# Language Impairment, Neurology and Linguistic Theory

M.A. Thesis

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# 1 Preliminaries

This chapter contains the preliminaries: first a general introduction to the structure of the paper, followed by my acknowledgements and a list of abbreviations.

## 1.1 Introduction

This study is about the neural predisposition of the brain underlying human species-specific linguistic competence. It is about the connection between neurology and linguistic theory. I discuss how findings from language impairments can play a crucial part in determining the proper linguistic theory, as the latter must be compatible with the patterns found in language deficits.

The structure of the study is as follows: First, I give a general introduction to the grammatical framework of generative grammar in chapter 2. I describe the modular structure of the grammar and introduce the modules (sub-theories) relevant for this paper. Chapter 3 is about the biology of language - the evolution of language, the localization of language in the language zone on the left hemisphere, and language acquisition as viewed from the brain. I then turn to language impairment in chapter 4, discussing the dissociation between language and intelligence as reflected in developmental deficits such as Down's syndrome and in acquired deficits, i.e. different types of aphasia. The survey of language breakdown will also provide evidence for the internal modular structure of the human language competence. Chapter 5 is a discussion on the correlation between lesion site and language function. In chapter 6 I present a syntactic approach to Broca's aphasia based on the general framework of generative grammar, which I use in chapter 7 to make some predictions about agrammatism in Danish. These predictions are tested empirically on a Danish subject with some aphasic symptoms due to lesions in the language area. Based on the previous chapter and the test results I return to the discussion on brain area and function in chapter 8. Finally, In chapter 9 I draw my conclusions, one of which is that language is reflected in the architecture of the brain and therefore linguistic theory can be used to predict specific symptoms of language breakdown in any language.

## 1.2 Acknowledgements

Thanks to TJ, who volunteered to help me by taking the language tests, and to Gerald Fischer (speech therapist at Kommunehospitalet, Aarhus) for establishing contact with

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## 1.3 Abbreviations

| | | | |
|---|---|---|---|
| **Adject** | Adjectival | **Obj** | Object |
| **AdjP** | Adjective Phrase | **P** | Preposition |
| **Adv** | Adverb | **PASS** | Passive |
| **AdvP** | Adverbial Phrase | **PERF** | Perfect |
| **AgrP** | Agreement Phrase | **PERF+** | Double perfect |
| **AUX** | Auxiliary verb | **PERS** | Person |
| **C** | Complementizer | **PF** | Phonetic Form |
| **Compl** | Complement | **PL.** | Plural |
| **Conj** | Conjunction | **PP** | Preposition Phrase |
| **CP** | Complementizer Phrase | **PRES** | Present |
| **DP** | Determiner Phrase | **Psych** | Psychological |
| **e** | Empty $X^0$ | **PT** | Past |
| **FEM** | Feminine | **PTCP** | Participle |
| **I** | Inflection | **SING** | Singular |
| **INFL** | Inflection | **Spec** | Specifier |
| **INF** | Infinitive | **Sub** | Subject |
| **IP** | Inflection Phrase | **t** | trace |
| **LF** | Logical Form | **TnsP** | Tense Phrase |
| **MASC** | Masculine | **V** | Verb |
| **N** | Noun | **VP** | Verb Phrase |
| **NegP** | Negation Phrase | **$X^0$** | Head of an XP |
| **NP** | Noun Phrase | | |

# 2 Linguistic Theory

The linguistic framework in which I shall be working is *generative grammar*. I shall try to avoid being too loyal to any specific version of generative grammar while trying to retain the principles underlying most recent versions of the theory within the principles and parameters frame, and therefore my grammatical analyses will be very much influenced by *Government and Binding Theory* (Chomsky 1981, Haegeman 1994, Vikner 1999). At least in principle, it will also be compatible with more recent linguistic developments such as the *Minimalist Program* (Chomsky 1993, 1995) and *Optimality Theory* (e.g. Archangeli & Langendoen 1997, Grimshaw 1997, Kager 1999, Vikner 2000), as these frameworks all share some of the same core principles.

Generative linguistics takes as its goal to give an account of the linguistic competence of humans, and as language is a universal human trait this competence is conceived as a universal grammar (UG). This grammar consists of two parts: First, the basic underlying universal *principles* that are shared by all languages of the world. They are motivated by the simple fact that language is universal. Second, there is a set of *parameters* whose settings determine the specifics of any language of the world, such as the basic word order, for example Subject–Verb–Object in Danish. This is motivated by the fact that languages are different in various but not arbitrary ways. Language acquisition is viewed as the setting of these parameters on the universal grammar by exposure to the ambient language. From this follows that the goal of generative linguistics is not to describe the details of one specific language but rather to formulate what principles determine the grammar of any language. In my description I only include the principles relevant for the task at hand and only the necessary elaboration. For general overviews I refer the reader to Grodzinsky 1990 (chapter 2 – an excellent introduction), Haegeman 1994 and Vikner 1995 (chapter 2). The following is only a brief and very general overview, but I shall give more specific definitions and introduce further principles when required throughout the text.

## 2.1 Modular Organization of the Grammar

The grammar generates several *levels* of representation for every sentence. First, there is an underlying structure called the *D-structure*. This is posited to account for the structural (and semantic) connection between corresponding actives and passives. For example, there is a strong connection between "*the boy kisses the girl*" and "*the girl is kissed by the boy*". They are not quite synonymous, but the relation is clearly felt. The scenario (the kissing), and the thematic relations (the kisser and the kissed) between the participants (the boy and the girl) are the same. The active and passive sentences are two instantiations of the second level of representation: *S-structure*. As will be explained below, some of the elements of the sentence are moved to other positions in order to reach the S-structure from D-structure, cf. the difference in structure between the active and the passive. Third, there is a phonological representation, or *Phonological Form* (abbreviated PF), which is the form used for phonetic interpretation. Fourth, there is the logico-semantic representation called *Logical Form* (LF). The levels are organized as follows:

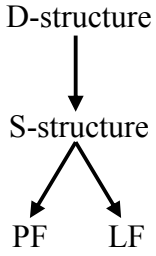



**Figure 1: The organization of the grammar**

The principles of grammar are modularly organized. A module is a mechanism, which is responsible for a designated domain. Therefore, the principles do not necessarily apply at all levels, as they may or may not share the same domain or even parts of the same domains. Anticipating the following descriptions of the principles involved, I just list the principles here without going into details. In the figure below the principles are placed in boxes, and the arrows point to the levels at which they apply, i.e. their domain (I leave out principles not presented in this paper):

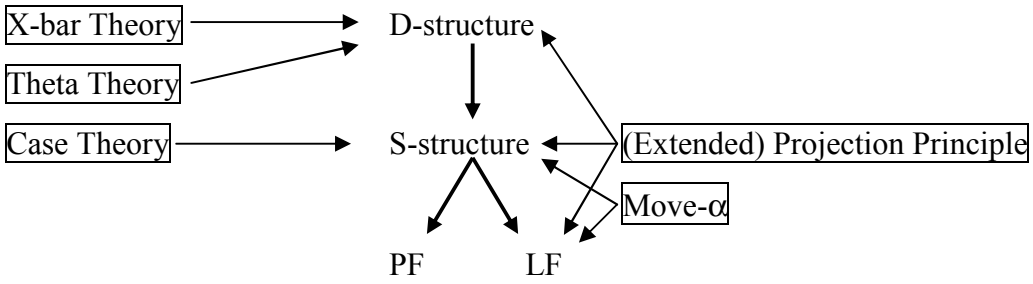



**Figure 2: The modular organization and the domains of application of the grammatical principles (adapted from Grodzinsky 1990: 25)**

Consider the following example, in which I have left out some syntactic elaboration that will be introduced later (I exclude PF and LF throughout the text, as they are not crucial for my account):

| | "*The boy kissed the girl*" | "*The girl was kissed by the boy*" |
|---|---|---|
| D-structure | [ – ed [ [the boy] kiss [the girl] ]] | |
| S-structure | [[the boy] – [ – kiss-ed [the girl]] | [[the girl] was [ – kissed – ]] by the boy |

**Table 1: syntactic representations.**

This is an oversimplification, but the concepts will become clear as the principles are presented. The important thing to notice in this example is the common underlying structure. The lines indicate the movement of the verbal inflection "*-ed*" and the noun phrases "*the boy*" and "*the girl*", while the "–" indicate the empty space left by the movement.

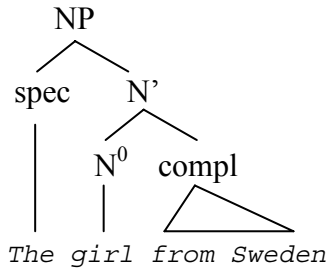
### 2.1.1 X-bar Theory

Important to the theory are the notions of *head*, *complement*, *specifier*, and *projection*. To explain this and the following principles it may be useful to consider an example:

(1) `The boy kissed the girl from Sweden`

A head is an element that gives a larger unit its characteristics. In the sentence above "*the girl*" constitutes a noun phrase. The head of the phrase is the noun "*girl*"[1], and hence the phrase it heads becomes a noun phrase, abbreviated NP. The determiner specifies the head, i.e. it is not just any girl, but the one "pointed out" by the *specifier*. The *complement* of the head "*girl*" is the preposition phrase PP "*from Sweden*", which in turn is headed by the preposition "*from*" taking the NP "*Sweden*" as complement (abbreviated as a triangle in (2) below). The elements are hierarchically ordered in the following way:

(2)




In the representation *spec* is the term used for *specifier*, and *compl* is the term for *complement*. The head of the noun phrase is called $N^0$, the zero level of the noun phrase, and the N' is the next higher level called *N-bar* (which is the level that has become the name of the theory: this level is present in all phrases so in an XP (e.g. a noun phrase or a preposition phrase this level is called *X-bar*). Finally, the highest level is called NP (for noun phrase). This is also called the *maximal projection* of the head.

The X-bar schema is a constraint on all syntactic categories, which means that all phrases must abide by it. Hence, depending on the head, the phrases are: NP (noun phrase), VP (verb phrase), PP (preposition phrase), AdvP (adverbial phrase), and AdjP (adjective phrase). In addition to these *lexical* categories (they are lexical because the heads are words) there are *functional heads*, for example IP (inflectional phrase), which is headed by the verbal inflection. All the phrases, regardless of the type of the head, which is therefore abbreviated X, share same structure: the X-bar structure, which is represented in the following way (a sort of 'flattened tree'):

[1] I leave out the notion of determiner phrases DPs where the head is the determiner (e.g. "*the*"), which takes a NP as complement ([$_{DP}$ *the* [$_{NP}$ *girl*]]) and use the classic term NP instead.

(3) [$_{XP}$ spec [$_{X'}$ $X^0$ compl]]

For example:

(4) [$_{NP}$ *the* [$_{N'}$ *girl* [$_{COMPL}$ *from Sweden*]]]
(5) [$_{NP}$ *boring* [$_{N'}$ *books* [$_{COMPL}$ *about linguistics*]]]

I shall use a slightly abbreviated version of this notation leaving out the X' branching orthographically as shown in (6) and exemplified in (7):

(6) [$_{XP}$ spec X compl]

(7) [$_{NP}$ *boring books* [$_{PP}$ *about linguistics*]]

In this NP, "*boring*" is the specifier of $N^0$, "*books*", and the preposition phrase (PP) is the complement. Henceforth I shall refer to the specifier position of an XP as [spec, XP], which can be read as "specifier of XP".

The structure of the clause includes functional as well as lexical categories. For example an embedded clause like "(*they said*) *that the boy kissed the girl*" is introduced by the complementizer phrase CP headed be the complementizer "*that*", which takes as its complement an inflectional phrase IP headed by the verbal inflection. This in turn takes a VP as its complement. This is illustrated in:

(8) [$_{CP}$ *that* [$_{IP}$ [$_{NP}$ *the boy*] - [$_{VP}$ *kissed* [$_{NP}$ *the girl*]]]]

### 2.1.2 The Lexicon

Words are stored in a mental dictionary called the *lexicon*. A word's lexical entry specifies its syntactic category and its semantic meaning. Consider the verb, or rather the predicate "*kiss*" in the example in (1) above. The lexical entry specifies that it is a verb (V), and that takes a nominal complement (NP) – the verb *subcategorizes* for an NP, which is the entity receiving the kiss (THEME). In addition it selects another NP, which is the entity doing the kissing (AGENT). In other words, the predicate "*kiss*" has

two arguments. The lexical entry specifies their syntactic categories and their semantic roles, and it may be represented like this:

(9) *kiss:* V <AGENT (NP), THEME (NP)>

### 2.1.3 The Projection Principle

The semantics of the predicate (the verb) determines to a large extent the structure of the sentence. First, the specifics of the predicate (its lexical entry) determine the number of arguments and their categories and semantic roles. So, lexical information is also reflected in the structure of the clause:

(10) [$_{NP}$ *The boy*] [$_{VP}$ *kissed* [$_{NP}$ *the girl*]]

So, to obey the *Projection Principle* lexical information must be syntactically represented. Leaving out, for example one of the arguments would result in ungrammatical sentence, as indicated with an asterisk *:

(11) *[$_{VP}$ *kissed* [$_{NP}$ *the girl*]]

### 2.1.4 Extended Projection Principle

According to the *Extended Projection Principle* clauses are projected by the verb. The VP contains the core thematic information: the predicate and its arguments (under the *VP-internal Subject Hypothesis*, defined below). In short, the functional categories (CP and IP, the latter to be further split up in section 6.2 below) do not contribute to the thematic information as such, but tense inflection locates the event in time and the [spec, IP] position assigns NOMINATIVE case to the subject. From a semantic point of view, the clause is an *Extended Projection* of the verb, hence the *Extended Projection Principle* (cf. Grimshaw 1991).

### 2.1.5 Move-α & Trace

As shown in Table 1 above, the connection between D-structure and S-structure involves certain changes to the positions of some of the constituents. These changes are known as *transformations* or *movements*. The principle (or sub-component) of grammar responsible for these transformations is the rule of *Move-Alpha* or *Move-α*.

(12) **Move-α**

"Move anything anywhere"

These movements are constrained by the other modules of grammar in order to rule out ungrammatical forms, such as "**the the kissed boy girl*" and "**was kissed the girl by the boy*". It is the interaction of *Move-α* with the other syntactic principles that results in grammatical strings. It is responsible for the mapping between active and passive, for example.

Movement of constituents results in a phonologically silent but structurally represented position, which is filled with a construct, called a *trace* (*t*). The moved constituent is the antecedent of the trace and together they form a *chain*. The two are further linked together by a shared index. Consider again the example from (8) (without the CP):

(13) $[_{IP}\ [_{NP}\ \textit{The boy}]_1\ t_2\ [_{VP}\ t_1\ \textit{kissed}_2\ [_{NP}\ \textit{the girl}]]]$

The verbal inflection that headed the IP has moved to the verb "*kiss*" in the VP, and has left a co-indexed trace ($t_2$) behind in $I^0$. The subject "*the boy*" has also undergone movement and left a trace, and this movement is due to the *Case Filter*, which I shall now explain.

### 2.1.6 Case Theory

This is the component of grammar specifying the structural position in which lexical NPs may appear. According to this theory all NPs must be assigned abstract case. In some languages this case is overtly realized as case endings, e.g. German, while in others it is invisible, e.g. English. Certain elements are case assignors, such as tense

inflection, verbs, and prepositions. Thus, syntactic structures containing NPs unmarked for abstract case are labeled ungrammatical and filtered out by what is called the *Case Filter* at the level of S-structure, cf. Figure 1:

(14) **Case Filter**:
*NP $_{[+lexical, -case]}$
In other words: all lexical NPs must have case.

In the example in (13) above, the subject was forced to move to [spec, IP] (specifier of the inflection phrase IP) in order abide the *Case Filter*. If it remains in its base position inside VP (I shall return to the position of the subject shortly; so far, suffice it to say that the subject is moved) it will not be case marked and the structure will be filtered out. The subject case NOMINATIVE is assigned to [spec, IP], and object case ACCUSATIVE is assigned by the verb to its complement "*the girl*". Thus, the interaction of the *Case Filter* and *Move-α* determines the position of the subject.

### 2.1.7 Theta Theory

Arguments are assigned semantic / thematic roles, known as theta-roles or *θ-roles*, such as AGENT (the 'doer' of the action specified by the predicate, e.g. "*the boy*" in (1)) or THEME (the entity affected by the action). A principle called the *Theta Criterion* (Chomsky 1981) ensures that all arguments are assigned one and only one θ-role and that all θ-roles of a predicate are assigned to appropriate structures in a one-to-one relation. This can be illustrated as follows:

(15) $\text{Argument}_1 - \theta\text{-role}_\alpha$
$\text{Argument}_2 - \theta\text{-role}_\beta$

θ-Roles constitute a universal set including the following:

(16) AGENT: The one intentionally doing or initiating the action expressed by the predicate.

THEME: The entity affected by the action or state expressed by the predicate.

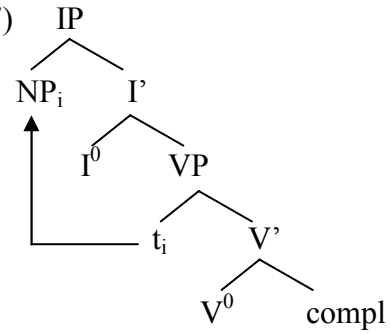
EXPERIENCER: The entity experiencing the psychological state expressed by the predicate.

There are other θ-roles, but the ones defined above are the only ones needed for my purposes in this study. For further information, see e.g. Haegeman (1994: 49ff) and Jackendoff (1972).

### 2.1.8 The VP-Internal Subject Hypothesis

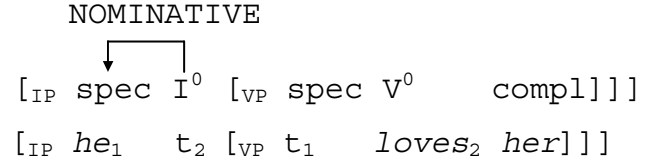
According to the *VP-Internal Subject Hypothesis*, the subject is base generated inside the verb phrase in [spec, VP] (specifier of VP), cf. Burton & Grimshaw (1992). As explained above, to abide the *Case Filter* the subject moves to [spec, IP] to be assigned NOMINATIVE case leaving behind a *trace*, with which it shares a common index (i):

(17)



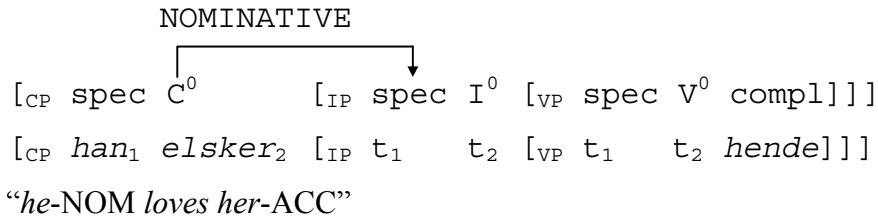

The idea is that in the underlying structure (the D-structure) the subject ($NP_i$ in the diagram) is generated in [spec, VP], where $V^0$ assigns a θ-role to the NP (in other words, the verb theta-marks the subject). In English NOMINATIVE is assigned to [spec, IP] by $I^0$ (cf. Haegeman 1994):

(18)




"*he*-NOM *loves her*-ACC"

In Danish, NOMINATIVE is assigned to [spec, IP] by $C^0$ (e.g. Vikner 1995: 54ff.):

(19)



"*he*-NOM *loves her*-ACC"

### 2.1.9 Parameters

As mentioned above, the grammar consists of principles and parameters. An example of the latter is reflected in the difference between (18) and (19) above. The parameter involved 'decides' what assigns NOMINATIVE case: in Danish $C^0$ is the NOMINATIVE-assignor and in English it is $I^0$.

Another parameter concerns word order: in e.g. Danish and Swedish the finite verb is always the second constituent in the sentence (preceded by the subject or a topicalized element), while this is not the case in English and French. All four language shave Subject-Verb-Object (SVO) word order, but in Danish and Swedish the verb is always second, so if e.g. the object is topicalized the subject follows the verb: Topic-Verb-Subject. This is not the case in English and French, where the verb must follow the subject: Topic-Subject-Verb. This parameter is the V2 (verb second) parameter: Danish and Swedish are V2 languages, English and French are not. Briefly, in the grammar of a child acquiring e.g. Danish parameters will be set to SVO and V2, while an English child will have the same parameters set to SVO and non-V2 (this is a simplification but it will suffice).

Still another example of a parameter is the type of case system a language has. For example English, German, Hebrew and Danish all have a NOMINATIVE-ACCUSATIVE case system while for instance Chukchi (a language of the north-east Siberia, cf. Comrie 1989: 104) and Bandjalang (spoken in the northern New South Wales in Australia, cf. Crowley 1997: 137) has ABSOLUTIVE-ERGATIVE. Other languages have both types, such Diyrbal (a language of the northeastern Queensland in Australia, cf. Comrie 1989: 113).

| | INTRANSITIVE | TRANSITIVE | |
|---|---|---|---|
| | *"she pushed"* | *"she pushed him"* | |
| Grammatical Roles | Sub | Sub | Obj |
| Accustive System | **NOM** | **NOM** | ACC |
| Ergative System | **ERG** | ABS | **ERG** |

**Table 2: (NOMINATIVE-) ACCUSATIVE and (ABSOLUTIVE-) ERGATIVE cases systems.**

In the ACCUSATIVE system the subject in both transitive and intransitive clauses is always in NOMINATIVE case. In the ERGATIVE system the subject of an intransitive clause has the same case marking as the object of a transitive clause, i.e. ERGATIVE case. The English gloss of the ERGATIVE version of "*she pushed him*" would be "*her pushed he*".

In summary, the principles and theories listed here are sub-components of a modularly structured grammar. In interaction they generate the grammatical structures of a language. In chapter 6 I shall argue that the modular structure of the grammar is relevant and even crucial in the definition and diagnostics of aphasia.

# 3 Normal Brains: The Language Area

In this chapter I first discuss the evolution of language and the brain, which most likely started with a cognitive 'arms race' leading to selection for bigger brains. In time language has become represented in the architecture of the human brain: species-specific, universal, and innate. Then I move on to discuss where language functions are located in the brain: nowhere, everywhere, in one place or in many places. This leads to the next section in which I zoom in and look at an area in the left hemisphere. This area, I shall argue, is the language organ and I support this claim with a brief survey of language acquisition from a neural perspective. In short, this chapter is about the biology of language.

## 3.1 Evolution of Language

As mentioned in the preceding chapter, the goal of generative linguistics is to provide an account of the human linguistic competence. This competence is both unique to mankind and universal among the peoples of the world. This *species-specificity* naturally entails that language is different from any other kind of communication in the animal kingdom (cf. Deacon 1997; Donald 1991; Pinker & Bloom 1990). Some aspects of animal communication and the rudimentary symbolic communication (laboriously) taught to apes may have some analogies to human language in the same way that bat wings are analogous to the 'wings' of flying squirrels – both are used for flying. It is clear though that the two kinds of wings are not *homologous*, which means sharing the same basic structural design stemming from a common ancestor. Bat wings are modifications of the hands of the common mammalian ancestor and the wings of the flying squirrel are modifications of the rib cage (cf. Pinker 1994, 1995). *Universality* covers the observation of the fact that all peoples of the world have a language – no mute and non-signing tribe has ever been discovered. Together these two facts, species-specificity and universality, point to some kind of specific human capacity or *faculty* represented in the brain as some sort of neural circuitry that is unique and universal to humans and dedicated to language processing. In other words, the universal grammar described above is *innate*. Such a claim, I think, has to be supported by a feasible account of the origins of such a competence. The following is a brief discussion of how this competence could possibly as well as probably have come to be innate.

It is generally believed (cf. Deacon 1997; Donald 1991; Dunbar 1993; Pinker & Bloom 1990; Pinker 1994, 1995) that the onset of human evolution and the break off from the chimps was the emergence of bipedalism in the *Australopithecus Afarensis* approximately 4 million years before present, which so to speak freed the hands for tool use. However, the evidence for a social structure capable of supporting language evolution is better with the later *Homo Habilines*, who cooperated in hunting and nurturing.

According to one theory (Deacon 1997) what was special about the early hominid social groups was that they were monogamous couples living together in larger groups. Following his argument, monogamy is restricted to animals living in deserted and preferably vast areas where there is little contact with other members of the species. The early humans on the other hand, had much contact as they were living in groups. This lead to the evolution of symbolic communication that would enable them to establish and maintain symbolic social relations, or rather marital contracts, and furthermore ensure that all members of the group honor them.

Pinker (1984) proposes a different theory, in which the primary initiator was not monogamy. What initiated the evolution of symbolic communication (besides the obvious benefit of sharing information) was the need to outwit potential social cheaters: those that reap the benefits of this cooperative hunting and nurturing, while not paying the costs of participation. See also Bickerton (1990), Donald (1991), and Foley (1997) for discussions on the evolution of language.

In either case there was selection pressure for organisms with communicative skills. This led to a cognitive ‘arms race’ which in turn lead to the enlargement of the human brain. The human brain is large in relation to the body – a phenomenon known as *encephalization*. This trait is not unique to mankind (sparrows and mice for example have even bigger brains in relation to their bodies than humans), but in this respect we clearly differ from the other apes. Actually our brain is three times larger than expected on the basis of our body size (cf. Deacon 1997). Of course, a larger brain does not inevitably produce support for language. In other words, language is not the result of a larger brain – whales for example have quite larger brains than humans, but they do not have a language. However, as Dunbar (1993) points out, there is a strong connection between group size, brain size and language. As primate groups grow in size, so does the structural complexity: there are more social relations to keep track of, so to speak (unlike large flocks of cattle, which has very little structure). This calls for greater

cognitive abilities, which in turn gives rise to the enlargement of the brain. However, it is unresolved whether this results from the complexity of living in groups of monogamous couples as Deacon claims or from the cognitive demands of outsmarting uncooperative social parasites as Pinker claims, i.e. *sexual* versus *natural selection* respectively (Darwin 1859). I suspect the truth lies somewhere in between.

The human brain is not just an 'inflated' chimp brain. Not all of it is larger than would be expected for a primate of human size. Due to the encephalization a relatively smaller portion of the cortex of the human brain is devoted to controlling bodily functions, the body being relatively small in relation to the brain. The size of the motor areas is thus actually reduced in relation to the rest of the brain. However, the auditory areas in the *superior temporal gyrus* including *Wernicke's area* (see Figure 3 below) is enlarged, and most important the *prefrontal cortex* including *Broca's area* (both areas are further discussed below) is twice its expected size (cf. Deacon 1997:217). This means natural selection has given the prefrontal cortex dominance over the rest of the brain. In development the different parts of the brain connect to all other parts of the brain. Through a process named *neural Darwinism* (Edelman 1998) the largest part, which thus has the largest number of connections to a given area, wins the control over it – in other words, this is 'survival of the fittest' played out on a developmental neuronal level.

