs children use in finite form are statives. This is corroborated by the data.

5.3 The optional infinitive stage

The onset of this stage is marked by the appearance of sentences with Aux+V_{INF} predicates, as well as an accelerated decrease of the number of root infinitives. The auxiliaries in the early periphrastic predicates tend to be modals. We have seen that prior to this stage, the child uses (X)-Y-V_{INF} structures (root infinitives), as well as (X)-V_{FIN}-(Y) structures, in which the verb slot is most often occupied by a modal auxiliary. These two structures can be seen as 'building blocks' of the (X)-Aux-(Y)-V_{INF} structure. One of the assumptions of the output-as-input approach is that the language learner's attention is drawn to small discrepancies between his or her own productions and those in the language input (the discrepancy principle). Sentences in child-addressed speech that are — in terms of major constituent order — maximally similar to children's root infinitives contain a finite auxiliary in the left periphery (first or second position). In 80-90 percent of the cases, this auxiliary is a modal or the aspectual auxiliary *gaan* 'to go' (Blom, Wijnen & Gillis, to appear). Therefore, we predict that (finite forms of) the modal verbs and gaan will become relatively salient. This salience is boosted by the fact that these elements are already used as independent predicates. The result is that the periphrastic predicate structure is added to the child's repertoire. It is interesting to note once again that the first aux+V_{INF} constructions children produce tend to have a sentence-initial modal verb. This testifies to the fact that perceptual salience, due to a distributional factor (position) is still contributing to the process of selecting from the input. Studies of the impact of input in English-speaking children (Newport, Gleitman & Gleitman 1977, Furrow, Nelson & Benedict 1979) have shown that auxiliaries are acquired faster when caregivers use many yes/no questions, in which auxiliaries are fronted. Generalizing this result, we may conclude that discrepancy between Dutch children's X-Y-V_{INF} template and the adult model is most noticeable if the modal auxiliary is in the perceptually salient utterance-initial position.

The (re)production of aux+V_{INF} structures, as well as the growing number of finite lexical verb forms in the vocabulary prepares the learner for the pre-final stage in the developmental sequence. The range of grammatical structures that the child now has productive command over is sufficient to enable the discovery of a distributional, or possibly a

transformational relation, between the sentence-final verb position and the verb second position. Furthermore, the child will be in a position to discover that infinitives are dependent on finite forms, in other words, that they cannot occur as matrix predicates.

6. Conclusions

In this paper, I asked how consistent and stereotypical sequences of stages in the acquisition of grammar can be explained. I presented three more or less 'classic' developmental hypotheses derived from the parameter setting framework, and argued that none of these is entirely successful in accounting for the data on the acquisition of Dutch verb placement. I sketched the outlines of a developmental hypothesis based on Elbers' (1995, 1997, to appear) 'output-as-input' framework. The core assumption is that the data set on the basis of which children derive grammatical representations, increases in a gradual, deterministic way. It is definitely not the case, though, that the actual input, i.e., the corpus of utterances that adults use to address their children, extends over time in any relevant way (see Kempen et al. 1997). Rather than that, I have proposed that the child's *selection* from the language input determines the expansion. While input is constant, the child's *intake* changes. What is taken in is thought to be determined by a conspiracy of factors which jointly affect the relative salience of parts of the language input. Among these are prosodic and distributional features. More importantly, the relative conspicuity of parts of the language input depends on knowledge the learner has already acquired. Utterances which contain elements that are in the child's productive repertoire are more salient than other utterances. Also, utterances that are partly familiar are more liable to further analysis than utterances which contain only unfamiliar elements. These assumptions lead to an incremental, iterative model of language acquisition: intake determines knowledge (and reproduction), which in turn determines new intake, and hence, new knowledge, and so forth, in recurrent cycles, until the difference between the input and what the learner is capable to output reaches an asymptote.

There are three major differences between the output-as-input approach and the parameter-setting approaches discussed previously. First of all, the output-as-input hypothesis is not a derivative of a theory devised to explain the logical problem of language acquisition. Rather, the ap-

proach is exclusively and purely focused on the empirical problem of language acquisition, and in fact is completely independent of theoretical approaches to the logical problem. It is, in other words, an algorithmic, rather than a computational hypothesis (Marr 1982). In this connection, I should stress that I have not had the intention to portray output-as-input as an all-encompassing hypothesis for language acquisition. Rather, its scope is limited to a single, albeit central, aspect of the empirical problem, viz. the orderly and highly stereotyped succession of steps in the attainment of the target grammar. The claim is that this phenomenon can be fully ascribed to the learner's changing perception of the primary data. But no more than that. Output-as-input has nothing to say on how learners project grammars from the data they have access to.

A second difference with the principles-and-parameters-inspired approaches presented above is that the output-as-input hypothesis is 'agnostic' with respect to the nature of the mature linguistic competence. Although I personally tend to think about linguistic competence in terms of Chomskyan approaches to grammar, the output-as-input approach may well be compatible with other, even radically different models of grammar. (This, by the way, underscores once more the algorithmic nature of the output-as-input approach, and its independence from computational theories about syntax and syntax acquisition.)