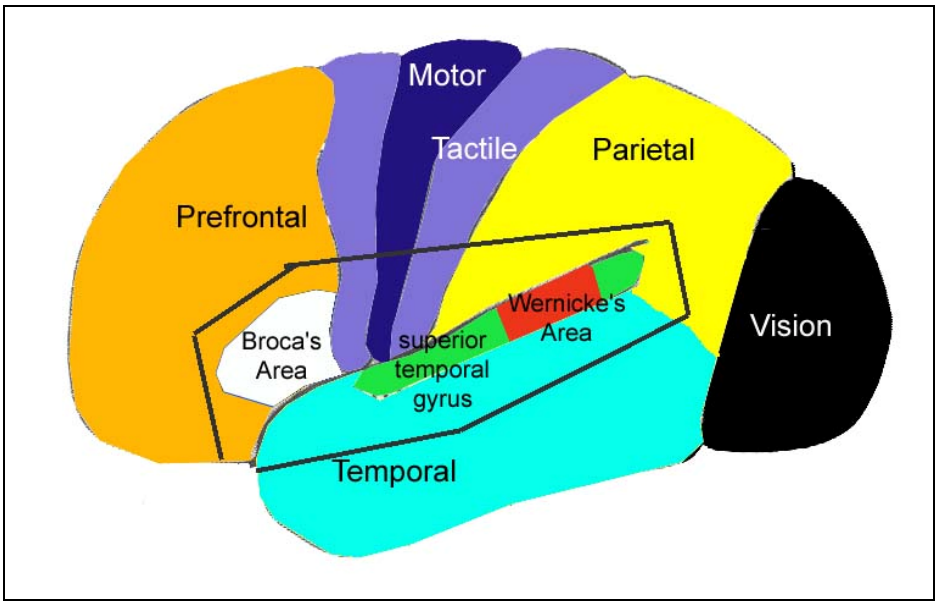



**Figure 3: Idealized map of cerebral areas in the left hemisphere. The black line surrounds the so-called *perisylvian region*. The names in white indicate functional areas, while the black names merely indicate location. In the text the term posterior refers to areas (in the figure) to the right of the motor area.**

To Deacon (1997) all this indicates that the prefrontal cortex houses a 'symbolic processor' (and (some) support comes from Donald 1991), which is also responsible for language. Language acquisition is thus based on a *specialized learning capacity for symbolic systems* (below I shall argue that this is not altogether plausible). In other words, humans are *predisposed* to language in the sense that they have a special *learning algorithm* for language. Deacon argues that the cortical areas in the *left perisylvian region* (see Figure 3) are not specialized for language but that they are computational centers also utilized for linguistic purposes.

According to Pinker (1994) on the other hand the left perisylvian region is *the language organ*, i.e. these areas are specifically dedicated to language. To Pinker language acquisition is not dependent on a general symbolic learning capacity, but rather a matter of *instinctive* and *automatic* acquisition of the ambient language, consisting of setting the parameters of the innate universal grammar to match the surrounding language. This explains why language is universal and species-specific and independent on general learning capacities.

Any way we slice it, language and the brain have co-evolved: language has shaped the brain and vice versa (cf. Christensen 2000 for a discussion on the co-evolution of language and the brain and a comparison of Pinker 1994 and Deacon 1997). It therefore seems natural to say that language has been *internalized*, i.e. represented in the neural architecture of the brain, and therefore the brain is already prepared for linguistic input. Furthermore, since neither typological language variation (Comrie 1989) nor diachronic language change (Crowley 1997) is completely arbitrary and unconstrained, it seems natural and plausible to claim that there is such a thing as a universal grammar (cf. Pinker 1994). Both cross-linguistic and cross-time variation is constrained by the specialized structures of the human brain. Below I shall argue that the areas in the left perisylvian region indeed are specialized for language.

Physiologically, the most obvious adaptation of the human body to language is the (again) species-specific position of the larynx deep in the throat, which gives us two cavities (mouth and throat), which together define the large array of possible human vowel sounds. This obvious benefit for our phoneme inventory comes with a severe disadvantage for breathing and swallowing, as there is a risk of food falling into our lungs (cf. Lieberman 1984).

## 3.2 Localization, Distribution and Lateralization

Where is language represented in the brain? There are four logically possible answers: 1: nowhere, 2: everywhere, 3: in one place, or 4: in several places. The first answer is not an option, as damage to the brain can lead to selective impairment of language, as I shall discuss in more detail in chapter 4. The second possibility, 'everywhere', is not plausible either. The implication is that language acquisition is done by a general learning mechanism and hence dependent on general intelligence and vice versa. Language is independent and distinct from 'general cognition', and impaired general intelligence need not have an impact on language, as I shall show below. This is of course closely related to the notion of *modularity* (Fodor 1983, 1985). Language is a cognitive module, a somewhat self-contained subsystem of the human mind (see also Pinker 1994, 1997). I shall return to the matters of modularity and dissociation between language and intelligence in the following sections.

This leaves us with the last two possibilities: 3: language is *localized* in one area, and 4: language is *distributed* over several areas. A logical place to start is to find out if language is represented in the right, the left, or in both hemispheres, i.e. left-, right-, or not *lateralized*. Studies of brain damage leading to language disorders have shown that language normally is localized in the left hemisphere, as the correlation of aphasia and right-hemisphere damage is very rare, and encountered only if the patient suffers from early left hemisphere damage (cf. Bishop 1988). Right *hemidecortication* (removal of the entire cortex in one hemisphere) and lesions in the right hemisphere cause some semantic and/or pragmatic disorders, such as problems with understanding narratives and jokes (cf. Damasio 1992: 537; Deacon 1997), and *aprosodia*, a syndrome where the patient's speech is flat and lacks prosody (cf. Donald 1991: 80 and Calvin & Ojemann 1994: chapter 4). These deficits are nonlinguistic, as language *per se* is not damaged. It would be very strange to diagnose a person as language impaired if he or she has problems with getting the point of jokes and stories or just speaks in a flat and monotonous manner. Grodzinsky (2000: 19) concludes:

> *Thus, the evidence is that this side of the brain* [i.e. the right side. K. R. C.] *has an important role in communication but makes no syntactic contribution to language use.*

The discussion so far points to a *localization* of language in the left hemisphere, and this is supported by results from tests where one hemisphere is anesthetized prior to brain surgery (this is called the *Wada test*, cf. Bishop 1988: 206). This is done in order to discover whether language functions are located in the left (as is almost always the case) or in the right, which is sometimes though rarely the case. Anesthetizing the 'linguistic' hemisphere causes language impairment (cf. Bishop 1988, Calvin & Ojemann 1994: chapter 3 and Donald 1991:80). Deacon (1997) views the difference between the hemispheres not as linguistic versus non-linguistic computation, but as a difference in speed of computation. The right hemisphere is specialized in large time domains (linguistic and non-linguistic), which should account for the above mentioned problems with narratives and prosody for patients with right-hemisphere injuries. Prosody is a feature of the inter-sentential domain, as it spans the entire utterance regardless of the number of clauses. The left side is specialized in short time domains. In other words, the left hemisphere is speed optimized, which should account for the breakdown of syntax and morphology in left-hemisphere injuries (cf. Deacon 1997: 316).

Much in the same line as Deacon, based on evidence from bilingual aphasics Paradis (1998) places what he calls *implicit linguistic competence* in the left hemisphere. Regarding the right hemisphere, he states that "one can safely assume that the RH [right hemisphere, K. R. C.] is crucially involved in the processing of pragmatic aspects of language use" (Paradis 1998: 422).

## 3.3 The Language Zone

Within the left hemisphere language functions are localized in an area around *sulcus lateralis*, also known as the *Sylvian fissure* (see Figure 4 below), which is the long 'gorge' that constitutes the upper 'border' of the temporal lobe. In the vast majority of cases where brain damage causes language deficits it is located the *perisylvian region*, i.e. in the region surrounding the Sylvian fissure (cf. Damasio 1992, Damasio & Damasio 1992, Calvin & Ojemann 1984, Gazzaniga 1989). PET studies have shown that there is increased blood flow, hence cerebral activation, in this area during linguistic processing. Broca's area (the left inferior frontal gyrus) is especially active during tasks involving syntactic analysis (Stromswold et al. 1996).

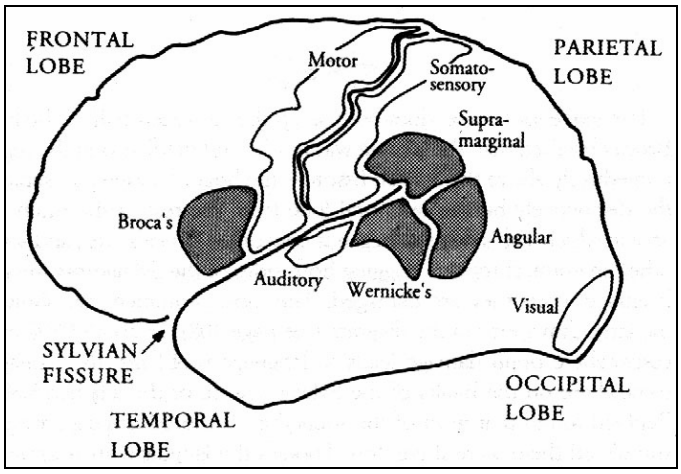



**Figure 4: Language areas (from Pinker 1994:308).**

This area, *the left perisylvian region*, is often discussed as if it consisted of a collection of separate parts or areas. This is apparent in Figure 4, where the different areas around the Sylvian fissure seem to be delimited in a nice clear-cut fashion. The brain does not have a flat surface; its surface is full of convolutions, much like if you take a large piece of cloth and crumble it up into a ball. Therefore, much of the surface is not 'visible' and the topmost parts seem adjacent, but sometimes they may appear to be separate. However, Gazzaniga (1989) has shown what this region of the brain would look like if it had been ironed flat. All the areas that are associated with language (and language breakdown, see below) form a contiguous area, which he labels *the language zone* (Gazzaniga 1989: 950). For the same reason Pinker (1994) and Grodzinsky (2000) call this region *the language organ*.

Further evidence comes from studies of bilinguals. Dehaene et al. (1997) investigated a group of French-English bilinguals. The subjects were scanned in a fMRI (*functional magnetic resonance imaging*) while listening to stories in the two languages. The results of the tests showed a consistent and significant increase in activity in the left perisylvian region during comprehension of the subjects' first language (L1, English), whereas the second language (L2, French) showed a weaker but similar pattern. Dehaene et al. suspect that the latter may be due to different teaching strategies in the schools, where the subjects had learned their L2. Whatever the reasons for the less consistent pattern of L2 in their investigation, the subjects' native language (L1) was located in the perisylvian region.

Others have found more consistent results showing that both L1 and L2 are located in the *language zone*. According to Paradis (1998: 422) (see also Menn et al.

1995) both languages are represented in the language areas of the left hemisphere in bilingual as well as unilingual individuals.

## 3.4 Language Acquisition

The maturation of the human brain is the driving force in language acquisition. In this section I briefly discuss the processes in the brain during language acquisition.

Before birth all the nerve cells of the brain, the neurons, are formed and migrate from the place where they are generated into their proper places. At birth, the brain is already biased towards a left-hemisphere specialization for language (cf. Bishop 1988: 212). After birth the size of the brain and the thickness of the cerebral cortex increase in the first year. The white matter (underlying the cortex or gray matter), which houses the long-distance connections between the major regions is not complete until around nine months of age. The synapses, which are the connections between the neurons in the cortex, continue to develop and peak in number sometime between nine months and two years, depending on the region of the brain. At approximately two years of age the brain has 50% more synaptic connections than the adult brain. The metabolic activity reaches an adult level at around nine months and rapidly exceeds it, peaking at around 4 years of age. Huge numbers of neurons die from birth to around the age of seven. The synaptic connections decrease in number until adolescence, when the brain falls back to the adult level of metabolism (for elaboration see Deacon 1997: chapter 6; Elman et al. 1996: chapter 5; Müller 1996: section 3.2.1; Pinker 1994: chapter 9, 1995).

I have summed up the correlation between developmental neural and linguistic events in the following table:

| Age | Neural development | Linguistic development |
|---|---|---|
| birth | Completed cell formation and migration | left hemisphere specialization |
| around 9 months | Adult distribution of metabolism, long-distance connections established | suppression of non-native sounds - fine-tuning the phonetic inventory |
| around 12 months | | one word stage |
| around 18 months | Peak in number of connections within and between cortical regions | vocabulary spurt, two word stage - primitive syntax |
| around 36 months | | grammar explosion - rapid increase in number of syntactic constructions and complexity |
| around 48 months | peak in overall brain metabolism | successful language acquisition |

**Table 3: Developmental neural and linguistic events.**

Evidence for the early left-hemisphere bias of language at birth comes from cases of brain damage. According to Bishop (1988) the majority of children suffering left hemidecortication or brain damage within the first couple of years of life do not develop aphasia. The ability to recover rapidly decreases with age and chances are best before the age of ten. Furthermore, there is a strong correlation between early damage to the language area and right-hemisphere language specialization. This is due to the fact that the child brain is very *plastic*, i.e. functional reorganization is possible in the very early stages. As Bishop states:

> *Provided that the traditional language areas were spared, even extensive early lesions of the left hemisphere did not result in right-hemisphere language representation. However, lesions that encroached upon Broca's area or Wernicke's area were likely to bring about a functional reorganization of the brain, with right-hemisphere specialization for language*. (Bishop 1988: 207)

It appears then that there is some sort of 'default brain plan'. The brain does not consist of a vast number of identical neurons – it is not an *equipotential mass* (Müller 1996: section 3.2.1) or a *meatloaf* (Pinker 1994). As mentioned above, the neurons migrate from the place where they are generated to their proper locations. The neurons themselves are thus in place at around seven months after conception (cf. Elman et al. 1996:288), but the number of neurons and the number and strength of the connections between them need to be adjusted to suit the environment. The important point is that the brain seems to be 'prepared' for language but still dependent on stimuli from the environment. The default brain develops following the *bioprogram* (Bickerton 1988), while adjusting / reorganizing itself to match the ambient language. This reorganization is dependent on the neural plasticity, which is highest in infancy and rapidly decreases during the first years of life, reaching the adult low at around puberty. This period may be called the *critical period* (Lenneberg 1967) or the *sensitive period* (e.g. Elman et al 1996). This period is the time window in which the brain is open to successful language acquisition and recovery from lesions. After this period successful first language acquisition is rare. Also, bilingual speakers' first language will usually permanently influence the acquisition of their second language (for example through accent) after this sensitive period, which is not the case if both L1 and L2 are acquired within the period.

Recall from chapter 2 that in generative linguistics a language is viewed as parameter setting on a universal grammar. Language acquisition is viewed as the process in which these parameter settings become fixed. This fits very well with the facts of brain development. Both nature and nurture, or genetics and environment must contribute in order to secure successful language acquisition. Thus, innateness does not mean that everything is pre-wired in the brain of the infant:

> *No nativist has ever supposed that innate capacities are unaffected or unformed by environmental interactions.* […] *How many times has this point been made in the last 30 years? How many times in the last three centuries? How many times is one going to have to make it again?*" (Fodor 1985: 36)

So far, I have argued that evolution has lead to a neural predisposition to language learning / acquisition. This predisposition is reflected in the architecture of the human brain in that linguistic functions are located in the left hemisphere, i.e. language is left lateralized. Within the left hemisphere, language is localized in the region surrounding the Sylvian fissure – the language zone. Furthermore, language functions are distributed over the language zone. This neural specialization is the basis of language acquisition. The infant brain develops according to some kind of a default plan / bioprogram, a process to which the environment provides crucial input. This interaction between (genetic) neural predisposition and environment has to take place within a limited time frame, the critical period, to be successful.

In the next chapter, I discuss what happens when the language zone is damaged – either by developmental deficits, which leads to neural malformation, or by damage to previously normal adult brains.

# 4 Language Breakdown

This chapter is about the kinds of impairment or trauma that lead to the breakdown of language. It is a brief survey of language deficits, some of which are developmental deficits – *autism*, *Down's syndrome*, *Williams syndrome*, and *Specific Language Impairment* – and other are acquired deficits due to brain damage – *aphasia and anomia*. From this survey I shall conclude like others before me that there is a double dissociation between language and intelligence. Hence, language acquisition is not a general learning problem for some central processor. Language is innate, which is also evident from the very robustness of language, which is (sometimes) acquired or spared in spite of brain damage. This also points to modularity – externally, in that it is independent of e.g. hearing and intelligence, and internally, in that there exist deficits specific to certain aspects of grammar. The dissociation between language and intelligence is used to establish a typology of language impairment and mental retardation, which again supports the modularity hypothesis. Finally, I link the different kinds of acquired language impairments to different areas of the brain – or rather to a certain region in the left hemisphere: *the language organ*.

## 4.1 Mental Retardation and Impaired Language: Autism

*Autism* is a severe developmental deficit that typically appears some time during the first three years of life. People suffering from an autistic disorder (Bishop 1989) tend to be (but are not always) mentally retarded with an I.Q. below 60. They lack what is known as a *theory of mind*; that is, they lack empathy and the awareness of other people as conscious beings with feelings and emotion. They tend to be socially withdrawn. According to Fay (1988) mutism is a frequent characteristic symptom associated with autism. Furthermore, autistic people tend to lack communicative intent. Interestingly, some appear to be deaf as they do not respond when spoken to, but this deafness is restricted to linguistic sounds, while they may show signs of intolerance to other environmental sounds, such as vacuum cleaners. Of the minority that does develop speech approximately 75% go through a prolonged period of *echolalia*, the repetition of words or fragments of sentences just uttered by others. Their speech is often monotonous and mechanical.

As is evident from this short description of autism, it is a mentally retarding deficit causing low intelligence and a blocking or mal-acquisition (abnormal acquisition leading to abnormal language) of language *per se* – not just of speech. In short, autism is a case of mental retardation and impaired language.

Yet another strange characteristic of the syndrome is the so-called *idiot savants* (see Frith 1989: 84), who seem to have an 'island' of spared skill on a background of generally poor learning abilities. Often this involves very good long-term memory, which is used to memorize long lists of names, animals, telephone numbers, bus routes, etc. Other kinds include mathematical geniuses who can mentally multiply large numbers at a rapid speed, and musical prodigies.

Neurologically, the basis of autism is still not completely resolved (cf. Frith 1989: 68-81). According to Deacon (1997: 275) (based on Damasio 1994), autistic people tend to have smaller cerebellums and brain stems, but the only direct evidence of cortical involvement in the deficit seems to focus on the reduced blood flow of the prefrontal lobes, which includes Broca's area.

## 4.2 Mental Retardation and Spared Language

In the following three subsections I first discuss two developmental deficits, *Down's syndrome* and *Williams syndrome*, and then discuss a patient called Christopher, who is a so-called *idiot savant*. All three are instances of mental retardation and spared language. They are not isolated cases; actually, this dissociation between language and mental retardation or alternative intelligence is abundant: dementia, schizophrenia, psychopathy, and insanity – all examples of non-normal intelligence/cognition and undamaged language, the latter sometimes quite clearly intact.

### 4.2.1 Down's Syndrome

As in autism, people suffering from *Down's syndrome* (also known as mongolism) are mentally retarded with an upper limit of a mental age comparable to that of a normal 4 to 5 year-old child. The intellectual maturation tends to be complete at around 12 to 15 years of physical age.

Unlike autistic patients, subjects suffering from Down's syndrome do not lack communicative intent and / or ability. Most children with Down's syndrome begin to speak between the age of two and four years in spite of many physical abnormalities.

Among the numerous factors working against them are pathologies such as an undersized mouth cavity, a protruding and edematous tongue, a larynx often positioned too high in the throat, hypotonia (reduced sensitivity to stimulation) of the speech muscles, abnormal lips, hearing loss due to malformations of the inner ear, etc. As Rondal puts it:

> *Given the number and severity of factors that militate against them, it is surprising that individuals with Down's syndrome develop language at all. Should we need another proof of the robustness of language in the face of biological and psychological hazards, Down's syndrome subjects amply supply this proof*. (Rondal 1988: 166)

Even though there is inter-individual variability within the syndrome, language acquisition is generally delayed, but it goes through the same stages as normal subjects. However, due to the physiological deficiencies, speech production is impaired. They have a reduced lexicon but it is used and understood correctly. According to Rondal (1988: 171) their utterances tend to be short and telegraphic with somewhat limited morpho-syntactic elaboration, and they show limited use of 'function words', such as prepositions, copulas, auxiliaries, pronouns and conjunctions. These claims are supported by measures of MLU (mean length of utterance), which however say nothing about morpho-syntactic elaboration, use of function words, or about telegraphic speech for that matter. In fact, the only example in the text (Rondal 1988: 170) includes all of these 'function words'.

As opposed to autistic patients, Down's syndrome subjects tend to be very social and generally happy. Furthermore, they are very close to normal people regarding the *theory of mind*. Baron-Cohen et al. (1985) tested 20 autistic children (mean I.Q. 82), 14 Down's syndrome children (mean I.Q. 64), and 27 clinically normal children. The test consisted of a marble and two dolls, named Sally and Anne, hence the test is called the *'Sally-Anne' Test*. Sally placed a marble in her basket and left the scene. Then Anne took the marble out of the basket and hid it in her box, after which Sally returned. The experimenter then asked the subjects where Sally would look for the marble. The correct response was to point at the basket and the wrong to point at the box. 86% of the normal subjects and 85% of the Down's syndrome children were correct, while only 20% of the autistic subjects were correct.

### 4.2.2 Williams Syndrome

Williams patients are characterized by a peculiar facial appearance, which includes a star-like pattern in the iris, eyebrow hair growth towards the nose, a narrow face, a broad forehead, a flat nasal bridge, sharp chins, and thick lips (cf. Bellugi et al. 1988: 178, Pinker 1994: 52). For this reason they are sometimes called "elfin-like" or "elfin-people" (or as Pinker points out, they look like Mick Jagger). They are severely mentally retarded with an I.Q. at approximately 50 and are unable to live independent lives even as adults. They have difficulties with dressing themselves, remembering routines, tying their shoes, finding their way, etc. Their visuospatial capacity is also severely impaired. For example, when they draw an elephant or a bicycle it is not a cohesive, recognizable drawing resembling what was intended, but a collection of parts (though correct parts). In spite of this visuospatial impairment their facial recognition is unimpaired, and they are friendly and highly social people, and notably very loquacious.

A striking dissociation exists between their inability to draw e.g. an elephant and their ability to describe it – which they do eloquently. Another characteristic of Williams syndrome is the unusual vocabulary for the mental age of the patients. Whereas a normal child would mention a dog, cat, horse, cow, etc. when asked to mention some animals, a Williams patient would mention such (to Europeans unusual) animals as hippopotamus, chihuahua, antelope, condor, vulture, sabretooth, etc. As opposed to Down's syndrome patients, their range of vocabulary is above their mental age.

Language acquisition is delayed, but apart from that their language (both comprehension and production) appears to be intact and normal. Their expressive language is complex in terms of morphological and syntactic structures, such as inflection, tense and aspect markers, passives and various types of embeddings, and generally grammatically correct, and they are able to use these structures productively and appropriately. "Complex structures in the spontaneous speech of the Williams syndrome children are abundant" (Bellugi et al. 1988: 183). And in sharp contrast to the autistic patients, their language use is clearly not echolalic or formulaic.

Williams syndrome subjects suffer from supravalvular aortic stenosis (a narrowing of the aorta) and from abnormalities in the metabolism of both calcium and calcitonin (Bellugi et al. 1988: 178). This rare and genetically based metabolic disorder is called hypercalcemia and has various effects on the organism:

> *The syndrome seems to be associated with a defective gene on chromosome 11 involved in the regulation of calcium, and it acts in complex ways on the brain, skull, and internal organs during development, though no one knows why it has the effects it does.* (Pinker 1994: 52)

As Deacon (1997:269) explains, postmortem and MRI analyses of Williams patients' brains have revealed reduction of the entire posterior lobes, while the prefrontal lobes are spared. The brains of Williams syndrome patients are even more 'front heavy' than normal brains, which already have relatively large frontal lobes (cf. section 3.1 above). Interestingly, this is the direct opposite neural pattern of the autistic subjects.

### 4.2.3 Christopher – a Linguistic *Idiot Savant*

Smith & Tsimpli (1995) describe a very special and quite unique person called Christopher. He is institutionalized because he cannot look after himself. He is mentally retarded and has an I.Q. around 60 (42-76 depending on the specific test, ibid. p. 4). As Smith & Tsimpli put it, his medical and neurological history is rather opaque, but several tests and scans have shown that he has suffered hydrocephalic brain damage and severe neural impairment of his motor co-ordination, some cerebral atrophy with wide sulci over both hemispheres. An EEG (*electroencephalogram*) scan showed slow waves in the frontal lobes, i.e. reduced activity there. He has not been diagnosed as autistic, but some evidence points in this direction. First, he failed on an equivalent to the 'Sally-Anne' test (see section 4.2.1 above) showing an apparent lack of a *theory of mind*, which is characteristic of (and perhaps specific to, cf. Baron-Cohen et al. 1985) autistic subjects. Second, the mentioned reduced activity in the frontal lobes is consistent with the reduced cortex characteristic of (at least some types of) autism. Third, and most interesting, he has a single spared (or overly developed) mastery or skill in the face of otherwise retarded intelligence: language. Christopher is a linguistic 'idiot savant' (cf. Frith 1989): he cannot button his shirt or tie his shoes but he can read, write and communicate (though with some differences in degree ranging from fluency to bare elements) in fifteen to twenty different languages for which he has had no formal training. This is very surprising because autistic subjects tend to lack any form of communicative intent and ability, as mentioned above, and if they have any it is

severely impaired. This single linguistic skill is characteristic of Williams syndrome, which also fits his very social nature but not his lack of *theory of mind*.

Christopher is a clear example of a person whose dissociation between language and intelligence is very clear. I mention Christopher in this separate section because he is not a prototypical case of autism but represents a 'borderline' case with elements characteristic of both Williams syndrome and autism. The former is characterized by spared linguistic abilities in the face of severe mental retardation, and he clearly has the will to communicate (as do Williams patients), which is not characteristic of autism. The latter is however a disorder with much interpersonal variance, and as he lacks the *theory of mind* and has a single 'super skill', he certainly has to be considered autistic to a certain degree, as these two traits are among the hallmarks of autism.

## 4.3 Impaired Language and Spared Cognition

In the next subsections I discuss the kinds of deficits that selectively damage language while leaving general cognition (relatively) intact. First, I give a survey of the different types of aphasia, which are all caused by brain damage and then I discuss the developmental deficit called Specific Language Impairment, or SLI.

### 4.3.1 Aphasia

The term *aphasia* actually covers a number of disorders that have as common ground of intact non-verbal cognition and impaired language. Aphasia is "the loss of or impairment of language abilities following brain damage" (Pinker 1994: 473). In other words, it is an acquired disorder of linguistic processing. Typically, six subtypes are distinguished (cf. Damasio 1992: 536, Bishop 1988:204): *Broca's* -, *Wernicke's* -, *global* -, *conduction* -, and *transcortical aphasia*, and *anomia*. I shall briefly discuss the different types in the same order in the following subsections.

#### 4.3.1.1 Broca's Aphasia

Damage to *Broca's area*, i.e. Brodmann's areas 44 and 45 (also called the *left inferior frontal gyrus*), see Figure 5 below, and its vicinity[2] results in *Broca's aphasia*, which is a drastic loss of speech fluency making speech effortful and telegraphic. The hallmark of Broca's aphasia is agrammatism, an impairment of the subject's grammar which manifests itself as an inability to organize words into grammatical sentences and an improper use or non-use of grammatical words and morphemes, such as conjunctions, prepositions, auxiliary verbs and tense-inflection. Furthermore, their ability to assemble phonemes into words is also defective, a feature shared with Wernicke's aphasics (cf. below).

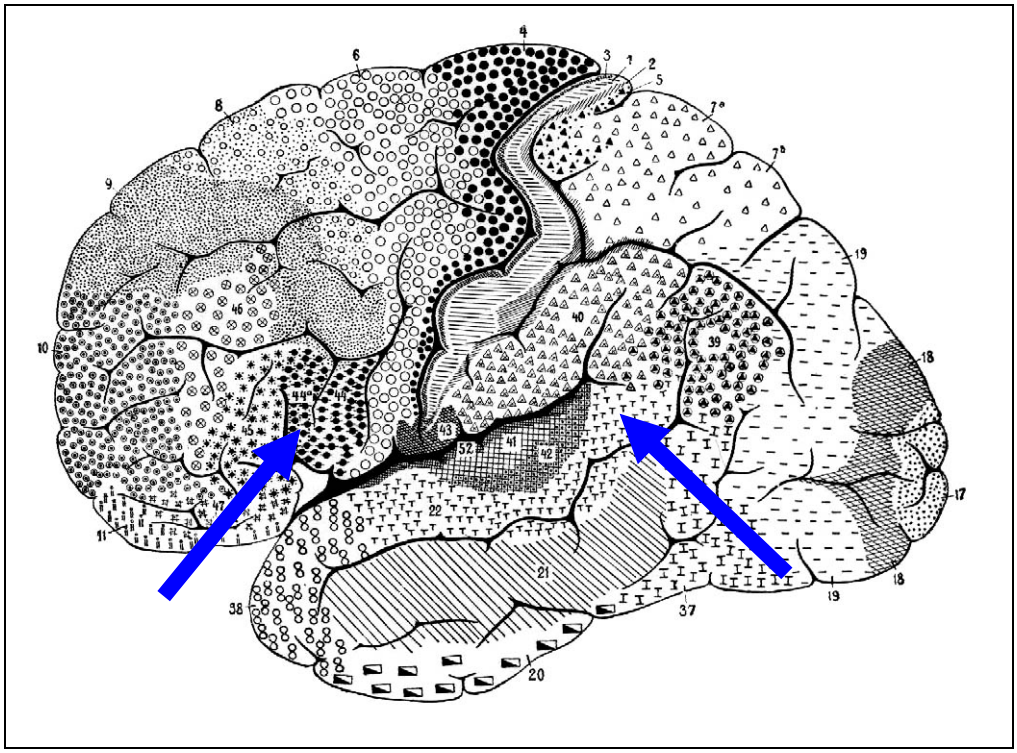


**Figure 5: Brodmann's areas. The left arrow points to area 44, Broca's area. The right arrow points to the posterior (rightmost) part of area 22 – this posterior part is Wernicke's area. The symbols indicate different cortical cell structures, which roughly coincide with functional areas.**
**From Sobotta & Becher (1975: 6, Fig 7)**

[2] The vicinity refers to three areas: the *operculum*, which is the lower part of the motor strip, just to the right of Broca's area); The *insula*, which is a group of convolutions at the base of the Sylvian fissure to the below to the right of Broca's area. Finally, it refers to the *subjacent white matter*, (beneath the cortex towards the inner parts of the brain).

Comprehension is also impaired. Broca's aphasics have difficulties with the interpretation of semantically reversible passives, which are sentences like "*John kissed Jill*", where both "*John*" and "*Jill*" can be "*kissers*" AGENTS (cf. chapter 2) as well as "*be kissed*" (THEME). An example of a non-reversible is "*John kicked the ball*", because only "*John*" can be a "*kicker*". Broca's aphasics have little or no difficulties with non-reversible passives where only one noun phrase can be the AGENT, such as (20). Example (21) is an active semantically reversible sentence. It does not cause any problems for the aphasic. The passive counterpart in (22), however, does.

(20) *The car was driven by the woman*.
(21) *The man touched the woman*.
(22) *The woman was touched by the man*.

The mechanism underlying this selective impairment has been the focus of research done by Yosef Grodzinsky (e.g. 1986, 1990, 1995a+b, 2000) and it is the topic of chapter 6 below so I will not go into further detail here.

Another aspect of this disorder is the aphasic's inability to repeat sentences they hear. They are even unable to repeat the types of sentences that they fully understand, much to their own surprise and dismay. Broca's aphasics are well aware of their impairment and are often depressed (Damasio 1992).

#### 4.3.1.2 Wernicke's Aphasia

*Wernicke's aphasia* is caused by damage to the posterior region of the left auditory-association cortex (Brodmann's Area 22, see Figure 5 above) and its adjacent areas. This type of aphasia is characterized by the fluency of the speech of the subjects and is therefore sometimes called fluent aphasia. Speech is laborious and produced with normal (or even above normal) speed and intonation. In this sense it can be said to be the complement of Broca's aphasia, which is effortful and slow. The utterances are fluent and more or less grammatical, but they are characterized by their lack of sense and frequent neologisms and word substitutions.

Wernicke's aphasics suffer from verbal or semantic *paraphasia* – they have great difficulty selecting the appropriate words that accurately match the intended meaning. For example they might say "*chair*" instead of "*table*", "*knee*" for "*elbow*", or "*dog*" for "*queen*". They also suffer from phonemic paraphasia, which cause them to

make phonemic substitutions or distortions such as "*tubber*" for "*butter*" or "*leasing*" for "*ceiling*". Furthermore, they use many (unintelligible) neologisms such as "*robbli*" for "*queen*" (cf. Harley 1995: 280; Pinker 1994: 310-311). As their utterances tend to be grammatical with 'distorted' words, and it has often been assumed that Wernicke's aphasia is a semantic deficit.

Comprehension in Wernicke's aphasics is also impaired, and sometimes their inability to understand what others are saying makes them anxious and agitated and perhaps even paranoid (Damasio 1992: 534). However, Wernicke's aphasics are less apt to become depressed and frustrated than Broca's aphasics are. They seem to be less aware of their impairment, which perhaps relates to general intelligence. How can they not be aware of their impairment? Indeed, studies have shown that there are some differences in intelligence in aphasics: *Broca's* and *conduction aphasics* (see section 4.3.1.4 below) and *anomics* (see section 4.3.1.6 below) are not intellectually impaired, whereas *Wernicke's* and global aphasics (see below) have been shown to have below normal intelligence (cf. Kertesz & McCabe 1975).

#### 4.3.1.3 Global Aphasia

The combination of Broca's and Wernicke's aphasia (i.e. damage to both Broca's area and Wernicke's area) is called *Global aphasia* and is the almost complete loss of language, both comprehension and speech. On the production side global aphasics' deliberate speech is limited to a few words and sentences. These structures may be used repeatedly and inappropriately in a vague attempt to communicate. Their non-deliberate (automatic) speech is preserved. They are able to appropriately use an inventory of expletives such as "*god damn it*" with correct inflection and articulation. Their auditory comprehension is limited to a small set of nouns, verbs, and idioms, and they seem to have no understanding of grammatical words or complex sentences.

#### 4.3.1.4 Conduction Aphasia

This kind of aphasia shares three features with Broca's and Wernicke's aphasia: phonemic paraphasia (word substitution), naming problems, and the lack of capacity for verbatim repetition. Conduction aphasia is distinguished by the relative preservation of auditory comprehension (unlike Wernicke's aphasia) and speech production (unlike Broca's aphasia). It is caused by damage to one of two loci: (1) *The supramarginal gyrus* (Brodmann's area 40, located in the posterior region of the temporal lobe, just

above Wernicke's area, see Figure 5. See also Figure 4). (2) The left primary auditory area (Brodmann's areas 41 and 42 just left of Wernicke's area, cf. Figure 5), the insula and the underlying white matter (see footnote 2, page 33), cf. Damasio (1992: 534).

#### 4.3.1.5 Transcortical Aphasia

So far the types of aphasia discussed all involved an impairment of the capacity for repetition. Transcortical aphasia is distinguished by the (relative) preservation of verbatim repetition (cf. Harley 1995: 275). It is divided into two variants: a sensory and a motor variant. *Transcortical sensory aphasia* is fluent and involves impaired comprehension. It is caused by damage to temporal or parietal cortex in the vicinity of Wernicke's area (i.e. parts of Brodmann's areas 21, 22, 37, 39, and 40). *Transcortical motor aphasia* is somewhat the mirror image of the sensory variant. Speech is non-fluent and comprehension is largely intact. It is caused by damage to the left frontal cortex above and in front of (and sometimes involving) Broca's area (i.e. parts of Brodmann's areas 9, 44, 45, and 46) (cf. Damasio 1992: 535).

#### 4.3.1.6 Anomia

Anomia is a naming disorder, which can be found in isolation or accompanying Wernicke's and Broca's aphasia. People with anomia are impaired in their ability to name objects or pictures of objects, as well as in their ability to recognize spoken or written names of things (cf. Harley 1995: 272). As Pinker (1994: 311) states, the name of the deficit speaks for itself. Literally, anomia means "*no-name-ia*".

Pure anomics do not suffer from the symptoms of the other kinds of aphasia. They are fluent patients with normal comprehension and no severe substitutions of words or inflections. They have problems with naming and finding the right words (cf. Bates et al. 1991: 144). Anomia can be described as a chronical state of "it's just on the tip of my tongue".

Neurologically, anomia is caused by trauma to an area to the right of Wernicke's area called the *angular gyrus* (cf. Grodzinsky 2000: 20), see Figure 4 in section 3.3 (page 23), also known as Brodmann's area 39, see Figure 5 above.

All types of aphasia have distinct symptoms and are all associated with distinct areas in the perisylvian region. This is summarized in Figure 6 on page 41 below.

### 4.3.2 Specific Language Impairment

Specific language impairment (SLI) is characterized by severe impairment in the development of language comprehension and production without any mental retardation, motor, hearing, social, or emotional disorders that could account for the impairment. The child is otherwise normal, only language is impaired. A most interesting aspect of this disorder is that it is not caused by brain damage:

> *Few children with specific language impairment have any history of brain disease or any hard neurological signs, and techniques such as CT scan or electroencephalography (EEG) reveal abnormalities only in a minority of children with particularly severe problems. Overall the evidence for an acquired brain lesion as the cause of specific language impairment is slim.* (Bishop & Mogford 1988: 258)

However, SLI tends to run in families, which points to a genetic explanation for the impairment. Of course, the mere fact that a form of behavior runs in families does not prove a genetic foundation. Consider for instance recipes, lullabies, stories, etc. which are transmitted in families, but friends, neighbors, colleagues and such may also "be contaminated" or "inherit" the use of them. SLI can reasonably be said to have a genetic cause as it runs in the family much in the same way as psoriasis, which affects only some (not all) descendants of a common ancestor and does not afflict close age-mates, friends or other family members. For example, in one single large family of 30 members, the KE family (Gopnik & Crago 1991), half of the members were language impaired, which is quite many as SLI affects only about 7% of children in general (van der Lely et al 1998: 1253).

SLI appears to be a rather heterogeneous disorder. Subjects may be with or without articulatory, phonological, or comprehension impairments (cf. van der Lely & Stollwerck 1996), and according to Bishop & Mogford (1988: 259) it is largely defined by exclusion – i.e. if the impairment is not caused by any of the other syndromes it is labeled SLI. Future research may answer the question whether SLI is a cover term for several distinct disorders or a single deficit. In fact, several homogeneous subgroups have been identified, cf. van der Lely & Stollwerck (1996: 486). Other findings point to

a single disorder with a common underlying deficit with several manifestations (as I will argue below that Broca's aphasia is).

However, SLI subjects are mostly characterized by varying degrees of grammatical and morphological impairment in comprehension and/or expression, i.e. a grammar deficit. Van der Lely et al. 1998 have investigated a case of pure grammatical SLI. The subject named AZ has a non-verbal I.Q. of 119, i.e. with intelligence above average. His grammatical skills (morpho-syntax), on the other hand, are severely impaired. AZ has been tested on a battery of tests in three domains: grammatical abilities, non-grammatical language abilities, and non-verbal cognitive abilities. Analysis of AZ's speech has revealed that he uses only short sentences with frequent (70-80%) omission of inflection ('-s' for person and tense) and omission of phrases ("*the dog was poking* [*his head*] *in* [*-to the jar*]"). He uses very few embedded sentences (2 of 26) and only simple phrases (nothing like "*the small black dog*"), and he has severe problems in producing *wh*-questions. In fact, 83% of the *wh*-sentences contain errors, for example omission or ungrammatical use of auxiliaries, and he has severe problems with morphology and inflection. Furthermore, he is impaired in his ability to assign reference to pronouns and reflexives, when syntactic grammatical knowledge is crucial for the judgement. On the other hand, when non-grammatical knowledge is sufficient for the assignment AZ's performance is normal (96% correct). For example, in "*Grandpa says Grandma is pinching him*" the pronoun "*him*" can only refer to "*grandpa*" because it refers to a male and therefore only semantic knowledge is necessary for the assignment. On the other hand, in a sentence like "*John says that Jack is pinching him/himself*" the pronoun "*him*" can only refer to "*John*" and the reflexive "*himself*" only to "*Jack*". Here grammatical knowledge is crucially required for the right interpretation as both "*John*" and "*Jack*" are males and hence match the semantics of both "*him*" and "*himself*". Here, AZ's performance did not differ significantly from chance, cf. Van der Lely et al. (1998: 1255).

AZ has achieved an overall non-verbal I.Q. ranging from 119 to 131, clearly above average. He shows no deficits in any non-grammatical domain. His impairment is restricted to his grammar.

This resembles the diagnosis for Broca's aphasia, which is also associated with grammatical impairment and normal intelligence – even though Broca's aphasia is most clearly characterized by reduced speech fluency. However, it is important to distinguish between acquired deficits like aphasia, and developmental deficits like SLI, autism and

Down's syndrome. SLI is not caused by cerebral trauma. According to Bishop & Mogford (1988: 259), "it is possible that specific language impairment in children reflects an underlying immaturity of neurological development of those brain areas concerned with language development".

## 4.4 Discussion

We have seen that *autistic* subjects suffer from a developmental deficit that, in most cases, renders them mentally retarded with an I.Q. below 60. They are socially withdrawn and have no theory of mind. They lack the ability and intent to communicate and mostly they are mute but those who do acquire language are echolalic and speak monotonously and mechanically. Autism is associated with reduced activity and/or size of the frontal lobes, which result in the blocking or mal-acquisition of language. *Down's syndrome* is also a developmental deficit that causes mental retardation resulting in an I.Q. of about 60. Unlike the autistic subjects, *Down's syndrome* subjects are very social and possess a theory of mind. Their lexicon is reduced compared to normal subjects, but they are able to use and understand it correctly. Furthermore, Down's syndrome is clear evidence for *the robustness of language*, as the subjects acquire and use language in spite of massive physical handicaps in the speech production and perception systems.

In comparing autism and Down's syndrome it is clear that *language is independent of intelligence*. Both syndromes show severe mental retardation, but they differ on a very important point: one blocks out language while the other does not. Hence, language is not dependent on normal or high intelligence and it is not blocked by low intelligence. Therefore, *language acquisition is not based on general learning*, as these syndromes clearly limit learning abilities in almost every other field and the subjects are generally poor learners. This is an (indirect) argument in favor of the *innateness hypothesis* of language for two reasons: one, some sort of neural specialization must be a prerequisite for language learning since general learning cannot apply; and two, there is dissociation between intelligence and linguistic competence.

Another conclusion that might (incorrectly) be drawn from this comparison is that language acquisition is dependent on the theory of mind. Perhaps, one might argue, if one does not acknowledge other people as agents and speakers, the required parameter setting would not take place, and hence leave the child without a language. However intuitive and reasonable this may seem the hypothesis does not hold.

Christopher is a special case of autism (though he is not a typical case and has not been clinically diagnosed as autistic, his test results point to autism, cf. Smith & Tsimpli (1995) and section 4.2.3 above), because he has language as his special 'super skill'. He lacks the theory of mind, but speaks several languages. In this way he is a counter example to the hypothesis. Thus, *language is independent of the theory of mind*.

*Williams syndrome* is also a developmental deficit. The subjects have an I.Q. of around 50, and they are very social and loquacious. They have an unusual vocabulary, clearly above their mental age. Their language is intact, both in terms of comprehension and production. Their posterior lobes are reduced, while the frontal lobes are spared (i.e. of normal size) – quite the opposite pattern of autism. This pattern leads Deacon (1997) to propose a symbolic processor in the frontal lobes that controls language. But again, the case of the autistic Christopher provides counter evidence. He has reduced activity in the frontal lobes, but he is clearly not deprived of language.

The last of the developmental deficits I discuss is SLI, which is characterized by normal or even high intelligence and a selectively impaired language. Grammatical impairment seems to be a defining characteristic of SLI, though the deficit is rather non-homogenous and has several manifestations. The study by Van der Lely et al. 1998 of pure grammatical SLI offers further support for the above mentioned dissociation between language and intelligence: The subject AZ had an I.Q. above normal but a severe grammar deficit. This also points to *a modular internal structure of language*, as the deficit was confined to morpho-syntactic aspects of language. SLI has no neuro-pathological basis, as it is not caused by deformity of the brain. It appears to be caused by an immaturity of the development of the language areas.

We turn now to the different kinds of aphasia, language impairments caused by brain damage. *Broca's aphasia*, caused by damage to Broca's area and its vicinity, is characterized by agrammatism and a drastic loss of speech fluency, which result in effortful and telegraphic speech. Comprehension and repetition is also impaired. In *Wernicke's aphasia*, caused by damage to Wernicke's area and its vicinity, speech is effortless and fluent and it is produced with normal or above normal speed, but is nonsensical and full of semantic and phonemic substitutions and neologisms. Their comprehension is also impaired. The combination of damage to both Broca's and Wernicke's area results in *global aphasia*, which has features from both associated types of aphasia: both production and comprehension are severely limited. *Conduction aphasia*, caused by damage to either supramarginal gyrus or to the left primary auditory

area, is associated with phonemic paraphasia (substitutions), naming problems, an inability of verbatim repetition, and interestingly a sparing of production and comprehension. The two variants of *transcortical aphasia* are characterized by the ability to repeat spoken sentences in contrast to the other types of aphasia. Finally, *anomia*, caused by damage to the angular gyrus, is a naming disorder. Anomics understand nouns and names correctly but have problems finding the right ones for expression. I have summarized the loci of the different types of aphasia in Figure 6 below:

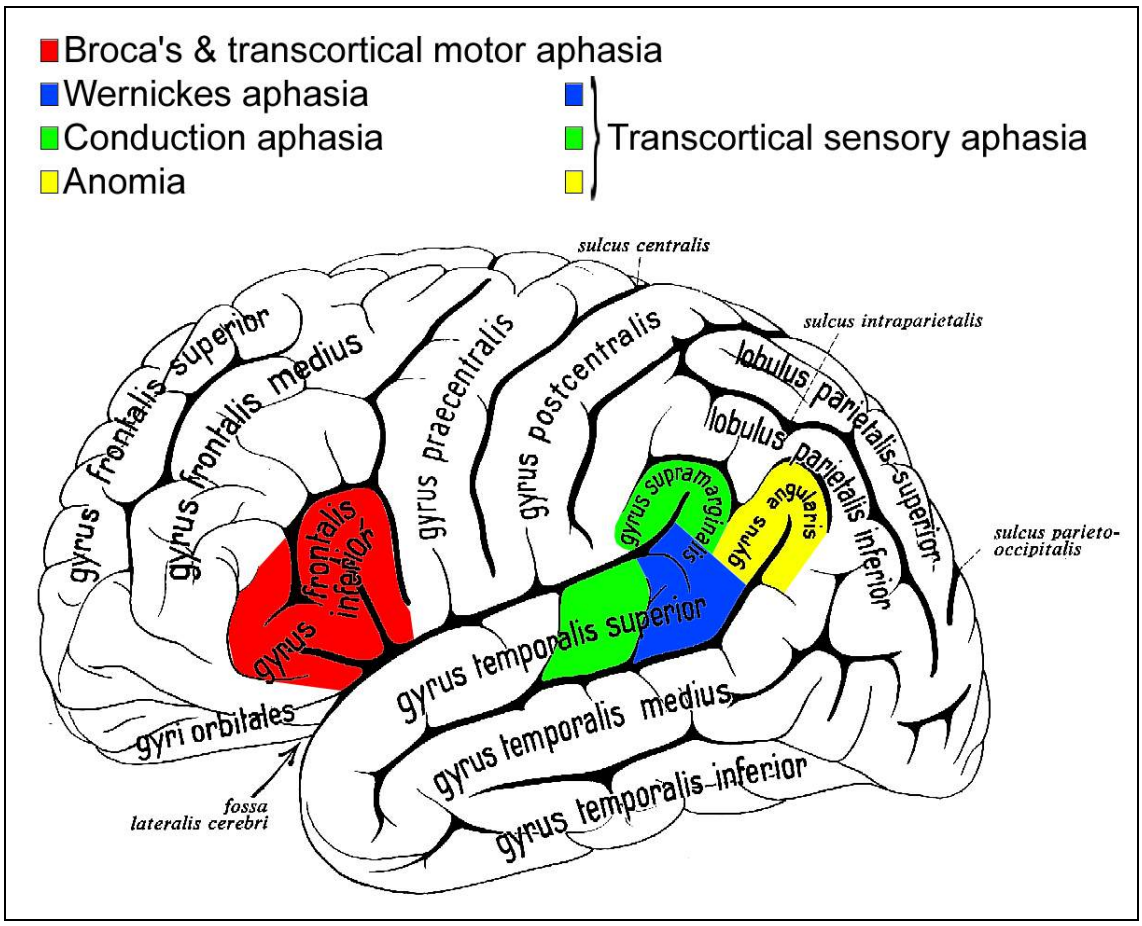



**Figure 6: Cerebral regions and their associated types of aphasia.**
**Based on Sobotta & Becher (1975: 4, Fig. 3)**

It is now possible to establish a typology of language and general intelligence, or rather mental retardation, which clearly shows the *double dissociation* between the two. It also offers some support for the *modularity hypothesis*. This typology is summarized in Table 4 below. The categories ‘mentally normal’ and ‘mentally retarded’ are not

intended to be interpreted too literally, as for example Wernicke's aphasia is also associated with reduced I.Q. as a consequence of the trauma.

| | | MENTALLY NORMAL | MENTALLY RETARDED |
|---|---|---|---|
| **NORMAL / GOOD LANGUAGE** | nerologically normal | **Normal subjects** | e.g. insanity, psychopathy |
| | nerologically abnormal | e.g. blindness due to brain damage | **Down's syndrome**<br>**Williams syndrome** |
| **IMPAIRED / POOR LANGUAGE** | nerologically normal | **S.L.I.** | ? |
| | nerologically abnormal | **Aphasia** | **Autism** |

**Table 4: A typology of language impairment and mental retardation. Some areas are shaded, because they refer to cases not covered in this study.**[3]

[3] For a similar classification see Vikner's web-site [http://www.hum.au.dk/engelsk/engsv/medfoedt.htm].

# 5 Cerebral Area and Function

As is clear from the survey of the different types of aphasia, the classic clinical description of language is based on the processes of comprehension and production. For this reason this kind of clinical description and definition is insufficient in that it seems to presuppose that language is a unitary skill (underlying the processes of comprehension and production). However, none of the above mentioned language impairments involve only a complete and undifferentiated loss of only linguistic comprehension or only production. For similar reasons a description in terms of syntax versus semantics is also insufficient, as for example aspects of syntax are impaired in e.g. Broca's aphasia, not all of it. Broca's aphasia is not a loss of syntax and likewise Wernicke's aphasia is not a loss of semantics. A description of the function of a cerebral area in terms of language processes, such as production or comprehension, or in terms of traditional linguistic distinctions, such as syntax and semantics, is misconceived.

What, then, are the functions of Broca's and Wernicke's areas? Let us consider some proposals. According to Damasio (1992: 534), *Broca's area* (and its vicinity, cf. footnote 2, page 33) is part of the network concerned with the *relational aspects* of language – that is, grammatical structure (cf. the characteristic agrammatism of Broca's aphasia), morphemes and verbs (Broca's aphasics have difficulties especially with verbs, cf. Bates et al 1991). In other words, Broca's area is concerned with *syntax and morphology*. On the other hand, *Wernicke's area* is

> […] *a processor of speech that allows sounds to be mapped as words and to be used subsequently to evoke conceptual meanings* [i.e. the coupling of phonological representations with semantic concepts. K. R. C.]. […] *Wernicke's area is no longer seen as a center for word selection. Rather, it appears that once a word is selected for possible use in an utterance, Wernicke's area is part of the network required to implement its constituent speech sounds, in the form of an internal auditory representation or of vocalization*. (Damasio 1992: 534)

At a first sight, Pinker (1994) seems to imply a classic localizationist approach: grammar in Broca's area and lexicon in Wernicke's area. But, as mentioned in section 3.3, Pinker labels the left perisylvian region *the language organ*, and hence he cannot at the same time lump all of grammar into one distinct small area like Broca's area and the

entire lexicon into Wernicke's area. If he did, then what would be the function of the rest of the language area (*the perisylvian region*)? He clearly does not make this mistake:

> *So, is Broca's area the grammar organ? Not really. Damage to Broca's area alone usually does not produce long-lasting severe aphasia.* […] *And, most surprisingly of all, some kinds of grammatical abilities seem to survive damage to Broca's area. When asked to distinguish grammatical from ungrammatical sentences, some Broca's aphasics can detect even subtle violations of the rules of syntax* […]. (Pinker 1994: 309) *Still, aphasics do not detect all ungrammaticalities, nor do all aphasics detect them, so the role of Broca's area in language is maddeningly unclear* (ibid. p.310).

Wernicke's area he assigns a role in looking up words in the lexicon and sending them on to other areas of the grammar. Thus, the lexicon itself can be distributed over a much larger area; Wernicke's area is just the "librarian", to put it crudely.

This model, I think, is quite compatible with Damasio's (1992) model described above. Damasio suspects that Wernicke's area has something to do with assigning a chosen word its proper phonological form but does not mention lexical semantics, which then must be handled by something else. In Pinker's view, a word's lexical entry includes both semantic content and phonological form. Both authors seemingly agree that this phonological form is implemented by the grammar in some sort of an internal representation of the utterance (which, at least for Pinker, would correspond to PF in Figure 1 in chapter 2). This is at least partly done in Broca's area, which they both state is part of the network responsible for 'relational aspects' of language, such as sequential order, sentence structure and morphology. Damasio (1992) is typical of clinical papers on these matters in that no particular linguistic theory is mentioned and no linguistic examples are included in the text. For this reason it is not possible to determine exactly what Damasio has in mind.

Deacon (1997), based on work by Roman Jakobson (1956), has a different approach. To him, there is no language-specific cerebral region. Rather, Wernicke's and Broca's areas are responsible for the computation of *paradigmatic and syntagmatic relations* respectively and are as such bottlenecks in larger computational chains,

linguistic as well as non-linguistic. He explains the two different kinds of relationships as follows:

> *In the most general sense, all words of the same part of speech are paradigmatic of each other to some degree since they can substitute for one another*. […] *Syntagmatic operations are reflected in the complementary relationships between words from different parts of speech (e.g., nouns, verbs, adjectives, adverbs, or articles) and the way these different classes of words alternate in sequence in a sentence.* (Deacon 1997: 305-306)

To Deacon, the frontal lobes house a symbolic processor. The frontal lobes are very large in proportion to the rest of the brain in humans (cf. section 3.1), and Deacon correlates this fact to the species-specificity of language – or symbolic communication and thinking. Coupled with the fact that trauma to the perisylvian region causes language deficits, this leads him to postulate that the frontal lobes house the central symbolic processor and that Broca's and Wernicke's areas are computational centers for information from the frontal lobes. Deacon's proposal fits quite well with the finding that there is a severe reduction in blood flow in the frontal lobes of autistic subjects with severe communicative impairments and with the spared frontal lobes of William's syndrome patients (cf. sections 4.1 and 4.2.2 respectively). But the mere facts, that normal subjects with normal frontal lobes have normal language, that Williams patients have normal frontal lobes and (near) normal language, and that autistic patients have abnormal frontal lobes and abnormal language do not place language in the frontal lobes. Again, it should be kept in mind that there is a difference between acquired impairment and developmental deficits. The facts just stated cannot account for the aphasic effects of brain damage to the language area. Furthermore, a lack of drive to communicate (*mutism*, not autism), which Deacon correlates with the diminished frontal lobes in autism, can be caused by damage to the *internal* cerebral surface of the *left* hemisphere in the area including the *anterior cingulate gyrus* and supplementary motor area, cf. Damasio (1992:537).