Finally, despite my own bias towards the principles-and-parameters framework, the output-as-input approach does not seem very comfortable with an analysis of children's early grammatical patterns in terms of the highly abstract categories and representations such as are assumed by the maturational, ordered parameters, and lexical learning approaches discussed in section 3. An assumption implicit in output-as-input is that in the initial phases of the acquisition process, combinatorial patterns in children's speech are tightly bound to particular (sets of) lexical items. Such lexical-combinatorial patterns, or 'limited scope formulae' pave the way for generalized, more abstract representations.

I have attempted to show that output-as-input meets with some success in accounting for the developmental domain at hand, i.e., the acquisition of Dutch verb placement. An obvious question of course is whether the approach is viable in a broader sense. I would like to discuss two aspects of this matter. First, one might raise the question whether the idea that language learners' own production directs the acquisition process is valid. There are indications from other domains of language learning

which suggest that children's own productions have an impact on the way language input is perceived and processed. Notably, there are documented effects of babbling patterns on the acquisition of first words (Schwartz & Leonard 1982, Elbers & Ton 1985, Vihman 1993). In fact, the output-as-input model as applied here can be seen as an extension of the principle that has been argued to affect development in the lexical-phonological domain, to the domain of syntax.

Secondly, the present proposal contends that children learn the language of their mother tongue through the analysis of a restricted, albeit gradually extending data set. Is language learnable at all under this condition? Learnability theorists have argued that this is detrimental to the acquisition process, since the number of hypotheses that can describe a set increases as the variation in the data is restricted. Thus, the task of language learning will become more difficult (Wexler 1982). Gleitman and Wanner (1982) wonder why it is so hard to get this notion across to (most) developmental psycholinguists:

> "It seems reasonably obvious that learning should be more difficult from limited and biased ('degenerate' in Chomsky's wording) data than from rich and unbiased data." (Gleitman & Wanner 1982: 40).

Fortunately, there are psycholinguists who scrutinize the obvious. Elman (1991) constructed a recurrent network (i.e., a connectionist network that 'stores', and has access to its previous states through a feedback loop), and trained it to process sentences. He used a large corpus of utterances derived from a toy grammar that allowed recursive embedding, which is one of the hallmarks of natural language, and that cannot be learned by statistical inference. The criterion variable was the network's success in predicting the form of a verb, given a particular subject. The network was unable to learn subject-verb agreement relations when it was presented with a corpus containing all sentence types generated by the grammar. However, when the presentation of data was organized in such a way that the system saw only simple (non-embedding) sentences in the initial phase, and gradually increasing numbers of complex sentences in the subsequent training phases, the network was highly successful. A quantitative analysis of the activation states at the end of the training revealed that the system had 'identified' the main sources of variance in the data (i.e., the main grammatical principles) and represented them in an orderly fashion. The same result was obtained when the network's 'memory capacity' (i.e., the depth of the internal feedback loop) was

restricted in the initial training phase and gradually expanded in subsequent phases. Thus the — non-obvious — outcome of this study is that learning is improved when either the input or the processing capacity is reduced.

Why is Elman's 'incremental learning' successful? When the data base is reduced (either through input or processing restrictions), the number of grammatical principles that are relevant for, or are capable of, adequately describing the data is restricted. Consequently, the number of possible interactions between these principles is reduced. The learner's task — determining the characteristics of the principles that generate the data set — is therefore simplified. The learner is required to generate internal representations of this limited set of principles only. "When learning advances (either because of new input, or because the network's memory is expanded), all additional changes are constrained by this early commitment to the basic grammatical factors" (Elman 1991: 9; see Goldowsky & Newport 1993 for a related argument).

In considering the consequences of his study for primary language acquisition in humans, Elman argues that it is highly unlikely that the set of input data is restricted in the early phases of learning. However, he deems it likely that the young child's processing capacity is restricted, and that it gradually expands as a result of, for instance, neurological maturation. This would constitute the natural counterpart of gradually expanding the temporal window in the artificial system. However, although there is undoubtedly neurological maturation in the young child, it is highly unclear what shape it takes, and in what ways it may interact with language processing. On the other hand, a restricted and gradually expanding set of data available for analysis may not be so far-fetched. The output-as-input hypothesis provides a mechanism by which language *intake* (rather than input) expands gradually and predictably.

Is the framework sketched here applicable to other domains of grammatical development? My expectation is that it can be successfully applied to all areas of phrasal structure, but this awaits further empirical work. And of course, as 'output-as-input' draws on supposedly universal properties of language processing, it is necessary to test it against acquisition data of other languages. In this connection, I should stress once more, that such expansions can only be validly pursued if accurate descriptions of the actual input to the child are available.

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