As Broca's area is part of the region affected in autism one would predict that the capacity for syntagmatic computation *per se* should be severely impaired as well. I find this at least dubious. Cases of *idiot savants* (Fay 1988, Frith 1989) clearly cast a shadow of doubt on this. How can one explain autistic geniuses of e.g. art, music, or

mathematics? These abilities clearly involve *syntagmatic* computations, as they cannot be described as mere skills of substitution, or in other words, as *paradigmatic* operations. It is rather superfluous to state that music and mathematical equations are sequentially ordered and dependent on syntagmatic computation. Furthermore, and clearly contrary to the facts, Christopher (who I argued is autistic in section 4.2.3 above), should not be able to learn language, and if so (as he actually has) he should only be able to compile lists of words in paradigmatic relation to each other (due to the sparing of Wernicke's area). This prediction is not borne out. Christopher's linguistic "super skill" is clearly not limited to recitation of huge lists of remembered words, since his abilities involve grammatical skills as well, cf. Smith and Tsimpli (1995).

Deacon states that "Syntactic operations and grammatical judgements can involve many different syntagmatic and paradigmatic processes, and these can differ from language to language" (1997: 306). As support for his hypothesis he cites findings by Bates et al. (1991)[4] who show that there is cross-linguistic variation in the correlation between lesion site and aphasia type. The important point is that a lesion in Broca's area has different effects on e.g. English and Italian. English (and German) uses fixed word and phrase position to signal such grammatical relationships as possession, subordination, question vs. statement, active vs. passive. The same relationships are signal by inflectional affixes in highly inflected languages like Italian (and Latin). Hence, the claim is, damage to Broca's area, which supposedly is responsible for syntagmatic relations, will have great effect on English, but a much less severe effect on Italian, which in turn would be more effected than English (regarding syntax) by a damage to Wernicke's area. Deacon interprets this as evidence for his claim that there is no language-specific module:

> *So if there is a grammar module, then the parts of this module map in very different ways to different grammatical operations, depending on the relative importance of positional or inflectional tricks for cuing* [sic] *grammatical decisions in different languages. This sort of module is a will-o'-the-wisp.* (Deacon 1997: 307)

[4] Bates et al. (1991) is actually a summary of findings by a number of researchers published as articles in a special issue of *Brain and Language*, issue 41.

But this variation is only strange if one assumes that language competence is divided into only two modules: grammar and lexicon. As already mentioned, lumping together all aspects of grammar into one is a misconception. Grammatical abilities are *not* lost in an either/or manner, such that a lesion in Broca's area would lead to a complete loss of all grammatical competence. No one, at least in linguistic circles (as far as I know), believes in this kind of gross localizationist approach anymore. In fact, one of the cornerstones of generative grammar is that language is modular, internally (cf. section 2.1 above) as well as externally (cf. section 4.4).

Actually, I don't think that there is much in favor of Deacon's hypothesis that Broca's area and Wernicke's area are but computational centers that also compute linguistic signals from the frontal lobes. The mere distinction between syntagmatic and paradigmatic relations within a semiotic system has little explanatory or descriptive value. His claim that the frontal lobes house the central processor that is also responsible for language is also rather dubious, as language is clearly located in the language zone of the left hemisphere (the frontal lobes may, however, still be crucially involved in symbolic cognition as such). Furthermore, he claims that language is acquired so easily and fast because humans have a special kind of learning ability to do so, due to the co-evolution of language and brain. Deacon claims that general symbolic cognition, most clearly reflected in the *theory of mind*, is a prerequisite for language, i.e. general intelligence. I have already argued that this dependency is false (cf. chapter 4).

Damasio, Pinker, and Deacon are all too unspecific in their proposals on the functions of the areas inside the language zone. Nevertheless, they share a common feature: they all place a responsibility for syntagmatic, relational, or sequential computation of grammatical structure on Broca's area (and vicinity). In the following chapter I shall return to this aspect with a refined theory of grammar.

What is lacking in the three proposals is a grounding in a specific linguistic theory, which is capable of describing the linguistic competence of normal language users and which accounts for the observed breakdown patterns – a theory that is *breakdown compatible* (Grodzinsky 1990: 111). That is, a framework that provides the proper descriptive tools to give an account beyond the inadequate dichotomies, such as syntax vs. lexicon or syntagmatic vs. paradigmatic. Though Pinker adheres to the Principles and Parameters framework (see chapter 2) he does not go sufficiently into detail in his 1994 account. Damasio is a clinician and it is unclear to which linguistic framework he would adhere. Deacon's proposal, as I have shown, has little to offer but

the old distinction between syntagmatic and paradigmatic relations. The fact that language deficits vary cross-linguistically is, I think, the only linguistic phenomenon he does account for and that is not covered by the others. However, as I shall show below, this phenomenon is accountable for by a generative framework, which also provides a description of normal speakers' competence in terms of a specific grammatical framework.

# 6 A Syntactic Approach to Broca's Aphasia

The distinction between syntax and lexicon, and the conception of the two being localized in two distinct areas of the left hemisphere, was argued in the preceding chapters to be insufficient and wrong on empirical grounds, both cross-linguistically (as shown in e.g. Bates et al 1991) as well as pathologically. Language functions are distributed over the language zone. It appears that the anterior part is responsible for the syntagmatic aspects of linguistic computation, which clearly includes syntax. Damage to this area, however, does not lead to the loss of all of syntax. As Grodzinsky (2000: 4) states:

> "*On testing, Broca's aphasics showed near-normal abilities in comprehension and grammaticality judgement on many syntactic constructions, and thus did not appear to have "asyntactic comprehension". There was a disruption, but it was restricted to* certain aspects of syntax. *It was becoming clear, then, that a distinction between different levels of linguistic analysis would not suffice, and that* distinctions within syntax *were needed to account for the comprehension deficit, just as they were for speech production.* (Emphasis added.)

(The meaning of the loose terms "*many syntactic constructions*" and "*certain aspects of syntax*" will become clear below.)

Let me once again point out the important distinction between developmental and acquired impairment. The former is the result of a brain that is different from a normal brain, while the latter is the result of damage to a hitherto normal brain. As Broca's aphasia is an acquired impairment, it is obvious to consider Broca aphasics' linguistic competence as a normal grammar with some damaged part or parts – not as a completely different grammar. Therefore, the theory that accounts for the linguistic competence in normal people has to able to account for the competence in aphasics as well. The theory must meet the *Criterion of Breakdown-Compatibility*:

(23) **The Criterion of Breakdown-Compatibility**:

*Every pattern of impairment and sparing of linguistic ability must be accounted for in a natural, non-ad hoc fashion*. (Grodzinsky 1990: 111; see also Grodzinsky 1986: 137)

The accounts in the preceding chapters have primarily been clinical accounts. The scientific field concerned with the linguistic abilities of the human species is, of course, linguistics. Therefore, the framework of linguistics should also be applied to language impairments such as aphasia, in order to properly describe what impact trauma to different regions of the brain have on peoples linguistic competence, and in turn to aid in establishing proper diagnostics. Granted that this is true, it is natural to approach the domain of aphasia from a syntactic point of view.

In the next sections agrammatic comprehension and production will be viewed from a syntactic point of view, and I shall argue that the deficits to both of these domains are due to selective impairments to aspects of grammar. First, in section 6.1 I present an account of the comprehension deficit. Briefly, the hypothesis is that the comprehension problems associated with Broca's aphasia are due to a loss or deletion of traces in the syntactic representation. Hence, the hypothesis is called the *Trace Deletion Hypothesis*. This deletion of traces is what causes the subsequent misinterpretation of thematic roles. Then, in section 6.2 I present the *Tree-pruning Hypothesis*, which accounts for the production impairment in Broca's aphasia. According to the hypothesis, the production errors are caused be a disruption to the syntactic tree, in which one or more nodes (maximal projections, cf. chapter 2) are missing from the representation.

## 6.1 Comprehension: The Trace Deletion Hypothesis

As Broca's aphasics have some linguistic competence, their entire grammar cannot be lost. In fact, as already mentioned, their understanding is not entirely impaired, and their speech production also present intact features of grammar, such as word order. Based on research both by the author himself as well as others in a diversity of languages including Japanese, Chinese, Hebrew, Dutch, Russian, Italian and English, Grodzinsky (2000; see also 1990) argues that in fact most of the Broca aphasics' grammar is intact. The following domains of grammar are supposedly left unimpaired in processes of

comprehension in Broca's aphasia (cf. Grodzinsky 1995: 31, 2000: 4) (I shall deal with production below):

i. In comprehension, Broca's aphasics can construct basic syntactic trees for simple sentences not containing intra-sentential dependencies (such as trace-antecedent relations), for example active sentences. They are also able to detect violations of phrase structure rules (cf. Grodzinsky 1995a), such as ii-iv.

ii. They seem to have no impairment to the part of the lexicon that interfaces with sentence grammar. They are able to detect violations of subcategorization, e.g. the verb "*to eat*" subcategorizes for a NP such as "*a cake*"; and argument structure, i.e. how many and what kinds of arguments (AGENT, THEME etc.).

iii. The module called the Theta-theory is also intact. Broca's aphasics know the theta-roles of predicates and are able to assign them directly to positions, which is evident from comprehension tasks on simple structures such as active sentences.

iv. They are able to compute (interpret) some intra-sentential dependencies, such as grammatical case (for example ACCUSATIVE or DATIVE) which is typically assigned to canonical positions, such as the object position. They are also able to handle binding relations (cf. Grodzinsky et al. 1993), which are constraints on anaphoric relations between pronouns and reflexives and their antecedents (Chomsky 1981, Haegeman 1994).

However, certain aspects of pronominal reference are impaired, but they have to do with discourse (pragmatic skills) and not with intra-sentential binding relations (cf. Balogh & Grodzinsky 2000, Grodzinsky & Reinhart 1993).

In contrast to these spared abilities, Broca's aphasics suffer severe difficulties with constructions involving syntactic movement, such as passives, where a noun phrase is moved from object position to subject position leaving a trace:

(24) [*The boy*]$_1$ *was pushed* t$_1$ *by the girl*.

In (24) the NP "*the boy*" is the THEME and "*the girl*" is the AGENT, the one doing the pushing. Canonically, the role of THEME is assigned by the verb to the position to its right – the typical object position of actives. The passive morphology absorbs (cf. Haegeman 1994) the argument to the left (in this case "*the girl*") which is optionally adjoined in a PP. In order to abide the *Case Filter*, the NP *the boy* is moved to [spec, IP] to be assigned NOMINATIVE, subject case (see chapter 2 for more information).

Numerous experiments (see for example Grodzinsky 1990 and 1995a) on semantically reversible sentences have supported the claim that transformation (i.e. movement) implies comprehension problems. The experiments typically involve the *sentence-to-picture-matching* test, in which the patient hears a sentence and then he/she has to point out a picture, which depicts the semantic content of the sentence. For example, the patient hears the sentence "*the boy pushed the girl*" and has to choose between a picture where a boy is pushing a girl and a picture where a girl is pushing a boy. The experiment is supposed to probe the patient's abilities on theta-assignment to structural positions. The data categorizes sentential structures into three sets: Those where the patients perform above chance, at chance level, and those where the patients perform below chance (for statistical details, see e.g. Grodzinsky 1995b: 491 or Balogh & Grodzinsky 2000: 17). I have summarized these findings in the following table:

| Construction | Example | Theta-Structure | Performance |
|---|---|---|---|
| Active | *the girl pushed the boy* | AGENT-THEME | above chance |
| Subject-subject relative | *the girl, who pushed the boy, is angry* | AGENT-THEME | above chance |
| Object-subject relative | *show me the girl, who pushed the boy* | AGENT-THEME | above chance |
| Subject cleft | *it is the girl who pushed the boy* | AGENT-THEME | above chance |
| Adjectival passive | *the boy was interested in the girl* | EXP.- THEME | above chance |
| Psychological verb | *the boy admires the girl* | EXP.- THEME | above chance |
| Passive | [*the boy*]$_1$ *was pushed* t$_1$ *by the girl* | THEME-AGENT | Chance |
| Subject-object relative | [*the boy*]$_1$ *who the girl pushed* t$_1$ *was tall* | THEME-AGENT | Chance |
| Object-object relative | *show me* [*the boy*]$_1$ *who the girl pushed* t$_1$ | THEME-AGENT | Chance |
| Object cleft | *it is* [*the boy*]$_1$ *who the girl pushed* t$_1$ | THEME-AGENT | Chance |
| Psychological passive | [*the girl*]$_1$ *is admired* t$_1$ *by the boy* | THEME-EXP. | below chance |

**Table 5. For expository reasons the total syntactic complexity of the examples is left out, and will be described in due course below. Roughly, chance refers to 30%-70% correct performance. Note also that the θ-role EXP. is short for EXPERIENCER.**

The term *psychological verb* refers to *non-agentive verbs*, such as *feel*, *love*, *hate*, and *admire*, which denote experience rather that action. You can deliberately kick someone (you are the AGENT), so *kick* is an agentive verb. You can not deliberately love someone, but you can experience (feel) love for someone (you are the EXPERIENCER).

From the table above it is clear that the distinguishing factor dividing the syntactic constructions is movement. In the types on which agrammatic aphasics perform above chance (near normal) there are no traces in the examples given in the table. The other types all involve movement of the 'underlying' object to subject position and hence the representations have traces. This finding gives rise to *the Trace-Deletion Hypothesis* (I refer the reader to Grodzinsky 1986, 1990, 1995a+b and 2000 for elaboration):

(25) **The Trace-Deletion Hypothesis**:
*In agrammatism, traces in θ-positions (structural positions to which θ-roles are assigned) are deleted from the syntactic representations.*

So, in the representations of a sentence in Broca's aphasics, the moved NP will not have a theta-role assigned to them because the trace that would normally transmit the role is deleted. Perhaps a note on the term 'deleted' is in order. In comprehension the hearer constructs a mental grammatical representation of the utterance, which can be represented orthographically as a syntactic tree. The agrammatic tree either lacks the traces of the moved NPs or the links between the trace and its antecedent is broken. In either case, the theta-transmission fails. I will not go into further discussion on the two possibilities (*no traces* or *broken chains* - note that chains are instances of the relational aspects of language discussed in the previous chapter). The point is that the theta-transmission fails and this can be accounted for by saying the traces of the moved NPs are deleted. Keep in mind that traces are constructs (cf. chapter 2), and deletion does not refer to some sort of mental eraser removing **t**s from trees in the patient's head.

The *Trace-Deletion Hypothesis* alone, however, is not enough to account for all the constructions in the table, for three reasons. First, the hypothesis does not predict chance performance in itself in tests on e.g. passives, only that they are problematic and that comprehension is impaired. Second, it does not predict that the performance on psychological passives would be below chance. Third, under the *VP-internal Subject Hypothesis* (see chapter 2) all constructions involve movement of the subject, and hence

the prediction is that all constructions would be problematic, which is not borne out. What remedies these problems is the application of a heuristic non-linguistic strategy that assigns NPs theta-roles according to their linear position. This strategy is based on knowledge of the world, such as frequency of occurrence / canonical order of roles, which means that the initial (argument) NP will be assigned the role of AGENT:

(26) **The Default Strategy**:
*Phrasal constituents with no theta-role are assigned one by default, by linear considerations ($NP_1$=AGENT).*

This strategy applies after the grammar has built the syntactic representation with the missing theta-role(s). In normal as well as in aphasic speakers, the information the grammar uses in the construction of representations is not available to higher cognition, such as world knowledge – this is called the *informational encapsulation* of the grammar (cf. Fodor 1983, Grodzinsky 1990). Therefore, in Broca's aphasia the *Default Strategy* is applied blindly resulting in counterintuitive assigning:

(27) *John was killed _ by Bill*

| | | |
|---|---|---|
| THEME | AGENT | (normal assignment) |
| AGENT | AGENT | (agrammatic assignment) |

In this example *Bill* is not moved and is therefore assigned the θ-role AGENT by the grammar. The NP *John*, on the other hand, is moved and its trace is deleted (illustrated with _) and therefore theta-transmission is impossible leaving the NP without a θ-role. Then the *Default Strategy* kicks in and assigns it the role of AGENT. The representation now has two AGENTS, which are in *competition*. This leads to chance performance as the agrammatic subject is forced to guess which is correct.

The second problem was with psychological passives. Let's consider an example:

(28) [*The girl*] *is admired _ by the boy*

| | | |
|---|---|---|
| THEME | EXPERIENCER | (normal assignment) |
| AGENT | EXPERIENCER | (agrammatic assignment) |

Here the result of the application of the strategy no longer leads to competition between two identical roles, as was the case in (27) above. The two θ-roles in the agrammatic representation are not identical like they were in (27), hence only one interpretation is made in (28), even though it may seem a bit odd to consider admiration as something one deliberately does (*I deliberately admire her* / *I admire her on purpose*). The agrammatic interprets such sentences directly complementary of normal language users: In (28) the girl is doing the admiring, not the boy. To account for this we have to consider how the different theta-roles are related. Jackendoff (1972) ranks the θ-roles in a hierarchy according to thematic salience:

(29) **The Thematic Hierarchy**:

AGENT > EXPERIENCER > LOCATION, SOURCE, GOAL > THEME

Thus, the NP assigned the highest ranking is 'the doer', in (28) *the girl* is doing the admiring because of the role as AGENT, not the NP *the boy* even though it is assigned the role of EXPERIENCER by the grammar as this role is lower ranked. Another such hierarchy is the *Animacy Hierarchy*. A NP is higher in animacy (more animate) the more to the left it is on the following hierarchy (cf. Comrie 1989: 128):

(30) 1ST / 2ND PERS. PRONOUNS > OTHER HUMAN NPS > ANIMAL NPS > INANIMATE NPS

For an account of experiments involving non-agentive animate and inanimate NPs and therefore θ-roles other than AGENT, THEME, and EXPERIENCER, see Grodzinsky 1995b. In my account I restrict myself to NPs that are animate.

This consistent reversal of the roles in sentences with psychological verbs is the reason why an account merely based on canonical order fails. According to such an account, when the aphasic encounters a structure that does not have the AGENT first, he or she will guess, and this would result in chance performance. However, the data shows performance below chance and a reversal of the roles, which is not predicted by such an account. This supports the transformational account outlined here (see also Grodzinsky 1989).

The third problem was of a theoretical nature. According to the *VP-internal subject hypothesis* the subject moves out of the verb phrase (in which it is base

generated) to receive NOMINATIVE. Without the *Default Strategy* the subject would not be assigned a θ-role. Through the application of the *Default Strategy* the subject is assigned AGENT in non-problematic actives:

(31) [*John* [(t) *killed Bill*]]

| | | |
|---|---|---|
| AGENT | THEME | (normal assignment: θ-transmission from t) |
| AGENT | THEME | (agrammatic assignment: Default Strategy) |

Under normal circumstances the subject is assigned its θ-role by transmission from its trace. In agrammatic comprehension, however, this is not possible as the trace is deleted (or the trace-antecedent chain is broken). The strategy assigns it AGENT, and thus *compensates* for the lost grammatical θ-transmission and leading to the right interpretation. The same θ-role is assigned, but for a different reason.

In short, the account of agrammatic comprehension consists of two interacting parts: the *Trace Deletion Hypothesis* and the *Default Strategy*. According to the *Trace Deletion Hypothesis*, traces in θ-positions are deleted from the syntactic representation, which leads to separation of θ-assignor and θ-assignee, which in turn results in NPs without θ-roles. The *Default Strategy* states that constituents without grammatically assigned θ-roles are assigned one by linear considerations, such that the first NP (in a θ-position) is assigned AGENT. The interaction of the two parts lead to chance performance on movement derived clauses (except psychological passive, which is associated with below chance performance).

## 6.2 Production: The Tree-Pruning Hypothesis

The production side of the deficit does not mirror the comprehension side. After all, it was long believed that Broca's aphasia was an impairment of speech production with a sparing of comprehension. Mostly, it is characterized as improper use or omission of grammatical words and morphemes (cf. section 4.3.1 above). However, a number of researchers have pointed out that this is not altogether true, as there is cross-linguistic variation within this deficit (e.g. Bates et. al 1991 and Grodzinsky 1990, 2000). Bates et al. (1991) relate this variation to differences in competition between two emergent connectionist neural networks, somewhat reminiscent of the Jakobsonian *syntagmatic* vs. *paradigmatic* computation of information that Deacon (1997) supports. I have

already explained why this approach, in my opinion, is wrong. Grodzinsky's approach to this is, I think, more elegant. It obeys the important *Criterion of Breakdown-Compatibility*.

The differences between languages are constrained by the typological space defined by the possible parametric variation of the universal grammar. Therefore, it should not be surprising to find that at least some aspects of agrammatism reflect this parametric variation. Grodzinsky's studies (1984, 1990, and 2000) have shown a correlation between zero-morphology and omission of inflection in agrammatics (i.e. people suffering from agrammatism) in a variety of languages. In both nominal and verbal inflected elements morphemic omission is observed if the bare stem is a real and well-formed word in the current language, i.e. if the language has +zero-morphology. Otherwise, if the omission of inflection results in nonwords, i.e. if the language has –zero-morphology, substitution errors occur instead:

(32) `+Zero-morphology ⇔ omission` (e.g. English and Japanese)
`-Zero-morphology ⇔ substitution` (e.g. Russian, Italian, Hebrew)

Agrammatics do not produce non-words (cf. Grodzinsky 1990: 52). There is thus no violation of constraints on lexical well-formedness, as omission of inflection only occurs if the resulting word is a real word. Otherwise the inflectional morpheme is substituted, giving rise to grammatical aberration. This supports the proposed connection between the typological parameter (+/- zero-morphology) and observed agrammatic behavior.

Here are some examples of omission and substitution respectively (taken from Grodzinsky 1990: 52):

(33) **Omission:**

English: *Uh, oh, I guess six month… my mother pass away*
(Omission of number and tense inflection)

Japanese: *inorimasu* (correct: *inorimasushita*)
I-pray I-prayed
(Omission of tense inflection)

**Substitution:**

Russian: *grustnaja malchik*
sad (FEM.) boy (MASC.)
(Substitution of agr. inflection: *grustn-iy > grustn-aja*)

Italian: *Cappuceto rossa andava*
Little Ridinghood (MASC.) Red (FEM.) went
(Substitution of agreement inflection: *ross-o > ross-a*)

Hebrew: *tiylu anaxnu ba'ali ve'ani*
'take-a-walk'.PAST.3rd PERS.PL. we husband.my and-I
("*They took a walk, we my husband and I*")
(Substitution of agreement inflection: *tiyl-nu > tiyl-u*)

The deficit is, however, more restricted than to the correlation between omission/substitution and +/-zero-morphology. The omission/substitution is determined by the elements' structural position. According to Grodzinsky and Friedmann (1997, 2000), there is dissociation between tense and agreement inflection. This runs contrary to the common belief that Broca's aphasics have equal problems with all functional categories. Evidence from Hebrew, Arabic, Italian, French, Dutch, German, Icelandic, Swedish, Finnish, Japanese has shown that agrammatics may be impaired in tense, while not having problems with agreement (based on both new tests as well as retrospective literature reviews). On the other hand, the opposite, impaired agreement and spared tense, is never found, cf. Friedmann & Grodzinsky (1997, 2000).

Impaired agreement implies impaired tense, not vice versa. These findings offer support for the *Split-Inflection Hypothesis* (Pollock 1989), according to which the INFL node IP (inflection phrase) in (34) is split up into an agreement phrase AgrP and a tense phrase TnsP in (35) (NegP is short for negation phrase):

(34) $[_{CP}$ spec $C^0$ $[_{IP}$ spec $I^0$ $[_{NegP}$ spec $N^0$ $[_{VP}$ spec $V^0$ compl ]]]]

(35) $[_{CP}$ spec $C^0$ $[_{TnsP}$ spec $Tns^0$ $[_{NegP}$ spec $N^0$ $[_{AgrP}$ spec $Agr^0$
$[_{VP}$ spec $V^0$ compl ]]]]]

The ordering or ranking of the functional categories is not uncontroversial, something which I will come back to in the next chapter. This dissociation between tense and agreement suggests a possible deficit that involves the tense node but not the agreement node. It also allows for varying degrees of severity. If the AgrP node is impaired, the syntactic tree is disrupted from AgrP and up, and errors of agreement will occur accompanied by errors of tense. If the tense node is impaired, TnsP and CP are disrupted, and hence only tense errors will occur (no agreement errors). Based on these findings Grodzinsky (2000:16) states the following hypothesis:

(36) **The Tree-Pruning Hypothesis**:
*Agrammatic aphasic patients produce trees that are intact up to the Tense node and "pruned"*[5] *from this node up*

Or in more formal terms (from Friedmann & Grodzinsky 2000:25 [pdf version]):

*a) T is impaired in agrammatic production*
*b) An impaired node cannot project any higher*.

The hypothesis is further supported by the finding that the verb stays *in situ* (in its base position) instead of moving up the tree[6]:

*In Germanic languages such as Dutch, German, and Icelandic, patients frequently use the infinitive instead of the inflected verb. Crucially, a non-finite form always appears in a sentence-final position, indicating that the verb has not moved up the*

[5] The term "pruned" refers to the way trees are trimmed. A gardener may trim a tree to control its growth by cutting off branches, and thus prevent he tree from growing higher. This is called pruning. In the same way the syntactic tree in agrammatic production is cut or rather destroyed from the tense node up, which means that the TnsP and CP 'branches' are missing.

[6] This phenomenon is also known from studies of language acquisition (cf. Wexler 1994). Children also produce sentences with uninflected verbs *in situ*; such verbs are also called root infinitives. Wexler (1994) argues that children go through an "optional infinitive" stage, in which they utter both sentences with finite verbs and sentences with non-finite verbs (infinitives). The interesting point is the position of the verbs: e.g. English and French speaking children put the finite verb before the negation and the non-finite (infinitive) after the negation; Dutch and German children place the finite verb in V2 position, while the non-finite forms are sentence final. The same results are predicted in agrammatism: if the verb cannot move due to impaired nodes under the *Tree-pruning Hypothesis* it stays *in situ* in the infinitive form in $V^0$; if the verb moves it will be finite (inflected for tense).

> *tree to C, where tensed verbs in matrix clauses of V2 languages should move.* (Friedmann & Grodzinsky 2000: 8 [pdf version])

Furthermore, Grodzinsky & Friedmann (1997, 2000) show that agrammatics make no *Wh*-questions and no embedded sentences involving a complementizer in CP. Both structures depend on the presence of CP, since *wh*-elements (such as English *who* and *which*) normally move to [spec, CP], and complementizers like *that* are generated in $C^0$. Correlated with the disruption of tense and the sparing of agreement, the absence of embeddings supports the *Tree-Pruning Hypothesis*. As mentioned, their model also allows for varying degrees of impairment. In this (rather simplified) tree structure the double slashes (//) indicate possible points of impairment:

(37) $[_{CP}$ // $[_{TnsP}$ // $[_{NegP}$ $[_{AgrP}$ // $[_{VP}$ …

Agrammatics may be impaired from agreement up (deficit to agreement, tense, and CP), from the tense node up (deficit to tense and CP), or just to the topmost node CP (see Grodzinsky & Friedmann 1997).

In the next chapter I want to apply the *Trace-Deletion Hypothesis*, the *Default Strategy* and the *Tree-Pruning Hypothesis* to Danish, which is a verb-second (V2) language. Because of its V2 status certain predictions can be made about Danish agrammatic speech production. Furthermore, I present an alternative order of the functional categories TnsP and AgrP. I also show how differences in degrees of severity are predicted to be reflected in the speech production of Danish Broca aphasics.

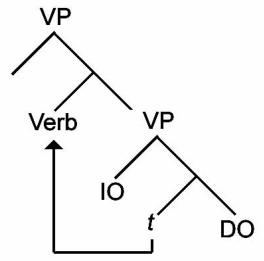
# 7 Is Grodzinsky's thesis applicable to Danish?

Linguistic competence is universal to humans and only humans (the hypotheses of *Universality* and *Species-Specificity*) and based on common cerebral predisposition (the *Innateness Hypothesis*). Therefore a theory assumed to be able to account for language breakdown has to be applicable to all languages of the world. For this reason it is important to test whether Grodzinsky's hypotheses are applicable to Danish (as well as to every other language).

## 7.1 The Danish Language

Danish is the official language of Denmark. It belongs to the East Scandinavian language group of the Germanic family. It has a fairly strict word order, SVO (Subject-Verb-Object), in both main and embedded clauses. Moreover, Danish is a verb-second (V2) language, which means that the finite verb is always the second constituent of the *main* clause. *Yes/no* questions constructions constitute the only exception, where the verb is sentence initial (see (42) in Table 6 below). Furthermore, if another constituent is fronted (topicalized), it triggers inversion of the subject and the finite verb, which places the finite verb in second position (V2) and the subject in third ((40) in Table 6 below). In embedded clauses fronting and inversion are prohibited. In brief, the linear word order in Danish is as follows[7]:

[7] I leave out structures that contain both a direct and an indirect object. Either the indirect object is realized as a preposition phrase or as part of a *double object construction* (cf. Larson 1988, Vikner 1989), in which the VP has the following structure:




For example:

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| [$_{CP}$ | *han*$_1$ | *har*$_2$ | [$_{IP}$ | t$_1$ | t$_2$ | [$_{VP}$ | t$_1$ | t$_2$ | [$_{VP}$ | t$_1$ | *købt*$_3$ | [$_{VP}$ | *hende* | t$_3$ | [$_{NP}$ | *en* | *gave*]]]]]] |
| | *he* | *has* | | | | | | | | | *bought* | | *her* | | | *a present* | | | |

| | Conj | Sub/Topic | Verb-finite | (Sub) | Adv | Neg | Verb-nonfinite | Obj |
|---|---|---|---|---|---|---|---|---|
| (38) | | *Jeg*<br>I (Sub) | *spiser*<br>eat-PRES | | *endda*<br>even | *ikke*<br>not | | *bananer*<br>bananas |
| (39) | *Men*<br>But | *jeg*<br>I (Sub) | *har*<br>have-PRES | | *tit*<br>often | | *smagt*<br>taste-PT.PTCP | *ferskener*<br>peaches |
| (40) | | *Pærer*<br>Pears (Obj+Top) | *spiser*<br>eat-PRES | *jeg*<br>I | *også*<br>also | | | |
| (41) | *Og*<br>And | *Hvad*<br>What | *køber*<br>*buy-PRES* | *du?*<br>you? | | | | |
| (42) | | | *køber*<br>Buy-PRES | *du*<br>you | *også*<br>also | | | *æbler?*<br>apples? |

**Table 6: Topological analysis of Danish main clauses.**

| | | Conj | Sub | Adv | Neg | Verb-finite | Verb-nonfinite | Obj |
|---|---|---|---|---|---|---|---|---|
| (43) | *du ved*<br>you know | *at*<br>that | *jeg*<br>I | *endda*<br>even | *ikke*<br>not | *spiser*<br>eat-PRES | | *bananer*<br>bananas |
| (44) | *Piger*<br>Girls | | *der*<br>who | *tit*<br>often | | *har*<br>have-PRES | *smagt*<br>taste-PT.PTCP | *ferskener*<br>peaches |
| (45) | … | *hvis*<br>if | *du*<br>you | *aldrig*<br>never | | *prøver*<br>try-PRES | | |

**Table 7: Topological analysis of Danish embedded clauses.**

The structural analysis of main clauses and embedded clauses are given below in (46) and (47) respectively, with the split-IP order proposed by Pollock's (1989) (the symbol '–' indicates an unfilled specifier position. The word "*ikke*" is the Danish negation equivalent to the English "not".) For expository reasons I have left out the structure of the complement (compl) of the verb.

(46) **Main Clause (preliminary version):**

$[_{CP}$ Conj $[_{CP}$ $Sub_1$ $Verb_2$ $[_{TnsP}$ $t_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ Adv]
$[_{NegP}$ (*ikke*) $t_2$ $[_{AgrP}$ - $t_2$ $[_{VP}$ $t_1$ $t_2$ Compl ]]]]]]]

For example:

$[_{CP}$ *og* $[_{CP}$ $jeg_1$ $spiser_2$ $[_{TnsP}$ $t_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ *faktisk*]
$[_{NegP}$ *ikke* $t_2$ $[_{AgrP}$ - $t_2$ $[_{VP}$ $t_1$ $t_2$ *bananer*]]]]]]]

"And I actually do not eat bananas" (lit.: and I eat actually not bananas)

(47) **Embedded Clause (preliminary version):**

$[_{CP}$ Conj $[_{TnsP}$ $Sub_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ Adv] $[_{NegP}$ (*ikke*) $t_2$
$[_{AgrP}$ - $t_2$ $[_{VP}$ $t_1$ $Verb_2$ Compl ]]]]]]

For example:

$[_{CP}$ *at* $[_{TnsP}$ $jeg_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ *faktisk*] $[_{NegP}$ *ikke* $t_2$
$[_{AgrP}$ - $t_2$ $[_{VP}$ $t_1$ $spiser_2$ *bananer*]]]]]]

"That I actually do not eat bananas." (lit.: that I actually not eat bananas)

Note the CP-recursion in the main clause (46): In V2 languages the verb always moves from $V^0$ through $Agr^0$, $Neg^0$ and $Tns^0$ to $C^0$ in *main* clauses. SO, in the presence of a coordinating conjunction (it must be coordinating as it occurs in a main clause) another CP is projected, which is headed by the conjunction (the *complementizer*), cf. Vikner (1995), because the first CP is 'occupied' by the verb. Note also that in embedded clauses the tense and agreement inflection is lowered to the verb in $V^0$ instead of being attached to the verb by movement out of $V^0$.

Perhaps a description of the derivation of a standard main clause is in order. Consider the following example:

(48) $[_{CP}$ $hunden_1$ $bed_2$ $[_{TnsP}$ $t_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ *faktisk*]
$[_{NegP}$ *ikke* $t_2$ $[_{AgrP}$ - $t_2$ $[_{VP}$ $t_1$ $t_2$ *katten*]]]]]]

"The dog actually didn't bite the cat."

(Literally: *the dog bit actually not the cat*.)

First of all, following the *Projection Principle*, the verb "*bide*" projects a verb phrase VP and subcategorizes for two NPs, one for each argument "*hunden*" og "*katten*" (their structure is left out for expository reasons). The former is placed left of $V^0$ receiving the AGENT role and the latter to the right receiving the role of THEME, thus satisfying the

*Theta Criterion*. The sentential adverbial phrase (AdvP) is adjoined to the NegP[8]. Due to the *Extended Projection Principle* the clause structure is projected by the verb, and the *Case Filter* forces the subject to move from its base position in [spec, VP] to [spec, TnsP] where it is assigned NOMINATIVE case. The object is assigned ACCUSATIVE by the verb in $V^0$. The verb is moved up to $Agr^0$ and via $Neg^0$ on to $Tns^0$ to receive tense inflection, and finally assuming V2 position in $C^0$. The subject moves from [spec, TnsP] to [spec, CP], which is vacant as no other topic is fronted.

As mentioned in the section 6.2, the above ordering of the functional categories TnsP, NegP, and AgrP is not uncontroversial. Belletti (1990), Haegeman (1994), and Vikner (1995) have a different order of tense, negation and agreement, i.e. $[_{AgrP}\ [_{TnsP}\ [_{NegP}\ ]]]$ rather than $[_{TnsP}\ [_{Neg}\ [_{AgrP}\ ]]]$ as Pollock 1989 proposes. This re-ordering (Belletti 1990) has serious consequences:

i. Under the *Breakdown Hypothesis*, in order to maintain neurological support, Pollock's order somehow has to be possible, as it is applicable to agrammatic production in the languages studied by Grodzinsky (e.g. 2000).

ii. However, it is widely accepted that Belletti's order is correct. The argument is based on the ordering of the inflection on the verb. This order should reflect the movement of the verb. This is known as the *Mirror Principle*. If the verb moves to $Tns^0$ before $Agr^0$ then the tense inflection should be closer to the verb stem than the agreement inflection. This is the case in for example German: "*Du glaub-t-est*" 'you think-PAST-2nd PERS.SING' (cf. Haegeman 1994 for discussion). This may imply that the ranking of the functional categories is not universal, but open to parametric variation.

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[8] In order not to complicate matters unnecessarily, I only include sentence adverbials and leave out structures with VP-adverbials, which are adjoined to VP:

… $[_{NegP}\ [_{AdvP}$ Adv ] $[_{NegP}$ spec $Neg^0$ $[_{VP}\ [_{AdvP}$ Adv ] $[_{VP}$ spec $V^0$…

Sentence adverbial VP-adverbial:

An example of a VP-adverb is "*langsomt*" (slowly), which can only appears after the negation:

*jeg spiser ikke langsomt*
"I don't eat slowly" (literally: I eat not slowly)

**jeg spiser langsomt ikke*

iii. It follows from the possibility of parametric variation in the ordering of the functional categories that the *Tree-Pruning Hypothesis* will give rise to language specific variation in agrammatism. Hence, impairment to the Agreement phrase alone with a sparing of Tense is possible, but as mentioned in section 6.2 above this has never been found (Friedman & Grodzinsky 1997, 2000). This may be an artifact of the languages studied. Perhaps there are agrammatic speakers of some language that is only poorly studied. On the other hand, if no such language can be found then we will be forced to reevaluate the internal structure of IP.

Movement of the verb $V^0$ is cyclic and is done step-wise and cannot skip a position (this is known as the *Head Movement Constraint*). For this reason, it is necessary to assume that negation in Danish ("*ikke*") is in [spec, $Neg^0$] like English "*not*" and French "*pas*". Otherwise it would block verb movement. The English negation "*n't*" (and the French "*ne*") is a $Neg^0$ element, i.e. a head. It is attached to (incorporated into) the verb, resulting in e.g. "*didn't*" (thanks to Sten Vikner for pointing this out). This gives us the following structure, main clause structure version 2, in which the order of TnsP and AgrP is reversed in the line of Belleti:

(49) **Structure of Danish Main Clauses , final version (replaces (46)):**

$[_{CP}$ Conj $[_{CP}$ $Sub_1$ $Verb_2$ $[_{AgrP}$ $t_1$ $t_2$ $[_{TnsP}$ - $t_2$
$[_{NegP}$ $[_{AdvP}$ Adv] $[_{NegP}$ (*ikke*) $t_2$ $[_{VP}$ $t_1$ $t_2$ Compl ]]]]]]]

For example: $[_{CP}$ *hunden*$_1$ *bed*$_2$ $[_{AgrP}$ $t_1$ $t_2$ $[_{TnsP}$ $t_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ *faktisk*]
$[_{NegP}$ *ikke* $t_2$ $[_{VP}$ $t_1$ $t_2$ *katten*]]]]]]

"The dog actually didn't bite the cat" (Literally: the dog bit actually not the cat)

(50) **Structure of Danish Embedded Clauses, final version (replaces (47)):**

$[_{CP}$ Conj $[_{AgrP}$ $Sub_1$ $t_2$ $[_{TnsP}$ - $t_2$ $[_{NegP}$ $[_{AdvP}$ Adv]
$[_{NegP}$ (*ikke*) $t_2$ $[_{VP}$ $t_1$ $Verb_2$ Compl ]]]]]]

For example: $[_{CP}$ *at* $[_{AgrP}$ *hunden*$_1$ $t_2$ $[_{TnsP}$ $t_1$ $t_2$ $[_{NegP}$ $[_{AdvP}$ *faktisk*]
$[_{NegP}$ *ikke* $t_2$ $[_{VP}$ $t_1$ *bed*$_2$ *katten*]]]]]]

"That the dog actually didn't bite the cat" (Literally: that the dog actually not bit the cat)

The figures below show the structure of main clauses and embedded clauses respectively. In Figure 7 shows the movement of the subject and the verb in main clauses from their base positions inside VP to their surface positions in CP, which result in the obligatory V2 word order. Figure 8 shows the movement in embedded clauses, where the subject moves from [spec, VP] to [spec, AgrP], and the verbal inflection moves downwards to the verb, which remains in its base position in $V^0$. For expository reasons, I have left out the structure of the complement (compl) and the adverbial phrase AdvP:

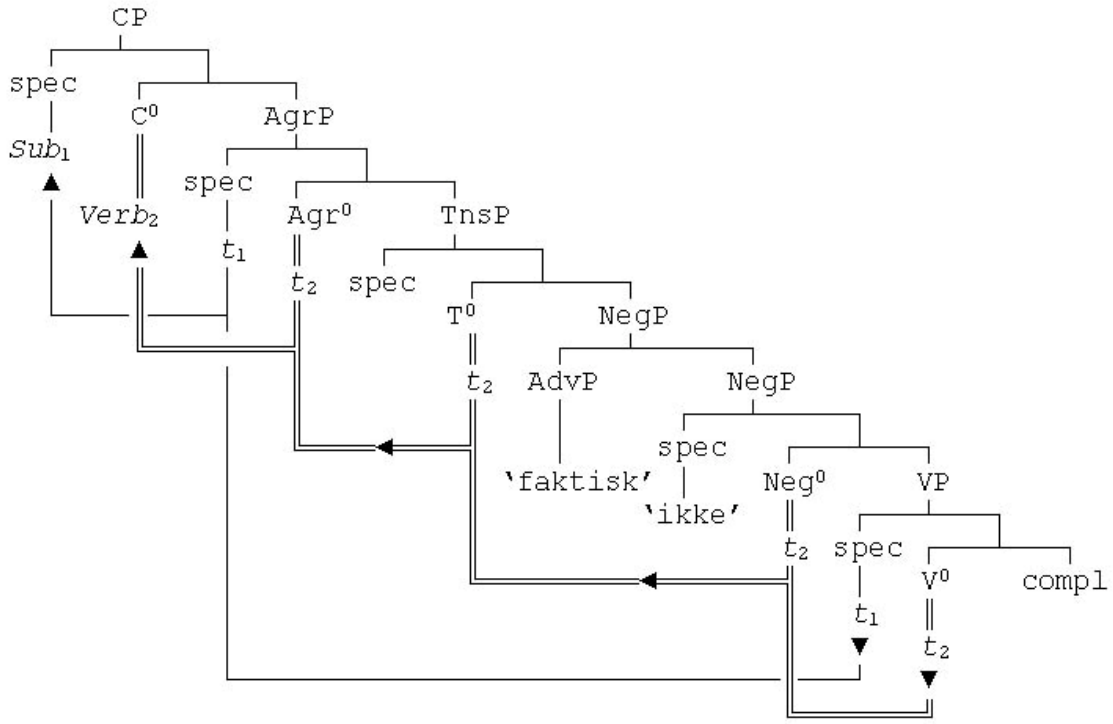


**Figure 7: Structure of Danish main clauses.**

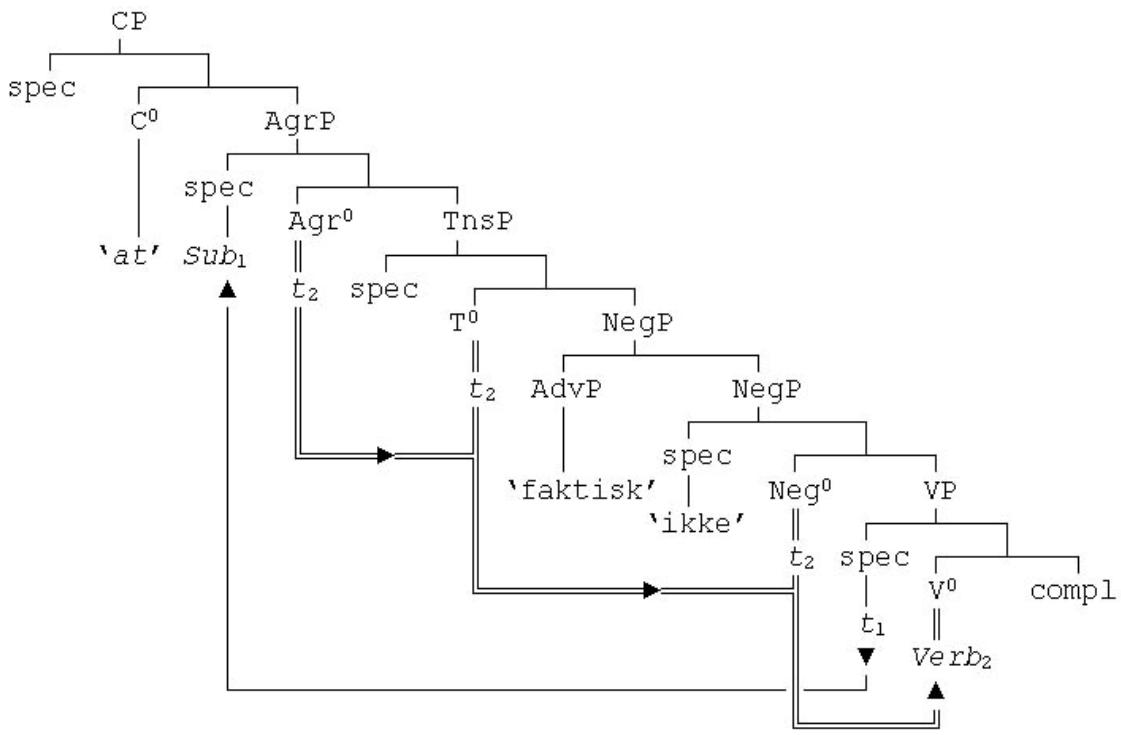


**Figure 8: Structure of Danish embedded clauses.**

Note that NOMINATIVE is assigned to [spec, $Agr^0$] (in Danish by $C^0$ and in English by $Agr^0$ for reasons not discussed here, cf. Vikner 1995; see also section 2.1.8).

## 7.2 Predictions About Agrammatism in Danish

Based on the interaction between the *Trace-Deletion Hypothesis* and the *Default Strategy* and on the *Tree-Pruning Hypothesis*, certain predictions can be made about the performance of agrammatic aphasics in Danish (as well as in any other language). Depending on the specifics of the Danish typological parameter-settings, the aphasic's comprehension of certain types of sentences will be impaired, while other types will turn out normal. In production, the structure of the sentence will be the crucial factor in predicting impairment, as the hypothesis states that certain parts of the grammatical representation (syntactic tree) are disrupted. Furthermore, predictions can be made with regards to omission or substitution of inflection based on the presence or absence of zero-morphology.

### 7.2.1 Comprehension

First of all, let us take a look at the structure of the relevant clauses in Danish in the following two tables:

| Type | Structure |
|---|---|
| Simple active | [$_{CP}$ *pigen*$_1$ *skubber*$_2$ [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ t$_1$ v$_2$ [$_{NP}$ *drengen*]]]]]]]<br><br>*pigen skubber drengen*<br>the girl pushes the boy<br>AGENT THEME<br><br>[$_{CP}$ *pigen*$_1$ *peger*$_2$ [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ t$_1$ v$_2$ [$_{PP}$ *på* [$_{NP}$ *drengen*]]]]]<br><br>*pigen peger på drengen*<br>the girl points at the boy<br>AGENT THEME |
| Subject -subject relative | *pigen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ t$_1$ *skubber*$_2$ [$_{NP}$ d*rengen*]]]]]] *er høj*<br><br>*pigen*$_1$ [ *som*$_1$ *skubber drengen* ] *er høj*<br>the girl who pushes the boy is tall<br>AGENT THEME |
| Object-subject relative | *vis mig pigen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ t$_1$ *skubber*$_2$ [$_{NP}$ *drengen*]]]]]]<br><br>*vis mig pigen*$_1$ [ *som*$_1$ *skubber drengen* ]<br>show me the girl who pushes the boy<br>AGENT THEME |
| Subject cleft | *det er pigen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ t$_1$ *skubber*$_2$ [$_{NP}$ *drengen*]]]]]]<br><br>*det er pigen*$_1$ [ *som*$_1$ *skubber drengen* ]<br>it is the girl who pushes the boy<br>AGENT THEME |

(Continued on next page)

| Type | Structure (continued from above) |
|---|---|
| Lexical passive | [$_{CP}$ *drengen*$_1$ *synes*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ $t_1$ $v_2$ [$_{PP}$ *om* [$_{NP}$ *pigen*]]]]]]]<br><br>*drengen synes om pigen*<br>the boy thinks about the girl ("the boy likes the girl")<br>EXPERIENCER THEME |
| Adject. Passive | [$_{CP}$ *drengen*$_1$ *er*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ $t_1$ $v_2$ [$_{AdvP}$ $t_1$ *interesseret* [$_{PP}$ *i* [$_{NP}$ *pigen*]]]]]]]<br><br>*drengen er interesseret i pigen*<br>the boy is interested in the girl<br>EXPERIENCER THEME |
| Psych.-verb | [$_{CP}$ *drengen*$_1$ *beundrer*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ $t_1$ $v_2$ [$_{NP}$ *pigen*]]]]]<br><br>*drengen beundrer pigen*<br>the boy admires the girl<br>EXPERIENCER THEME |

**Table 8: Danish clause structure 1.**

| Type | Structure |
|---|---|
| Verbal passive | [$_{CP}$ *drengen*$_1$ *skubbes*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ [$_{VP}$ $t_1$ $v_2$ $t_1$ ] [$_{PP}$ *af* [$_{NP}$ *pigen*]]]]]<br><br>*drengen*$_1$ *skubbe-s* $t_1$ *af pigen*<br>the boy push-PRES.PASS by the girl ("the boy is pushed by the girl")<br>THEME AGENT |
| "*Blive*" passive | [$_{CP}$ *drengen*$_1$ *bliver*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ [$_{VP}$ $t_1$ $v_2$ [$_{VP}$ $t_1$ *skubbet* $t_1$]] [$_{PP}$ *af* [$_{NP}$ *pigen*]]]]]]<br><br>*drengen*$_1$ *bliver skubbet* $t_1$ *af pigen*<br>the boy is pushed by the girl<br>THEME AGENT<br><br>[$_{CP}$ *drengen*$_1$ *bliver*$_2$ [$_{AgrP}$ $t_1$ $v_2$ [$_{TnsP}$ - $v_2$ [$_{NegP}$ - $v_2$ [$_{VP}$ [$_{VP}$ $t_1$ $v_2$ [$_{VP}$ $t_1$ *peget* [$_{PP}$ *på* $t_1$]]] [$_{PP}$ *af* [$_{NP}$ *pigen*]]]]]]]<br><br>*drengen*$_1$ *bliver peget på* $t_1$ *af pigen*<br>the boy is pointed at by the girl<br>THEME AGENT |

(Continued on next page)

| Type | Structure (continued from above) |
|---|---|
| Subject -object relative | *drengen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ *pigen*$_2$ v$_3$ [$_{TnsP}$ - v$_3$ [$_{NegP}$ - v$_3$ [$_{VP}$ t$_2$ *skubber*$_3$ t$_1$ ]]]]] *er høj*<br><br>*drengen*$_1$ [ *som*$_1$ *pigen skubber* t$_1$ ] *er høj*<br>the boy who the girl pushes is tall<br>THEME AGENT |
| Object-object relative | *vis mig drengen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ *pigen*$_2$ v$_3$ [$_{TnsP}$ - v$_3$ [$_{NegP}$ - v$_3$ [$_{VP}$ t$_2$ *skubber*$_3$ t$_1$]]]]]]]<br><br>*vis mig drengen*$_1$ [ *som*$_1$ *pigen skubber* t$_1$ ]<br>show me the boy who the girl pushes<br>THEME AGENT |
| Object cleft | *det er drengen*$_1$ [$_{CP}$ *som*$_1$ e [$_{AgrP}$ *pigen*$_2$ v$_3$ [$_{TnsP}$ - v$_3$ [$_{NegP}$ - v$_3$ [$_{VP}$ t$_2$ *skubber* t$_1$]]]]]]]<br><br>*det er drengen*$_1$ [ *som*$_1$ *pigen skubber* t$_1$ ]<br>it is the boy who the girl pushes<br>THEME AGENT |
| Psych. Passive | [$_{CP}$ *pigen*$_1$ *beundres*$_2$ [$_{AgrP}$ t$_1$ v$_2$ [$_{TnsP}$ - v$_2$ [$_{NegP}$ - v$_2$ [$_{VP}$ [$_{VP}$ t$_1$ v$_2$ t$_1$ ] [$_{PP}$ *af* [$_{NP}$ *drengen*]]]]]]]<br><br>*pigen*$_1$ *beundre-s* t$_1$ *af drengen*<br>the girl admire-PRES.PASS by the boy<br>THEME EXPERIENCER |

**Table 9: Danish clause structure 2.**

The structures in the two tables above are all semantically reversible transitives. The distribution of performance rates between above chance, at chance, and below chance is expected to be the same as in English. Table 8 contains the structures on which agrammatics are expected to perform above chance, as all the clauses have AGENT-THEME theta-structure. The subject, which is moved out of [spec, VP] under the *VP-internal Subject Hypothesis*, is assigned the AGENT-role by the *Default Strategy* and no comprehension problem arises. The object has not undergone movement and is therefore assigned its role of THEME grammatically.

Table 9 contains the structures expected to be problematic. All the clauses involve movement of the object. The prediction is that due to the *Trace-Deletion Hypothesis* the θ-role can no longer be transferred through the link to the trace and the result is a wrong assignment by the *Default Strategy*. The double occurrence of the AGENT-role leads to chance performance. The exception to this is, as in English, the

psychological passive in which the result of θ-role assignment (in interaction with the *Thematic Hierarchy*) gives rise to the reversal of the roles (or rather their salience) resulting in below chance performance.

These predictions about Danish aphasic comprehension (which in fact is identical to the pattern observed in English) are summarized in the following table:

| Structure | Normal Assignment | Aphasic Assignment | Predicted Performance |
|---|---|---|---|
| Simple active | AGENT-THEME | AGENT-THEME | **above chance** |
| Subject -subject relative | | | |
| Object- subject relative | | | |
| Subject cleft | | | |
| Lexical passive | | | |
| Adject. Passive | | | |
| Psychological verb | EXPERIENCER-THEME | AGENT-THEME | |
| Verbal passive | THEME-AGENT | AGENT-AGENT | **chance** |
| "*Blive*" passive | | | |
| Subject-object relative | | | |
| Object-object relative | | | |
| Object cleft | | | |
| Psychological passive | THEME-EXPERIENCER | AGENT-EXPERIENCER | **below chance** |

**Table 10: Predicted Danish aphasic performance on comprehension tests.**

### 7.2.2 Production

The *Tree-Pruning Hypothesis* predicts impairment to the top-most nodes of the syntactic tree – more precisely, from the tense (TnsP) node up, from the agreement (AgrP) node up, or to the CP alone depending on the degree of severity of the deficit. In the illustration below the points of breakdown is indicated with double lines:

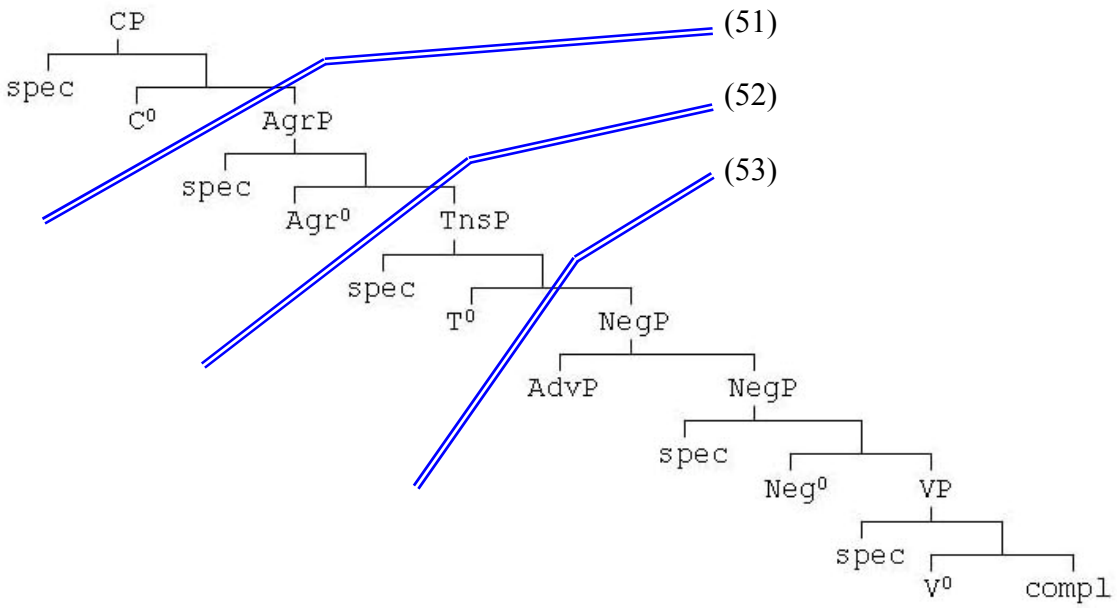


**Figure 9: Possible points of breakdown in the syntactic representation in Danish (the numbers refer to examples below).**

However, as Danish is a V2 language, the verb always (in normal language users) moves to $C^0$ (see Table 8 and Table 9), and as there is no agreement inflection in Danish, it is not possible to tell whether the agreement node is intact if the tense node is impaired. For this reason it is not possible to decide on the relative ordering of AgrP and TnsP. So in practice it will only be possible to place the site of breakdown in TnsP or CP (or actually perhaps only in CP; I return to this problem shortly). This will reveal itself in the following way: If the impairment is restricted to CP (51) (cf. Figure 9 above) the verb will only be able to move as far as to $Tns^0$, where it is inflected for tense (perhaps the verb can move to $Agr^0$ (51) but there would be no way of telling. If the tense node is disrupted (53) (cf. Figure 9) in the entire TnsP is missing (and so are AgrP and CP) and the verb cannot move farther than to $Neg^0$ and thus appears uninflected for tense – i.e. in the infinitive.

(51) * [$_{AgrP}$ – Verb$_1$ [$_{TnsP}$ – t$_1$ [$_{NegP}$ [$_{AdvP}$ Adv] [$_{NegP}$ – t$_1$ [$_{VP}$ {sub} t$_1$…

(52) * [$_{TnsP}$ – Verb$_1$ [$_{NegP}$ [$_{AdvP}$ Adv] [$_{NegP}$ – t$_1$ [$_{VP}$ {sub} t$_1$…

(53) * [$_{NegP}$ [$_{AdvP}$ Adv] [$_{NegP}$ – Verb$_1$ [$_{VP}$ {sub} t$_1$…

(54) * [$_{VP}$ {sub} Verb…

There is of course another logical possibility, which is not shown in Figure 9. The impairment may theoretically be from the negation phrase (NegP) up, in which case the verb remains in its base position inside VP, as shown in (54). This would be distinguished from (53) by the position of the verb in relation to the negation in negative clauses and to the medial adverb (adjoined to VP) in positive clauses. If the NegP is intact the verb precedes the adverb or negation, if NegP is impaired the verb follows it. An impaired NegP would result in non-normal use or non-use of negation, for the simple reason that there would be no base position for the negation.

There are thus four possibilities, where the first two are phonetically indistinguishable (for the sake of brevity I have left out the adjoined AdvP), listed here in order of degree of severity of impairment (from least to most severe):

(55) **Normal: Unimpaired CP**

$[_{CP}$ *han*$_1$ *skubber*$_2$ $[_{AgrP}$ $t_1$ $t_2$ $[_{TnsP}$ - $t_2$ $[_{NegP}$ *ikke* $t_2$ $[_{VP}$ $t_1$ $t_2$ *pigen* ]]]]]

he push-PRES not the girl

(56) **Impaired CP**

*$[_{AgrP}$ – *skubber*$_1$ $[_{TnsP}$ – $t_1$ $[_{NegP}$ *ikke* $t_1$ $[_{VP}$ {*han*} $t_1$ *pigen* ]]]]

push-PRES not {he} the girl

(57) **Impaired AgrP**

*$[_{TnsP}$ – *skubber*$_1$ $[_{NegP}$ *ikke* $t_1$ $[_{VP}$ {*han*} $t_1$ *pigen* ]]]

push-PRES not {he } the girl

(58) **Impaired TnsP**

*$[_{NegP}$ *ikke skubbe*$_1$ $[_{VP}$ {*han*} $t_1$ *pigen* ]]

not push-INF {he} the girl

(59) **Impaired NegP**

*$[_{VP}$ {*han*} *skubbe hende* …

{he} push-INF her

The consequences of disruptions of the syntactic tree not only affects verb-movement; it also affects other aspects of syntax related to the node in question. The subject is dependent on $C^0$ to assign NOMINATIVE case in Danish. Being an argument, the subject normally undergoes A-movement (cf. Haegeman 1994 and Vikner 1995), which is movement from one argument position to another, i.e. directly from

[spec, VP] to [spec, AgrP] not via the intermediate specifier positions. This movement is only possible in (51)/(56) where the [spec, AgrP] position is intact. However, even in this case the subject will not be overt (phonetically realized), because it has not been assigned NOMINATIVE case. Arguments depend on case in order to pass the *Case Filter*, and if CP is missing $C^0$ will not be present to assign case. This means that theoretically the subject will be dropped. Therefore, I have put the subjects in (51)-(54) and (56)-(59) above in "curly" brackets ({}).

According to Friedmann and Grodzinsky (2000) subject *pronouns* are only dropped when verbal inflection is *substituted*, i.e. in languages without zero-morphology, cf. (32) above. As Danish has +zero-morphology, Danish speaking aphasics should not drop subject pronouns, if the predictions hold. *Lexical* subjects as well as pronouns should not be overt without case, so Friedmann & Grodzinsky (2000: 14-15 [pdf version]) proposes that "the agrammatics may use subjects as topicalized elements, and assign them a default case […]", which in Danish is NOMINATIVE. This means that the subject is moved to the topmost available specifier. The fact that it is overt (phonetically realized) may be due to an impaired *Case Filter* (the same would be the case if the subject was adjoined to the topmost node). Here is an example of a clause pruned at the tense node:

(60) * $[_{NegP}$ $SUB_1$ $VERB_2$ $[_{VP}$ $t_1$ $t_2$ compl…
*the boy push (inf.) the girl*

Another problem with this proposal is that only [spec, VP], [spec, AgrP], and [spec, CP] are argument positions. If none of these positions are available the subject will have nowhere to go, so to speak, without breaking a general rule of movement: arguments move to and from argument positions only. An admittedly a bit *ad hoc* solution to this problem might be that the subject is placed in front of the sentence *after* the representation has left the grammar (which is *informationally encapsulated*, cf. section 6.1). In other words, the subject is fronted and overt due to knowledge other than grammatical (such as pragmatics and meta-linguistic knowledge), i.e. in the same non-linguistic (non-grammatical) way as with the *Default Strategy*. Perhaps the subject is 'named' or stated first and then the rest of the sentence. The subject and the rest of the sentence may be uttered in two distinct but related parts instead of in one construction. Presently, I see no apparent solution to this problem.

Above I briefly mentioned that perhaps it would only be possible to place the locus of breakdown in CP. The problem with subject movement just discussed is related to a problem of verb movement. Danish is, as mentioned, a V2 language, which means that the verb *always* moves to $C^0$ in *main* clauses. Any disruption of the syntactic tree will affect CP, and therefore all main clauses in Danish will also be affected. If the CP is missing the verb will not be able to move out of VP unless one assumes that the verb always moves if possible, which in fact is the strategy I have used so far in this section. However, in generative grammar it is generally assumed that movement does not take place unless it is necessary (for example, in the *Minimalist Program* this is called *movement as last resort*). As the $C^0$ position is not present to motivate movement, the verb will most like remain uninflected in its base position in $V^0$. Danish is thus quite vulnerable to agrammatism, as in theory any structural degree of severity will have the same effect on main clauses:

(61) **Normal main clause: intact tree**

[$_{CP}$ *han*$_1$ *skubber*$_2$ [$_{AgrP}$ t$_1$ t$_2$ [$_{TnsP}$ - t$_2$ [$_{NegP}$ *ikke* t$_2$ [$_{VP}$ t$_1$ t$_2$ *pigen* ]]]]]

he push-PRES not the girl

(62) **Agrammatic main clause: impaired tree**

*[*han*] ([$_{AgrP}$ - e [$_{TnsP}$ - e) [$_{NegP}$ *ikke* e [$_{VP}$ {*han*} *skubbe pigen* ]]

he not {he} push-INF the girl

(I have placed the subject of (62) in front of the sentence in square brackets to indicate the indeterminacy whether it is cognitively or grammatically fronted; either it is a free-standing constituent or else it occupies the top-most available specifier position (or it is adjoined).) It is up to empirical research to choose between the two different models of verb movement outlined here: either the verb always moves if possible or it only moves when necessary. Studying agrammatism may provide the evidence needed to verify one and falsify the other.

Another effect of pruned trees is that "*Wh*-questions and embedded clauses are nonexistent or completely ill-formed in the speech of the patients" (Grodzinsky 2000: 16). This is due to (again) the missing CP, where the complementizer or *wh*-element should be. That means that relatives (with *wh*-elements or complementizers) and clefts (see Table 8 above for subject relatives and clefts and Table 9 for object relatives and clefts) will be either nonexistent or ill-formed. However, some embeddings are

constructed without complementizers or *wh*-elements, for example the Danish complementizer "*at*" (that) is optional, as it sometimes is in English:

(63) *han ved* [$_{CP}$ (*at*) [$_{AgrP}$ *hun*$_1$ $t_2$ [$_{TnsP}$ - $t_2$ [$_{NegP}$ *ikke* $t_2$ [$_{VP}$ $t_1$ *kommer*$_2$ ]]]]]
he know-PRES (that) she not come-PRES
"He knows she's not coming"

Embedded clauses with optional complementizers should not be as vulnerable to impairment as other sentence types, because the CP is not involved in verb movement and therefore the verb should theoretically be inflected for tense and agreement depending on which node is impaired. However, the subject depends on $C^0$ to assign NOMINATIVE. So if $C^0$ is missing so may the subject – unless it may occupy a non-argument position, such as [spec, TnsP], as it cannot be fronted (the main clause is already there). A Danish agrammatic person with (only) an impaired CP node would probably utter (63) as:

(64) *[*han*] [$_{AgrP}$ - e [$_{TnsP}$ - e [$_{VP}$ {*han*} *vide* [$_{AgrP}$ *hun*$_1$ $t_2$ [$_{TnsP}$ - $t_2$ [$_{NegP}$ *ikke* $t_2$ [$_{VP}$ $t_1$ *kommer*$_2$
he know-INF she not come-PRES
"He know she's not coming"

### 7.2.3 Summary

All of these predictions of the previous section can be summed up in a series of questions that need to be answered through empirical tests in order to either validate or falsify the hypotheses of trace deletion and tree-pruning underlying agrammatism in Broca's aphasia.

i. In *comprehension*, do Danish agrammatics perform according to the distribution outlined in Table 10 above:

No syntactic movement ⇨ No comprehension problem ⇨ above chance performance
Syntactic movement ⇨ comprehension problem ⇨ chance performance
Psychological passive ⇨ comprehension problem ⇨ below chance performance

The following questions deal with *production*:

ii. Do Danish aphasics produce constructions without movement of the finite verb? If so, are these instead produced as infinitives?
iii. If the verb has moved, is it inflected for tense?
iv. What is the position of the verb relative to the medial adverb or negation?
v. What is the degree of severity?
vi. Do speakers drop the subject? If not, is it fronted?
vii. Danish has zero-morphology, implying omission of inflection. True or false?

## 7.3 Empirical Tests

Agrammatism manifests itself differently with regards to comprehension and production. Therefore, the linguistic tests used to examine agrammatism are also different: one for comprehension and one for production. First I describe the tests I have used, and then I discuss the data I have obtained from applying the test to a patient with agrammatism.

I am very much aware that a single case is not much to base any statistics on, and that the value and weight of my empirical data would have been significantly increased had I had several test subjects. For various reasons, my efforts to find more than one patient for this study were in vain. First of all, the institutions and speech therapists responsible for the treatment and rehabilitation of aphasics were not open to outside research by linguists. Second, of the two helpful places one institution had no patients with Broca's aphasia and the other currently treated only one agrammatic aphasic patient – the patient tested here.

### 7.3.1 Comprehension: the Sentence-to-Picture Matching Test

The comprehension test is a *sentence-to-picture* matching test. As described in section 4.3.1 above, this test proceeds as follows. First the patient is presented with two pictures that semantically mirror each other. The patient then hears a *semantically reversible* sentence and the task is then to point out the picture that depicts the meaning of the sentence. Consider the following example. The patient is presented with the pictures below depicting a boy loving a girl (A) and a girl loving a boy (B):

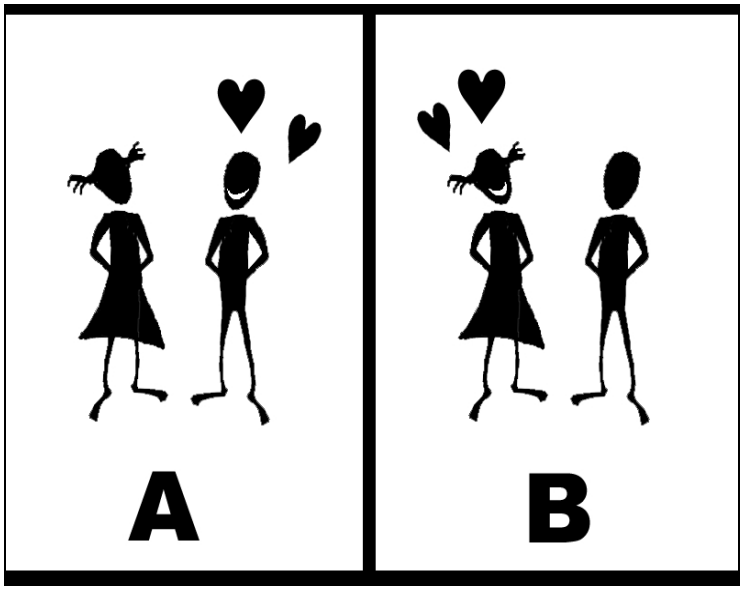


**Figure 10: Picture of "the boy loves the girl" and "the girl loves the boy".**

Next, the patient hears the sentence "*The girl loves the boy*" and has to point out the corresponding picture, in this case the correct answer is of course (B). I have devised 15 sets of pictures that correspond to the two interpretations of semantically reversible predications. I have also constructed 144 semantically reversible sentences that can be matched with the pictures, such that each of the two pictures of the same set is represented equally frequent. The pictures and the sentences that have the semantic meaning corresponding to the pictures can be found in appendix A, left and right column respectively. I have constructed the set of sentences in such a way that that each type of construction is represented by ten token sentences, see appendix B. Lexical passive is an exception with only four tokens, as it is quite rare in Danish - rare in the sense of distribution. The few lexical passives are actually quite frequently used, such as:

(65) *Drengen væmme-s ved pigen*
The boy disgust-PRES.PASS with the girl
"The boy is disgusted at the girl"

Note that the lexical passive does not involve movement of the object (see Table 8) unlike for example the verbal passive (see Table 9).

Another important thing is that I have included ten additional tokens of simple actives and ten "*blive*" passives that have a verb that subcategorizes for a preposition

phrase (cf. Section 2.1.2). In the following example the first preposition "*på*" is subcategorized for by the verb and it is therefore inside the VP that is projected by the verb, while the second preposition "*af*" heads the PP adjoined to the VP (structural information not central to this point is left out for expository reasons):

(66) *Pigen*$_1$ *bliver* [$_{VP}$ [$_{VP}$ t$_1$ *peget på* t$_1$ ] [$_{PP}$ *af drengen*]]
the girl is pointed at by the boy

The VP-internal preposition is *governed* by the verb (I shall not go into further formal detail of government relations. The terms *VP-internal* and *adjoined to VP* will suffice. For elaboration see Haegeman (1994)). It will thus be possible to see whether the presence or non-presence of a governed proposition affects comprehension.

The sentences are presented to the patient in a random order, such that the correct answer, either (A) or (B), of the presented sentences appear in series of no more than three. For example, the correct answers may come in sequences such as A-A-B-A-B-B-A-A-A-B, but not for example A-B-A-A-A-A-B-B. The latter has a sequence of more than three consecutive identical correct answers: 4 As in a row. This is done to secure that the intact comprehension of certain structures that happens to be presented consecutively does not affect performance, which may otherwise become biased towards either (A) or (B) if longer series were allowed. Furthermore, sentences that relate to the same pair of pictures (such as the pair in Figure 10) do not occur in series of more than two, also to avoid any bias or other unpredicted influence on the results.

### 7.3.2 Production: Repetition Test

The production test is a repetition test. The patient hears a sentence, which he or she then has to repeat. This is done to ensure that all types of structure are present in the corpus. Moreover, it can be difficult sometimes to determine what was intended when the utterance is severely malformed. By doing a repetition test, it is ensured that both intended and produced are known.

I have constructed a set of 100 sentences listed in appendix C. The sentences are distributed over the 13 structural types (see Table 10 above). Each type is represented by seven tokens, one for each of the tense/aspects:

(67) **Tense/Aspects:**

Past double perfect[9]:

*Drengen hav-de haf-t skubb-et pigen*

The boy have-PAST have-PAST.PTCP push-PAST.PTCP the girl

"The boy had pushed the girl"

Past perfect

*Drengen hav-de skubb-et pigen*

The boy have-PAST push-PAST.PTCP the girl

"The boy had pushed the girl"

Past

*Drengen skubb-ede pigen*

The boy push-PAST the girl

"The boy pushed the girl"

Present double perfect

*Drengen har-Ø haft skubb-et pigen*

The boy have-PRES have-PAST.PTCP push-PAST.PTCP the girl

"The boy has pushed the girl"

Present perfect

*Drengen har-Ø skubb-et pigen*

The boy have-PRES push-PAST.PTCP the girl

"The boy has pushed the girl"

[9] The double perfect constructions are not used by all Danish speakers and some even find them ungrammatical. However, most speakers would not doubt accept the double perfect in sentences about phone calls, such as "*jeg har haft ringet* [*men du var ikke hjemme*]" ('I have phoned you [but you weren't home]'). I include the construction knowing it may be controversial.

Present

*Drengen skubb-er pigen*

The boy push-PRES the girl

"The boy pushes the girl"

Future

*Drengen vil-Ø skubb-e pigen*

The boy will-PRES push-INF the girl

"The boy will push the girl"

In addition I have added a set of simple actives and "*blive*" passives with the negation "*ikke*" in order to be able to test whether the use of negation is intact.

However, eleven of the 105 sentences generated in the set had to be excluded due to ungrammaticality (see appendix C). Most of the excluded sentences are in the passive voice and constructed with the double perfect. For example this verbal passive, which is ungrammatical for two independent reasons: first, the verbal passive is only possible in the present tense (and in past constructions involving the modality verbs "*skulle*" (should) or "*ville*" (would)); second the passive cannot be constructed on a participle (i.e. in the perfect aspect):

(68) ***Hunden hav-de vist haf-t bid-es af katten*

The dog have-PAST probably have-PAST.PTCT bite-PASS by the cat

To reach a total of 100 sentences I have added six simple passives. The set includes sentences both with and without governed prepositions.

In order to detect movement of the verb all the sentences include sentence medial adverbs or negation.

Finally, I have included sentences both with and without VP-internal (governed) prepositions, in order to see whether one or the other is dropped. According to Grodzinsky (1988) in agrammatics only the VP-internal prepositions are deleted (phonetically silent), while the adjoined prepositions that head phrases like "[*the boy was hit*] *by the girl*" are not.

The sentences are presented in random order, where the same structural type never occurs in sequences above two to avoid any bias.

Both tests were performed on two normal subjects with no prior history of brain damage or neural pathology. One was a 28-year-old male fellow student of linguistics at the University of Aarhus. The other was a 26-year-old woman studying to become an architect at the Aarhus School of Architecture. Both subjects performed 100% correct on both the comprehension test and the repetition test.

### 7.3.3 Patient TJ

In order to test the hypotheses and predictions of section 7.2 I have tested a patient diagnosed as showing signs of Broca's aphasia. I first provide his medical history and then the results of the test described in the previous sections.

#### 7.3.3.1 Medical history

TJ is a 31-year-old (right-handed) male with a master's degree in art history, who was hit by a truck while riding his bicycle. According to his medical report[10], the accident caused massive trauma to his left hemisphere. He suffered massive hematomas (blood-filled swellings) to the areas in the perisylvian region, stretching into the frontal-, parietal-, and temporal lobes. He had infarction (cell death) in most of his left temporal lobe. In addition he had a small hematoma in the right parietal lobe but, as shown in section 3.2 above, the right hemisphere makes no grammatical contribution to language use. I have summarized the zone within which the hematomas in the left hemisphere have occurred in the following illustration:

[10] The medical report is not listed as a reference due to the fact that it is confidential and not publicly accessible.

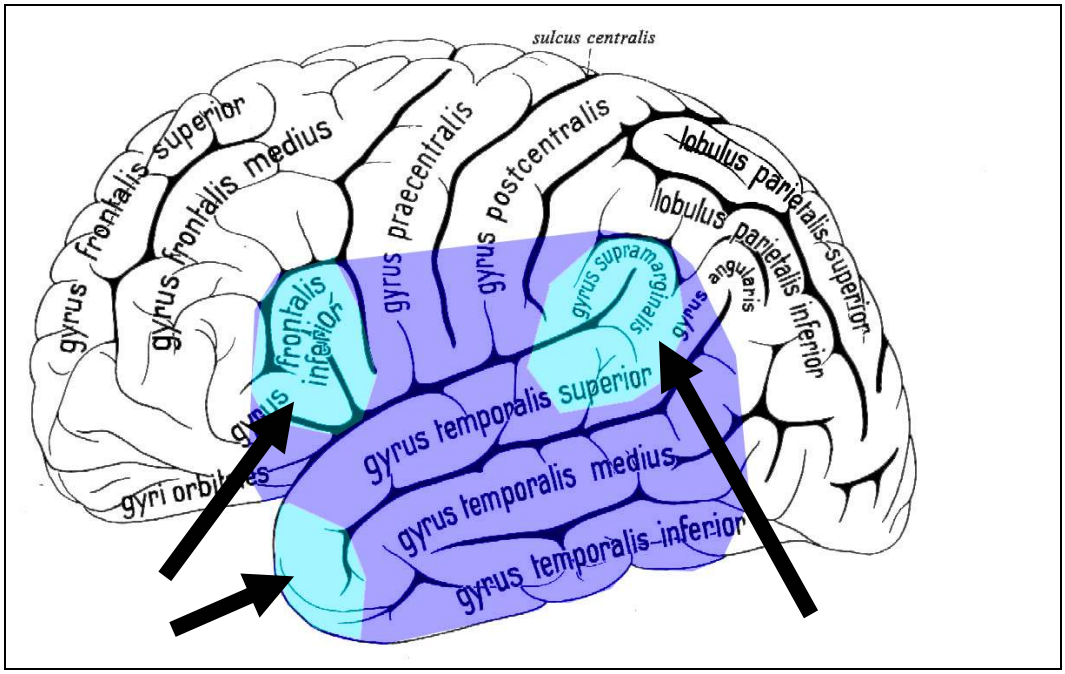


**Figure 11: Left-hemisphere damage in patient TJ. The medical report is rather vague with regards to the precise location of the hematomas. The shaded area is a gross summary of hematoma sites. The arrows point to major hematoma centers. Based on Sobotta & Becher (1975: 4, Fig. 3)**

According to the medical report, the neurologists diagnosed him as suffering from severe expressive aphasia, while his impressive functions (comprehension) were relatively spared. I tested TJ eight months after the accident, and at that stage he had improved significantly, according to his speech therapist.

#### 7.3.3.2 Comprehension Test Results

TJ was tested on the *comprehension* test described above. Due to fairly successful rehabilitation most of his linguistic abilities were restored to a near-normal level at the time of testing. This had the disadvantage that he was no longer a clear example of Broca's aphasia and therefore his test performance could not be expected to follow the predictions completely. On the other hand, it had the advantage that he was easily understandable. The following table shows a summary of his performance on the comprehension test, which was applied twice with a week's interval, each take with a duration of about half an hour.

| Type | Correct | % | Performance |
|---|---|---|---|
| Simple active | 20/20, 20/20 | 100 | Above chance |
| Subject–subject relative | 10/10, 10/10 | 100 | |
| Object-subject relative | 10/10, 10/10 | 100 | |
| Subject cleft | 10/10, 09/10 | 95 | |
| Lexical passive | 03/04, 03/04 | 75 | |
| Adjectival passive | 10/10, 18/10 | 90 | |
| Psychological verb | 08/10, 10/10 | 90 | |
| Verbal passive | 10/10, 10/10 | 100 | |
| "*Blive*" passive | 20/20, 20/20 | 100 | |
| Subject-object relative | 07/10, 07/10 | 70 | Chance |
| Object-object relative | 10/10, 10/10 | 100 | Above chance |
| Object cleft | 10/10, 08/10 | 90 | |
| Psychological passive | 09/10, 09/10 | 90 | |

**Table 11: TJ's performance on the Sentence-to-Picture Matching Test. I define 'chance performance' as between 30% and 70% knowing that this is a gross simplification of the mathematics of statistics. However, the important point is that the lowest performance (70%) is on a predicted type of construction.**

As can be seen in the table, TJ performed above chance on all but one sentence type, i.e. subject-object relative. The fact that he performs normal on subject-subject relatives shows that he has no difficulties with center-embedding as such. Neither does it matter whether the AGENT has the same or different grammatical 'roles' (subject / object) in the matrix clause and the embedded clause – only when the subject of the matrix clause is the object of the embedded clause. Also evident from the table is that he does not perform according to a canonical/non-canonical word order or role order distinction.

There is also a clear reduction in his performance on lexical passives, if one only considers the percentage. However, there are only four tokens of lexical passive, which is not much of a base for conclusions. Furthermore, he failed on the same token both times:

(69) *Drengen væmme-s ved pigen*
The boy disgust-PRES.PASS at the girl
"The boy is disgusted at the girl"

This seems to imply a problem with the lexical entry of the verb rather than the construction; but then again this is based on one of only four tokens.

The presence or absence of governed (VP-internal) prepositions did not affect comprehension.

#### 7.3.3.3 Production Test Results

On the *production* side, TJ was tested once on the Repetition Test, which took about twenty minutes. The results are given in the table below (the 'Changes' column for example '1 ⇨ Simple passive' should to read as 'one sentence was produced as a simple active'):

| Type | Error Rate | | Changes | Correct |
|---|---|---|---|---|
| Simple active | 5,3% | (1/19) | 1 ⇨ Simple passive | 94,7% |
| Subject–subject relative | 14,3% | (1/7) | 1 ⇨ Subject-object relative | 85,7% |
| Object-subject relative | 14,3% | (1/7) | 1 ⇨ ? ❷ | 85,7& |
| Subject cleft | 0,0% | (0/7) | | 100,0% |
| Lexical passive | 71,4% | (5/7) | 5 ⇨ ? ❸❹❺❼❾ | 28,6% |
| Adjectival passive | 0,0% | (0/5) | | 100,0% |
| Psychological verb | 14,3% | (1/7) | 1 ⇨ Simple active | 85,7% |
| Verbal passive | 25,0% | (1/4) | 1 ⇨ Simple active | 75,0% |
| "*Blive*" passive | 0,0% | (0/7) | | 100,0% |
| Subject-object relative | 85,7% | (6/7) | 2 ⇨ Subject–subject relative<br>1 ⇨ Object-subject relative<br>1 ⇨ Adjectival passive<br>2 ⇨ ? ❻❽ | 14,3% |
| Object-object relative | 57,1% | (4/7) | 4 ⇨ Object-subject relative<br>1 ⇨ $[_{NP}$ N [object relative]]❶ | 42,9% |
| Object cleft | 28,6% | (2/7) | 2 ⇨ Object-subject relative | 71,4% |
| Psychological passive | 20,0% | (1/5) | 1 ⇨ Psychological active | 80,0% |

**Table 12: TJ's performance on the Repetition Test.**

In the table and henceforth the numbers in black circles refer to a set of sentences in the test data results in appendix E (they are also marked in the appendix):

(70) ❶#93 ❷#14 ❸#35 ❹#52 ❺#43 ❻#15 ❼#55 ❽#71 ❾#44

This is done in order to keep the results and my treatment of them as transparent as possible and to be able to use the numbers as short hand references.

TJ has a tendency to avoid the passive morphology "*–s*". Of 13 intended instances of passive morphology[11], eight (61,5%) are not produced correctly. The passive morphology was intended in three passive construction types: 7 lexical passives, 2 psychological passives, and 4 verbal passives:

(71) **Passive "-*s*" omission**

| Type: | Error: | |
|---|---|---|
| Lexical passive: | 3 drop main V | ❸ ❹ ❺ |
| | 2 drop passive morphology | ❼ ❾ |
| Psych. passive: | 1 drop passive morphology | (#50 in appendix E) |
| Verbal passive: | 2 drop passive morphology | (#81 and #85) |

For example this verbal passive:

(72) Intended (#85):

*drengen skubb-ede-s jo af pigen*

the boy push-PAST-PASS after-all[12] by the girl

Produced:

**drengen skubb-ede jo af pigen*

the boy push-PAST after-all by the girl

The entire verb was dropped in three instances; the passive morphology was omitted in five cases, whereas no errors were made on the "*blive*" passive, which involves an auxiliary verb and no passive morphology. The omission of the passive ending is consistent with the prediction from above (page 57) that +zero-morphology leads to

[11] It should be noted that when talking about passive morphology, I am only referring to the Danish passive "*-s*" on the main verb, NOT to the passive "*-et*" (participle) inflected on the auxiliary, such as "*pigen blev skubb-et af drengen*" (the girl was push-ed by the boy).

[12] The Danish "*jo*" is equivalent to the German "*ja*" and is hard to translate without any context. Consider for example this German example: *Er ist ja ein Berliner*. Depending on the context, it can be translated as for example "*after all, he is a Berliner*" or "*but he is a Berliner*".

omission and not substitution in agrammatism. There are no examples of morphemic substitution in the test data, but there are examples of word substitutions (*semantic paraphasia*), for example "*kigget på*" (looked at) instead of "*inspireret af*" (inspired by) (see #31 in appendix E).

TJ has a strong tendency to use forms without movement of the (underlying) object as is evident from his performance on object relatives: Subject-object relative: 14,3% correct, object-object relative: 42,9% correct. Furthermore, he performs only 71,4% correct on object clefts, which is clearly a reduction. Again, a reference to center- versus right-embedding is insufficient. Subject-subject relatives are center-embedded and he performs near normal on them, while his performance is only 14,3% correct on the subject-object relatives, which are also center-embedded. He performs near normal on object-subject relatives but almost consistently wrong on subject-object relatives, both of which are right-embedded.

The performance on tense inflected forms is central to the *Tree-pruning Hypothesis*, cf. sections 6.2 and 7.2.2 above. The following table shows TJ's performance on the different tense/aspect constructions:

| Tense & AUX | Correct Performance | Produced | Verb Reduction |
|---|---|---|---|
| 1: PAST PERF+ [AUX AUX V] | 0,0% | 0X ⇨ PAST PERF+ | |
| | | 1X ⇨ PAST PERF | -1 AUX |
| | | 3X ⇨PAST | -2 AUX |
| | | 1X ⇨ PRES PERF+ | |
| | | 4X ⇨ PRES PERF | -1 AUX |
| | | 1X ⇨ ? ❸ | -1 AUX, -main V |
| 2: PAST PERF [AUX V] | 42,9% | 6X ⇨ PAST PERF | |
| | | 6X ⇨ PAST | -1 AUX |
| | | 1X ⇨ PRES PERF | |
| | | 1X ⇨ ? ❹ | -main V |
| 3: PAST [V] | 90,9% | 20X ⇨ PAST | |
| | | 2X ⇨ PRES | |

(Continued on next page)

| (Continued from above) | | | |
|---|---|---|---|
| **Tense & AUX** | **Correct Performance** | **Produced** | **Verb Reduction** |
| 4: PRES PERF+ [AUX AUX V] | 0,0% | 2X ⇨ PAST | -2 AUX |
| | | 0X ⇨ PRES PERF+ | |
| | | 6X ⇨ PRES PERF | -1 AUX |
| | | 2X ⇨ ? ❺ ❻ | -1 AUX, -main V |
| 5: PRES PERF [AUX V] | 42,9% | 5X ⇨ PAST | -1 AUX |
| | | 6X ⇨ PRES PERF | |
| | | 1X ⇨ PRES | -1 AUX |
| | | 1X ⇨ ? ❼ | -1 AUX |
| | | 1X ⇨ ? ❽ | -1 AUX, -main V |
| 6: PRES [V] | 68,8% | 3X ⇨ PAST | |
| | | 11X ⇨ PRES | |
| | | 2X ⇨ ? ❶ ❷ | -main V |
| 7: FUTURE (PRES) [AUX V] | 64,3% | 5X ⇨ PAST | -1 AUX |
| | | 9X ⇨ FUTURE | |

**Table 13: TJ's tense/aspect performance.**

TJ performs 0% correct on the double perfect constructions (PERF+) in both past and present tense. Only one is produced as a double perfect, but in the wrong tense. In addition, he performs only 42,9% correct on the perfect constructions (PAST.PERF and PRES.PERF) and 64,3% on the future constructions. All of these constructions involve an auxiliary verb. Clearly there is a tendency to reduce the number of auxiliary verbs. This is summarized in the following table:

| Verbs | Intended | Produced | % |
|---|---|---|---|
| AUX AUX V | 20 | 1 | 5,0% |
| AUX V | 52 | 33 | 63,53% |
| V | 38 | 58 | 152,6% |
| ? | | 8 | |
| TOTAL | 100 | 100 | |

**Table 14: Auxiliary verb reduction. Whatever one's opinion on the double perfect (see footnote 9 on page 80), the reduction of the number of VPs is still clear from the comparison of the remaining structures.**

TJ has a tendency to use constructions without auxiliary verbs, i.e. to minimize the structure – recall from section 2 that each verb projects a VP. It is not the case that tense/aspect *per se* is omitted, only the auxiliary verbs. All the verbs are inflected for tense, i.e. past or present, and therefore it is a case of structure reduction not tense/aspect omission.

Next consider the distribution of inflection for past and present. As mentioned all verbs are inflected. In some (5/8) of the clauses where TJ omitted the main verb (❸❹❺❻❼) he produced the auxiliary verb, which was inflected for tense. In three sentences (❶❷❽) he omitted the entire embedded clause. In summary:

| Tense Inflection | Intended | Produced | % |
|---|---|---|---|
| PAST | 46 | 53 | 115,2% |
| PRESENT | 54 | 44 | 81,5% |
| ? | | 3 | |
| TOTAL | 100 | 100 | |

**Table 15: The distribution of inflection for past and present in TJ's performance data. The question mark indicates that the verb as well as the rest of the clause has been omitted.**

The following changes in tense inflection are made:

(73) 10x past ⇨ present
17x present ⇨ past
3x present ⇨ ? (❶ ❷ ❽)

Note that present is changed more frequently than past: of 30 changes 20 are made to the present tense (66,7%). There is no clear 'default' tense, but a slight preference for past. This is evident from Table 13 above, where it is shown that TJ performs 90,9% correct on the constructions with only one verb and inflected for past tense, while he performs only 68,8% correct on the same construction inflected for present. Importantly, he produces no unmoved uninflected verbs (i.e. root infinitives), which suggests that the tense node TnsP is intact.

TJ's use of negation is normal. There are twelve clauses with the negation "*ikke*" (indicated with a P in the third column in appendix E), and TJ performed 100% correct. This shows that NegP is intact.

All the 100 sentences in the test set has a sentence medial adverb, which is adjoined to NegP, cf. Figure 7 and Figure 8 in section 7.1. In all but one sentence (99/100) the position of the adverb in relation the verb is correct. In matrix clauses the adverbial follows the finite verb and in embedded clauses the adverb precedes the finite verb. The only example of an incorrect adverb position is ❼, which should have had the matrix word order but instead has the word order of an embedded clause. The correct order of verb and adverb ($V_{FINITE}$-Adv) shows that the verb has moved out of VP (as the AdvP is adjoined to a node (NegP) higher than VP the base-generated order is Adv-$V_{FINITE}$, see Figure 7 on page 66). This of course means that there must be a position to which the verb can move. Therefore TnsP must be intact (recall from section 7.2.2 that it is not possible to tell whether AgrP is intact). There is no example of a non-moved verb in the infinitive in the data.

TJ correctly produces embedded clauses. This shows that the CP node is intact, because it contains the relative pronoun "*som*" (who) in [spec, CP] in the relative clauses. This, of course, also shows that both AgrP, TnsP, and NegP are intact because "an impaired node cannot project any higher", as stated in the *Tree-pruning Hypothesis* (cf. (36) in section 7.2.2 above). This is also supported by the fact that the subject is always present and in its correct position – [spec, CP] – preceding the finite verb in $C^0$.

As mentioned, the fact that he produces embeddings with a *wh*-element shows that the CP node is intact. In his main clauses, the verb has undergone movement and is in V2 position. On the basis of the evidence from TJ, it is not possible to decide on the problem (from section 7.2.2) of deciding between verb movement as 'movement when possible' or 'movement when necessary'.

Anyway, as the entire tree structure is intact, TJ has a very mild form of agrammatism. That is, he has evidently undergone successful rehabilitation.

In section 4.3.1 I mentioned that Broca's aphasics have an improper use (or non-use) of prepositions. According to Grodzinsky (1988) agrammatics frequently omit only one kind of preposition, i.e. the prepositions that are *inside* the VP, i.e. those that are *governed* by the VP, while they produce those that are *adjoined* to the VP, i.e. *ungoverned* by the VP (cf. section 7.3.2 above). This structural difference between the two types of prepositions is also found in the speech of TJ:

| Preposition | Intended | Omitted | Error Rate |
|---|---|---|---|
| Governed | 27 | 4 | 14,8% |
| Ungoverned | 19 | 1 | 5,3% |

**Table 16: Preposition drop in TJ's production. In appendix E the sentences with governed prepositions are marked with a P in the second column on the left. The omission of a governed or ungoverned preposition is indicated with –G and –U respectively in the second column on the right.**

Few prepositions are dropped but there is, however, a marked difference between governed and ungoverned prepositions. The governed prepositions are omitted almost three times as often as the ungoverned. Still, only 14,8% of the governed prepositions are deleted, which is close to normal production. Further evidence for TJ's relatively restored ability to use prepositions correctly, comes from the six cases where he substitutes a verb that does not subcategorize for a PP with one that does. In each of these cases he correctly produces the governed preposition. Consider for example this simplified version of #31 from appendix E (slightly modified for expository reasons):

(74) Target:

*pigen var* [$_{VP}$ *inspireret*] [$_{PP}$ *af* [$_{NP}$ *drengen*]]

the girl was inspired by the boy

(75) Produced:

*pigen har* [$_{VP}$ *kigget* [$_{PP}$ *på* [$_{NP}$ *drengen*]]]

the girl has looked at the boy

In (74) the verb "*inspirere*" (inspire) does not subcategorize for a preposition phrase; the optional PP is adjoined to VP. In (75) the verb "*kigge (på)*" (look (at)) optionally subcategorizes for a PP, i.e. if the object is present it is governed by the VP.

In appendix E such cases of substitution ([$_{VP}$] [$_{PP}$] ⇨ [$_{VP}$[$_{PP}$]]) are marked with +G in the second column on the right. There is no ungrammatical use of governed or ungoverned prepositions.

There is also evidence of a single impaired lexical entry in TJ's production. The Danish verb "*slå*" (hit) is a very common word, which has irregular inflection. Compare

the two common verbs "*ligne*" (resemble, look like) and "*slå*" (hit), which have regular and irregular inflection respectively:

(76)

| **Tense:** | **Regular:** | **Irregular:** |
|---|---|---|
| Infinitive | *lign-e* | *slå-Ø* |
| Present | *lign-er* | *slå-r* |
| Past | *lign-ede* | *slog* |
| Past Ptcp. | *lign-et* | *slå-et* |
| Present Ptcp. | *lign-ende* | *slå-ende* |

What is interesting is TJ's use of the past tense form of "*slå*". The correct form is "*slog*", but TJ only produced it once out of three intended and once before self-correcting it. In cases where he produced the wrong tense form and substituted it with the past form (4/8), he produced the verb stem with the *regular* inflection, i.e. "*slå-ede*" instead of the correct "*slog*":

| Intended | | Produced | | Appendix E |
|---|---|---|---|---|
| *slået* | ⇨ | *slået* | Correct | (#17, #18, #37, #69) |
| *slået* | ⇨ | *slåede* | Wrong | (#23, #65) |
| *slået* | ⇨ | *slog* ⇨ *slåede* | Wrong, Self-correction, Wrong | (#38) |
| *slået* | ⇨ | *slåede* ⇨ *slået* | Self-correction, Correct | (#95) |
| *slå* | ⇨ | *slå* | Correct | (#28) |
| *slog* | ⇨ | *slog* | Correct | (#04) |
| *Slog* | ⇨ | *slår* | Wrong | (#29) |
| *Slog* | ⇨ | *kiggede efter* | Wrong | (#68) |

**Table 17: TJ's use of the verb "*slå*" (hit).**

No other verb or other type of word was used in a similar manner. It seems that the lexical entry for this verb is selectively impaired.

Finally, Danish has +zero morphology, which implies that agrammatics will omit inflection affixes and produce bare stems. However, there are no bare stems in TJ's speech production. This may be a positive effect of the eight months of rehabilitation TJ has undergone.

#### 7.3.3.4 Conclusions

TJ does not confirm the hypotheses of *Trace Deletion* and *Tree-pruning*. First of all, his *comprehension* does not pattern the way that the *Trace deletion Hypothesis* would predict. He only has some problems with the interpretation of subject-object relatives. The hypothesis as such cannot explain this, but I fail to see any other and (importantly) better explanation. For example, he does not perform according to a canonical word order pattern, which would predict good performance on SVO and poor performance on all others. This is not borne out. Neither does he perform according to canonical θ-role order, which would predict that only AGENT-THEME order would be result in correct performance. He performs correctly on for example passives, which have the non-canonical THEME-AGENT order and he performs correctly on the sentences with and EXPERIENCER subject, which were predicted to result in performance below chance. Furthermore, subject-object relatives are not problematic because the relative pronoun (the *wh*-element) and its antecedent do not have the same grammatical roles (subject and object), because he has no problems with understanding for instance object-subject relatives. The subject-object construction is special because the object moves across the subject in the embedded clause *and* the relative pronoun and its antecedent do not have the same grammatical roles. It therefore seems likely that it is a case of trace deletion after all, as the movement of the object is crucial. Importantly, there is nothing in his comprehension performance that falsifies the hypotheses.

His *production* shows a clear tendency to reduce the number of VPs in the sentences, which is not predicted by the *Tree-pruning Hypothesis*. However, this phenomenon does not falsify the hypothesis. He shows some signs of preposition drop with a marked difference between the structural position of the preposition in question. As predicted, he omits governed prepositions more frequently than ungoverned prepositions. He shows no signs of impairment to the functional nodes CP, TnsP, AgrP, and NegP and his test results can therefore neither verify nor falsify the *Tree-pruning Hypothesis*.

I suspect that the reason why TJ's test results can neither falsify nor verify any of the hypotheses is that he has been in recovery for so long. At the time of testing TJ had ceased to be a clear and representative case of Broca's aphasia as he had almost fully recovered. I see nothing in his performance that is seriously problematic for the hypotheses. I discuss these matters in more detail in the following chapter.

# 8 Discussion: Cerebral Area and Function Revisited

TJ suffered massive hematomas in the areas of the perisylvian region, which means that his entire grammatical neural 'machinery' was implicated, but not necessarily destroyed. Once neurons are destroyed they are gone forever. They can not regenerate. However, the connective system between neurons can regenerate or reorganize. Disrupted connections can be 'rebuilt' (cf. Elman et al. 1996), and therefore brain damage does not necessarily lead to permanent impairment if the lesion site is not too great or encompassing with regards to the functional area in question. The function of the affected area can sometimes be restored over time. Figure 11 on page 83 above is a gross illustration of the region affected in TJ's case. The medical report is not specific or detailed enough to pinpoint the sites any more accurately than indicated with the light shaded areas. Hence, the figure is not intended to be interpreted too literally. The point is that his language areas, notably Broca's area (and Wernicke's area), are in the region affected by the massive hematomas, which should reveal certain predictable behaviors in the linguistic performance of the patient. As I showed in the previous section, TJ did in fact show traces of such behavior, but due to eight months of intense training with speech therapists he has come a long way. He has only fragments of aphasia left, but importantly his performance did not falsify the theoretical apparatus posited in chapter 6 and sections 7.1 and 7.2.

His *comprehension* is impaired, but only with regards to subject-object relatives, on which he performs 70% correct. His comprehension of all other constructions is not impaired, or rather has been restored. Admittedly, these results deviate from the pattern predicted by the *Trace Deletion Hypothesis*, which should have shown problems with all constructions involving syntactic movement. However, it should again be kept in mind that TJ has been in rehabilitation for eight months. Furthermore, it is important to notice that the lowest performance is on a construction with movement of the object across the subject. At least this is in accordance with the hypothesis. He had no problems with actives (except for lexical passives, but see section 7.3.3.2 for comments). Thus, his comprehension is near normal, with only chance performance on subject-object relatives – a deficit, for which subtle theoretical mechanisms are required to detect it. A distinction between center- and right-embedding is insufficient as a measure of his performance: He correctly interprets object-subject and object-object relatives, which are both right-embeddings (or right-branching structures); he also

correctly interprets subject-subject relatives, which are center-embeddings. Crucially, he performs poorly on only subject-object relatives, which are also center-embeddings. Hence, correlation between right-embedding and above chance performance and between center-embedding and chance performance is *not* found.

On the *production* side[13] he also seems to have problems with object-relatives (cf. TJ's performance on subject-object relatives, object-object relatives, and object clefts in Table 12). In 75% (9/12) of the wrongly produced, he changes the object relative clause to a subject relative. In total, 42,9% (9/21) of the object relatives are produced as subject relatives, which seems to be the preferred type of embedding. The most notable problematic type is the same as the one causing problems in comprehension: the subject-object relative. This reflects neither a problem with (and hence avoidance of) center-embedding, as he performs near-normal on subject-subject relative clauses, nor a strong preference for 'basic order' of AGENT and THEME, as for example he performs 100% correct on the "*blive*" passives. It does, however, reflect a *preference for a basic word order* (Subject-Verb-Object) in production, as is often noted as a characteristic of Broca's aphasia. For example:

> *Indeed,* some patients (particular Broca's) appear to overuse basic SVO*, as though this word order type provided a kind of "safe harbor" for sentence planning. Such overuse is only evident in languages that permit pragmatic word order variation* [such as Danish, K. R. C.]*; it could not be detected in a rigid word order language like English.* (Bates et al. 1991: 131. Emphasis added.)

This finding is compatible with the postulation that the front end of the perisylvian region, which is one of the centers of TJ's hematomas (see Figure 11), is crucially involved in linguistics syntagmatic relations. Recall from chapter 5 above, that Bates et al. (1991), Damasio (1992), Deacon (1997), and Pinker (1994) all shared a common important feature in their respective theories on area and function: Broca's area and its vicinity are responsible for syntagmatic / relational / sequential computation of grammatical structure. Importantly, this is also compatible with Grodzinsky's

[13] It should be noted that this production is repetition and spontaneous production. However, the fact that he changes the sentences on repetition in a systematic way, e.g. the auxiliary verb reduction, shows that he is not merely 'parroting', which would not necessarily involve his grammatical competence. Parrot-like repetition would result in random errors (e.g. due to memory limitations) or no errors, if he were just good at repetition. The systematic production errors suggest that TJ's grammar is involved.

hypothesis that Broca's area (and vicinity) is responsible for trace-antecedent (co-indexing) chains in comprehension and for the functional projections in the syntactic tree and their involvement in movement and hence chains.

Perhaps related to this is the fact that TJ has a tendency to use constructions without auxiliary verbs. Leaving out the auxiliaries reduces the structure (minimizes the size) of the syntactic tree, as the missing verbs do not project VPs. This means that less syntagmatic / relational / sequential computation is required. However, the omission of auxiliary verbs may be related to a lexical deficit. I shall return to this shortly.

As the CP node and all the nodes beneath it are restored in TJ no severe tense inflection errors are found. None of the verbs expected to be finite and inflected for tense were uninflected. Neither does TJ show any problems with correctly producing adverbs, negations, and subjects. As mentioned above, this shows that the entire syntactic representation is intact.

TJ does however make a few errors. He has a tendency to drop the verbal passive morphology "–*s*", he has a selective impairment to the past tense form of the "*slå*" (hit), and he omits few prepositions; Governed prepositions are more frequently omitted than ungoverned prepositions, cf. Table 16 on page 91. The omission of governed prepositions may also be an expression of the disruption of relational computation linked to a lesion in Broca's area. The verb that heads the verb phrase in which the omitted preposition was supposed to be subcategorizes for a PP. For example the transitive verb "*smile*" (smile) subcategorizes for a PP headed by the preposition "*til*" (at) with the THEME as complement:

(77) $[_{CP}$ *Drengen*$_1$ *har* … $[_{VP}$ $t_1$ *smilet* $[_{PP}$ *til* $[_{NP}$ *pigen* …]]]]

The boy has smiled at the girl

The point is that the verb determines the structure of the complement phrase that follows it. As this is matter of grammatical structure, it demands some *syntagmatic* computation. On the other hand, subcategorization is also very much a lexical matter, in the sense that the number and syntactic categories of a verb's arguments is determined by its lexical entry, cf. section 2.1.2 above. So, some *paradigmatic* computation is required as well. The lexical entry determines the presence of certain phrases as opposed to others, cf. the *Projection Principle* (section 2.1.3). The *X-bar component* (cf.

section 2.1.1) of the grammar determines the structure and in interaction with *Move-α* (and the rest of the grammar, such as the *Case Filter*) determines the structural position of the phrases. TJ's omission of governed prepositions is most likely caused by trauma to Broca's area, but may also be influenced by the damage to Wernicke's area.

Let us for a moment consider an alternative model. Myers-Scotton & Jake (2000) present a model of word selection or rather *lemma activation*. Lemma is another word for lexical entry. The model, called the *4-M model*, is based on a four-way classification of morphemes, as opposed to the classical two-way model: function words/morphemes (closed class) and content words/morphemes (open class). I shall give a brief overview of their hypothesis. First consider the model for the production of sentences:

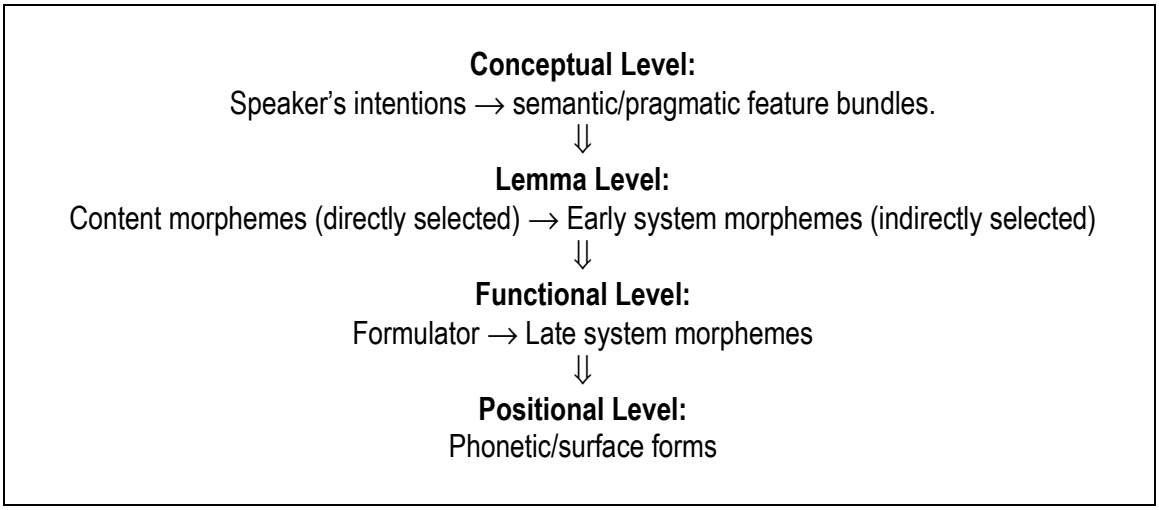


**Figure 12: Production process diagram. Based on Myers-Scotton & Jake 2000: 1056, figure 1.**

On the conceptual level the speaker has some kind of intention to say something, which leads to the activation of certain semantic/pragmatic feature bundles. In turn this activation selects the appropriate lemmas, prototypically predicates (verbs) and their arguments (typically NPs). These lemmas then potentially select certain system morphemes. For example, if the speaker intends to say something like "*She looks at him*" the verb "*look*" and its arguments "*she*" and "*him*" are directly selected by feature bundle activation. They are called *content morphemes* and distinguish themselves from the other types of morphemes by having the feature [+THEMATIC ROLE], i.e. they are either theta-assignors or theta-assignees. Information on the categories of predicate and arguments are also given by the feature bundles, such that "*look*" is the head of a VP

and the arguments are NPs. Furthermore, the verb (the head) selects the preposition "*at*", an *early system morpheme*. This is indirectly selected as it is the verb that 'calls' it – it is not directly selected by feature bundle activation. Together the content morphemes and the early system morphemes provide information to the formulator at the functional level, which assemble larger hierarchical constituents. In order to do this, some additional system morphemes are required (they are called by the formulator) such as the agreement suffix (3rd person singular) on the verb. These *late system morphemes* are divided into two categories: *outsider morphemes* and *bridge morphemes*. An example of an outsider morpheme is the before mentioned English 3rd person singular agreement suffix. They have to "look outside" their maximal projections (AgrP):

> *They depend on grammatical information outside of the immediate maximal projection in which they occur. This information is only available when the formulator sends directions to the positional/surface level for how maximal projections are unified in a larger construction.* (Myers-Scotton & Jake 2000: 1064)

In other words, the verbal suffix is dependent on movement in order to connect with the verb.

Bridge system morphemes "connect content morphemes with each other without reference to the specific semantic/pragmatic properties of a content head." Examples of this are the English preposition "*of*" in "*friend of Tom*" and the possessive suffix "*-s*" in "*Tom's friend*", which mark the orders of head-complement and complement-head, respectively. In summary, the distinction between the four types of morphemes can be stated as follows:

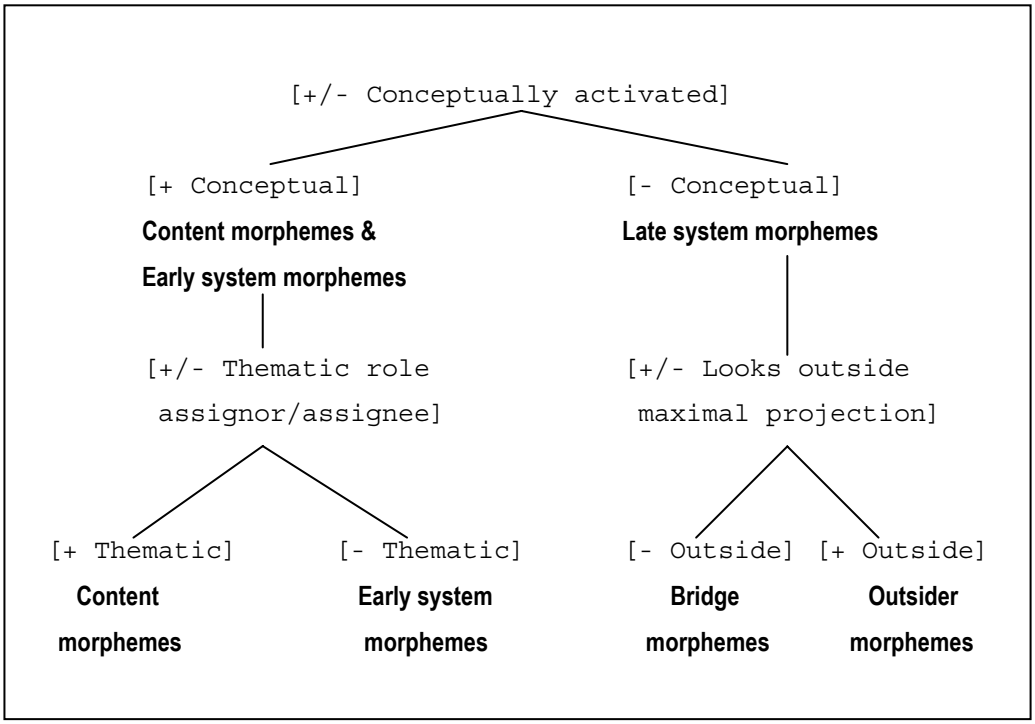


**Figure 13: Feature distribution and classification of morphemes. Adapted from Myers-Scotton & Jake 2000: 1062, figure 2.**

According to Myers-Scotton & Jake, patients with Broca's aphasia will produce content morphemes more accurately than any of the system morphemes, and late system morphemes will be missing or used less accurate. The late system morphemes are part of the "structure-building apparatus" or syntagmatic computation: “The 4-M model implicates late system morphemes, both outsiders and bridges, as expressions of the relational aspects of language” (Myers-Scotton 2000: 1076). This fits very well with the conclusions above (cf. the discussion in chapter 5): anterior and posterior lesions in the language area leads to damage to syntagmatic and paradigmatic linguistic computation, respectively.

Considering the data on TJ, the 4-M model provides the following classification of impaired morphemes:

(78) **Classification of impaired morphemes**

| | |
|---|---|
| Content morphemes: | none |
| Early system morphemes: | auxiliary verbs (aspect), "*blive*", VP-internal prepositions |
| Bridge morphemes: | passive "-*s*", adjoined prepositions |
| Outsider morphemes: | tense |

Content morphemes are predicates and arguments, the morphemes with the feature [+THEMATIC ROLE]. Early system morphemes are those selected by the content morphemes and part of the conceptually activated morphemes; the Danish auxiliary verbs "*have*" and "*blive*" are aspect markers and must therefore be conceptually activated. The VP-internal prepositions are subcategorized for by verbs (content morphemes) and are therefore early system morphemes. I have categorized the passive "-*s*" and the adjoined prepositions as bridge morphemes, because they merely signal the 'direction' of the predicate (i.e. the order of the arguments) in the same way as the English genitive "-*s*" and possessive "*of*" signal complement-head and head-complement order respectively. Tense inflections are outsider morphemes as they depend on information outside their own maximal projection TnsP. Tense inflection is dependent on the verb moving out of VP and into TnsP in main clauses; in embedded clauses the tense inflection itself has to move into VP to connect with the verb. If Danish had agreement morphology it would have been outsider morphemes as well.

Provided my classification is correct, the 4-M model correctly predicts that content words are not impaired. The predicate and arguments are produced. On the other possible extreme, the model predicts impairment affecting tense morphology, which is also predicted in the *Tree-pruning Hypothesis*.

From hereon, I think the 4-M model loses compatibility: First, it is predicted that early system morphemes are less impaired than late system morphemes. With regards to prepositions this is not identical to what was predicted in the model outlined in the previous chapters. Actually, it is quite the opposite: in the 4M model governed (VP-internal) prepositions are early system morphemes and should therefore be less impaired than ungoverned (adjoined) prepositions, which are late system morphemes. According to Grodzinsky (1988) in agrammatism VP-internal prepositions are deleted/omitted, while adjoined prepositions are not. This pattern is also reflected in the speech of TJ, cf. Table 16 on page 91. As argued above, VP-internal prepositions depend on both

syntagmatic and paradigmatic computation: they are called by the verb, such that the presence of a PP is specified, and they depend on the grammar to specify position in the structure. This is not accounted for in the 4-M model, which appears to clusters practically all of grammar into one: the formulator.

With regards to auxiliary verbs, TJ has a strong tendency to omit the verbs related to aspect (+/- perfect), while the passive marker "*blive*" is not omitted. If the auxiliary verbs are considered to be late system morphemes, i.e. part of the "structure building apparatus", TJ's auxiliary verb omission, which I considered structure reduction above, would be predicted correctly by the 4-M model. On the other hand, auxiliaries must be considered early system morphemes, as they are "called by" the main verb in order to specify semantic aspect. This is incompatible with the 4-M model as well.

The prediction by the 4-M model that the passive morphology is impaired is borne out in the speech of TJ.

On the whole, I think that the 4-M model is a clear and good proposal of the process of morpheme selection. However, the predictions provided by the model are incompatible with the data from TJ. This may, on the other hand, be an artifact of the lack of elaboration an examples in the article by Myers-Scotton & Jake. It does, however, once again support the distinction of syntagmatic (bridge and outsider morphemes) and paradigmatic (content and early system morphemes) computation, even though this distinction alone is insufficient. This has already been done by the other approaches discussed so far (Bates et al. 1991, Damasio 1992, Deacon 1997, Grodzinsky 2000, Pinker 1994). Furthermore, the model has nothing to say about on issues of movement related to the impairment of the top-most nodes. In the 4-M model agreement and tense, for example, are in the same category, and as such they must be equally impaired. Evidence provided by e.g. Grodzinsky (2000) and Friedmann & Grodzinsky (1997, 2000) point to a distinction between tense and agreement in agrammatism (see also the discussion on the *Split-inflection Hypothesis* in section 6.2 above). For this reason, the 4-M model lacks *breakdown compatibility*. Furthermore, using the 4-M model I fail to see how to account for the distinction in *comprehension* between constructions with and without syntactic movement (of the underlying object), as reported by Grodzinsky.

As stressed several times throughout the text, a mere distinction between syntagmatic and paradigmatic is insufficient. For example, Broca's aphasics do not lose

all of their syntax (syntagmatic linguistic computation), only parts of it. The distinction in comprehension between movement and non-movement clearly supports this. In production, agrammatic speech is not a random flow of words. According to Bates et al. (1991) agrammatics tend to overuse SVO order. Clearly not all relational aspects are lost.

In Wernicke's aphasia, the sentences, however incomprehensible, are not formed at random. The word substitutions are frequently within the proper semantic field, for example "*chair*" for "*table*" and "*knee*" for "*elbow*". The phonemic substitutions, e.g. "*tubber*" for "*butter*" also point to at least some sparing of paradigmatic relations, as the words appear not to be completely random. For these reasons the functional distribution within the language area has to be finer than assumed by a gross dichotomies such as syntagmatic vs. paradigmatic, syntax vs. lexicon, anterior vs. posterior language area. Even though this is hinted at in the 4-M model, it is still not elaborate enough to account for all the phenomena associated with agrammatism (or the other types of aphasia for that matter).

Grodzinsky proposed a syntactic approach to (Broca's) aphasia (cf. chapter 6 above), and I agree that the evidence seems to demand it. However little evidence of aphasia left in TJ, his performance is not distributed randomly over syntagmatic computation. He shows remnants of a movement-related deficit, only reflected in subject-object relatives in comprehension, but in production all object relatives are affected. Grodzinsky's hypotheses, however, do not capture this late stage in recovery in any precise manner, but still his deficit seems to be syntactic.

The lesion to his posterior region, I believe, is reflected in the few examples of lexical deficits, such as his problems with the irregular inflection of the verb "*slå*" (hit) in production, and perhaps his problems with the lexical passive verb "*væmmes*" (be disgusted) in comprehension. He also makes some word substitutions in production, so some aspects of word finding / paradigmatic relations appear to be affected.

# 9 Conclusions

Paradis (1998: 418) states that "[i]t is now known that the symptoms of agrammatism will vary in accordance with the structure of each language." Grodzinsky (2000: 15) relates this variation to the zero-morphology parameter, such that agrammatism is manifested differently depending on the morphology of the language: if the language has +zero-morphology agrammatics will tend to show omission of inflection, whereas if the language has –zero-morphology agrammatics will substitute inflection. Furthermore, the deficit will vary according to the word order of the language. The fact that this variation can be captured in the same grammatical framework that accounts for normal competence makes the theory *breakdown-compatible.* The lesion site thus has some sort of language-specific and grammar-specific function. As agrammatism is caused by trauma to Broca's area, the aspects of grammar affected must be located in that same area. In comprehension agrammatism is manifested as a disruption of trace-antecedent chains, and in production it is manifested as pruning of the topmost functional nodes of the syntactic representation. So, the apparatus responsible for these aspects of grammar must be located in Broca's area and its vicinity. As trace-deletion and tree-pruning are clearly two different representational aspects of grammar they can hardly be computed by the same neural mechanism. For this reason they may be located in close vicinity of each other instead of in the very same place. As Grodzinsky (2000: 18) puts it, it suggests "*anatomical proximity, but functional separation*." As other aspects of grammar are not disrupted by damage to Broca's area, only the mechanisms underlying the specific syntactic abilities affected in the deficit are located there, nothing else.

A look at Figure 6 on page 41 above, in which cerebral areas within the language zone are correlated with different types of aphasia, confirms the internal *modular structure* of language. Different aspects of grammar are affected depending on lesion site, and therefore all of grammar cannot be located in on spot. In fact:

> [*M*]*ost human linguistic abilities, including most syntax, are not located in the anterior language areas – Broca's area and deeper white matter, operculum, and anterior insula*. (Grodzinsky 2000: 17)

It is up to further investigation to discover the connections between different specific aspects of grammar and different types of aphasia in correlation with lesion site.

The human grammatical competence is *distributed* over the perisylvian region of the left hemisphere, but *localized* within this region, as argued in sections 3.2 and 3.3. This is the case in normal subjects without history of early childhood lesions in the left hemisphere or any other cerebral pathology. If normal development is not disrupted, language will be located in the language zone of the left hemisphere. This is what I called the default brain plan in section 3.4. In other words, language is innate and reflected in the architecture of the brain (as well as our speech apparatus). The *robustness* of language in the face of severe retardation (cf. section 4.2) also support a neural basis of language, i.e. innateness, as general learning in such subjects is severely reduced. Furthermore, this points to *external modularity* of language, as general intelligence and language are doubly dissociated. One may be present without the other (cf. Table 4, page 42).

As such the structure of the language zone constrains the range of possible human languages - it constitutes the *universal grammar*. Language acquisition is, in loose terms, a matter of adjusting the grammar to the one language spoken in the ambient society. Furthermore, as this language capacity can (supposedly) be described by a comprehensive linguistic theory, the very same theory should be able to describe all the reported types of aphasia (and recovery). Furthermore, such a theory should be able to make predictions regarding the performance of aphasics in any language, in which such research has not yet been made.

In order to test the hypotheses of Grodzinsky's syntactic approach to Broca's aphasia, I applied the framework to the Danish language and tested the predictions thus made on TJ, a Danish agrammatic aphasia patient. However, TJ was an unclear case for three reasons. First, his impairment was caused by hematomas in multiple places. Second, his medical report was rather unclear on the exact locations of these hematomas. Third, and most important, TJ had been in recovery for too long to show any clear signs of agrammatism (which, according to his speech therapist, had been apparent at earlier stages). Though his test results can neither falsify nor completely verify the hypotheses, they point to *a syntactic deficit – specifically related to movement and trace-antecedent chains*. TJ's deficit was at the time of testing reduced to a problem with object relatives, which involves movement of the object across the subject. As I have argued, his entire clause structure is intact, and therefore his production deficit

cannot be account for by reference to tree pruning. His comprehension deficit can not be accounted for by mere reference to trace deletion, which however, I think is still involved. Therefore, we have to consider what the comprehension and production deficits have in common: object relatives. What do the other constructions have that the object relatives do not have? A) All the constructions predicted to yield above chance performance in comprehension (cf. Table 10 on page 71) are not movement derived. B) The three types of passives (verbal, "*blive*", and psychological) have a preposition to assign AGENT/EXPERIENCER grammatically. In object relatives the object is not assigned case directly by the verb but through θ-transmission from the trace (both comprehension and production contains movement derived constructions; the former due to someone else's intact grammar, the latter due to the intact CP in TJ). If the trace is deleted or the chain otherwise broken this transmission is no longer possible and the cognitive *Default Strategy* assigns AGENT to the leftmost NP in a θ-position. This is predicted to lead to competition (two AGENTS) in e.g. verbal passives. However, it seems that in TJ the presence of the adjoined AGENT overrides this potential competition. I propose that the direct θ-assignor-assignee connection has been *strengthened*, such that the grammatical assignment has priority over the cognitive assignment. This would account for the fact that TJ only performs poorly on constructions where all θ-roles has to be assigned through θ-transmission or cognitive assignment. If I am correct, this underlying deficit of θ-transmission should be incorporated in the framework such that different stages of recovery are captured as well as the most severe stage, on which Grodzinsky's theory is based. Recovery would thus go through at least the following stages (some may recover fully, while others may not and thus stagnate at a prior stage):

a) Stages of severe agrammatism: Trace deletion, tree pruning.
b) Rebuilding of the syntactic tree and recovery of comprehension and production – not necessarily in that order.
c) Strengthened grammatical θ-role assignment, which is manifested as reduced error rates.
d) Reconstruction of trace-antecedent chains.
e) Recovery.

The strengthening of the direct grammatical θ-assignment will result in decreasing error rates as there is less competition between the two identical θ-roles in e.g. reversible passives; furthermore, it may lead to the reconstruction of grammatical θ-chains, such that the correct θ-roles will be assigned to the appropriate NPs. In turn, the Default Strategy will be down prioritized and eventually abandoned. Due to the reconstructed θ-chains object-relatives will reappear in the speech production.

Granted that my proposal of the strengthening of direct θ-assignment is correct (keeping in mind that TJ may not at all be a good example of agrammatism) it implies that Grodzinsky's theory has not yet fully gained *Breakdown Compatibility*. His theory currently captures only some of the earlier stages of recovery. Though my proposals may remedy some of the problems it still has nothing to say about the systematic omission of auxiliary (aspect) verbs. There is still much work to be done.

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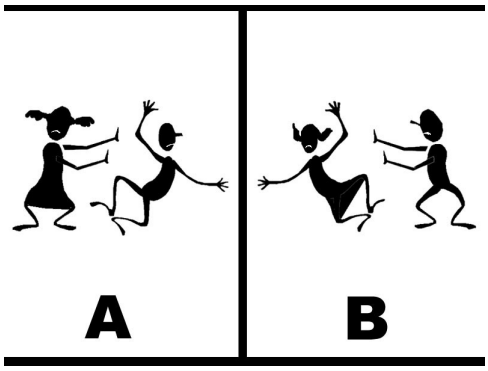
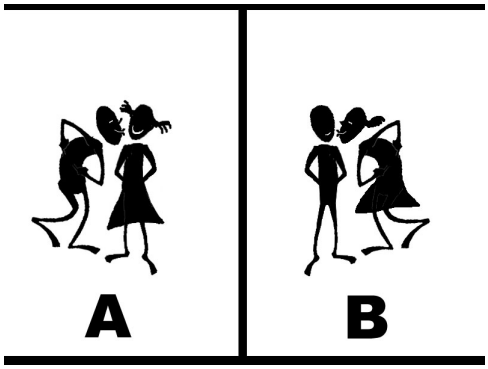
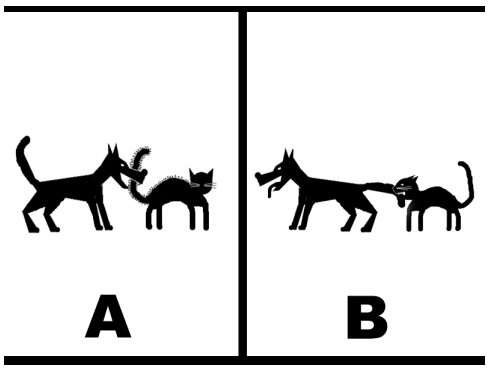
# 11 Appendix A: Sentence-to-Picture Matching Test

| | |
|---|---|
| 1. Pigen skubber drengen<br>  <br> | 1. Pigen skubber drengen<br>2. Drengen skubber pigen<br>3. Drengen skubbes af pigen<br>4. Pigen skubbes af drengen<br>5. Vis mig pigen som skubber drengen<br>6. Vis mig drengen som skubber pigen<br>7. Det er pigen som skubber drengen<br>8. Det er drengen som skubber pigen<br>9. Drengen bliver skubbet af pigen<br>10. Pigen bliver skubbet af drengen<br>11. Vis mig drengen som pigen skubber<br>12. Vis mig pigen som drengen skubber<br>13. Det er drengen som pigen skubber<br>14. Det er pigen som drengen skubber<br>15. Pigen som skubber drengen er sur<br>16. Drengen som skubber pigen er sur<br>17. Drengen som pigen skubber er sur<br>18. Pigen som drengen skubber er sur |
| 2. Pigen kysser drengen<br>  <br> | 1. Pigen kysser drengen<br>2. Drengen kysser pigen<br>3. Drengen kysses af pigen<br>4. Pigen kysses af drengen<br>5. Vis mig pigen som kysser drengen<br>6. Vis mig drengen som kysser pigen<br>7. Det er pigen som kysser drengen<br>8. Det er drengen som kysser pigen<br>9. Drengen bliver kysset af pigen<br>10. Pigen bliver kysset af drengen<br>11. Vis mig drengen som pigen kysser<br>12. Vis mig pigen som drengen kysser<br>13. Det er drengen som pigen kysser<br>14. Det er pigen som drengen kysser<br>15. Pigen som kysser drengen er glad<br>16. Drengen som kysser pigen er glad<br>17. Drengen som pigen kysser er glad<br>18. Pigen som drengen kysser er glad |
| 3. Hunden bider katten<br>  <br> | 1. Hunden bider katten<br>2. Katten bider hunden<br>3. Katten bides af hunden<br>4. Hunden bides af katten<br>5. Vis mig hunden som bider katten<br>6. Vis mig katten som bider hunden<br>7. Det er hunden som bider katten<br>8. Det er katten som bider hunden<br>9. Katten bliver bidt af hunden<br>10. Hunden bliver bidt af katten<br>11. Vis mig katten som hunden bider<br>12. Vis mig hunden som katten bider<br>13. Det er katten som hunden bider<br>14. Det er hunden som katten bider<br>15. Hunden som bider katten er sort<br>16. Katten som bidder hunden er sort<br>17. Katten som hunden bider er sort<br>18. Hunden som katten bider er sort |

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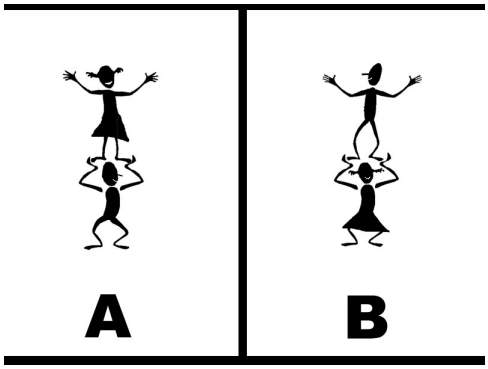
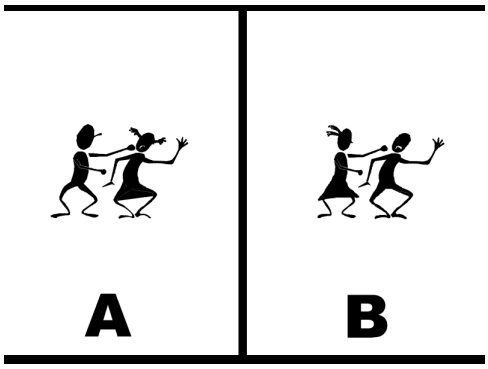
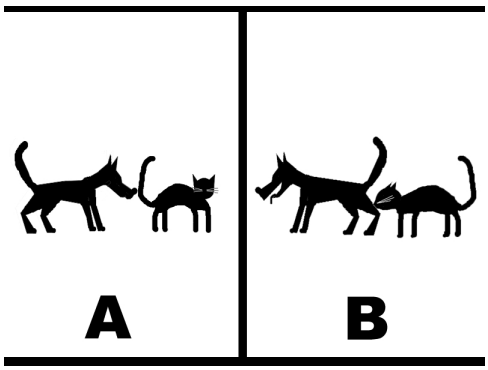
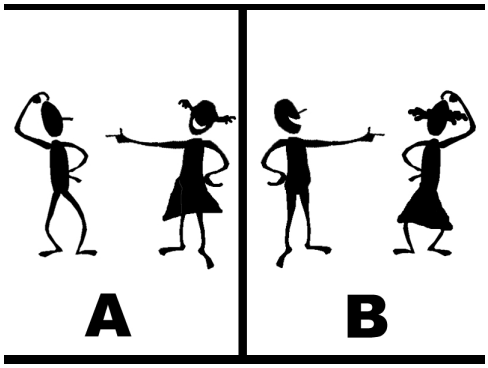
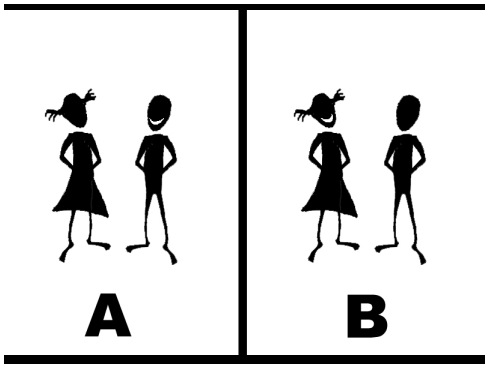
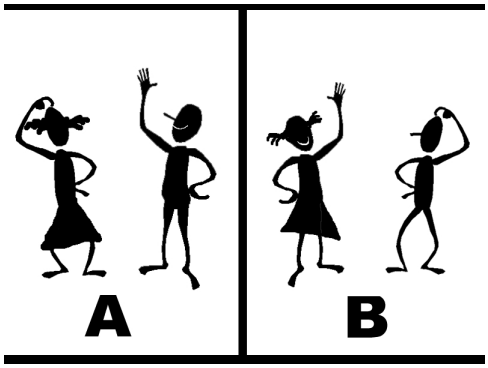
|---|---|
| 4. Pigen løfter drengen<br>  <br> | 1. Pigen løfter drengen<br>2. Drengen løfter pigen<br>3. Drengen løftes af pigen<br>4. Pigen løftes af drengen<br>5. Vis mig pigen som løfter drengen<br>6. Vis mig drengen som løfter pigen<br>7. Det er pigen som løfter drengen<br>8. Det er drengen som løfter pigen<br>9. Drengen bliver løftet af pigen<br>10. Pigen bliver løftet af drengen<br>11. Vis mig drengen som pigen løfter<br>12. Vis mig pigen som drengen løfter<br>13. Det er drengen som pigen løfter<br>14. Det er pigen som drengen løfter<br>15. Pigen som løfter drengen er glad<br>16. Drengen som løfter pigen er glad<br>17. Drengen som pigen løfter er glad<br>18. Pigen som drengen løfter er glad |
| 5. Pigen slår drengen<br>  <br> | 1. Pigen slår drengen<br>2. Drengen slår pigen<br>3. Drengen slås af pigen<br>4. Pigen slås af drengen<br>5. Vis mig pigen som slår drengen<br>6. Vis mig drengen som slår pigen<br>7. Det er pigen som slår drengen<br>8. Det er drengen som slår pigen<br>9. Drengen bliver slået af pigen<br>10. Pigen bliver slået af drengen<br>11. Vis mig drengen som pigen slår<br>12. Vis mig pigen som drengen slår<br>13. Det er drengen som pigen slår<br>14. Det er pigen som drengen slår<br>15. Pigen som slår drengen er sur<br>16. Drengen som slår pigen er sur<br>17. Drengen som pigen slår er sur<br>18. Pigen som drengen slår er sur |
| 6. Hunden snuser til katten<br>  <br> | 1. Hunden snuser til katten<br>2. Katten snuser til hunden<br>3. Katten bliver snuset til af katten<br>4. Hunden bliver snuset til af katten |

| | |
|---|---|
| 7. Pigen peger på drengen<br>  <br> | 1. Pigen peger på drengen<br>2. Drengen peger på pigen<br>3. Drengen bliver peget på af pigen<br>4. Pigen bliver peget på af drengen<br>5. Pigen griner ad drengen<br>6. Drengen griner ad pigen<br>7. Drengen bliver grinet ad af pigen<br>8. Pigen bliver grinet ad af drengen |
| 8. Pigen smiler til drengen<br>  <br> | 1. Pigen smiler til drengen<br>2. Drengen smiler til pigen<br>3. Drengen blivet smilet til af pigen<br>4. Pigen bliver smilet til af drengen |
| 9. Pigen vinker til drengen<br>  <br> | 1. Pigen vinker til drengen<br>2. Drengen vinker til pigen<br>3. Drengen bliver vinket til af pigen<br>4. Pigen bliver vinket til af drengen |

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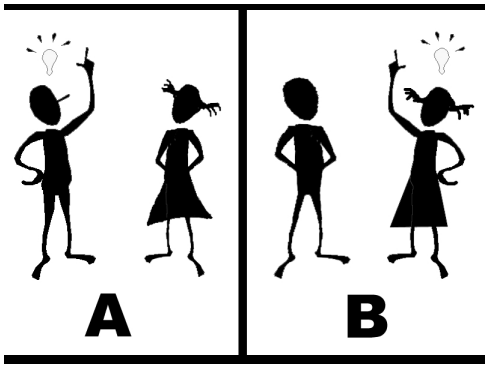
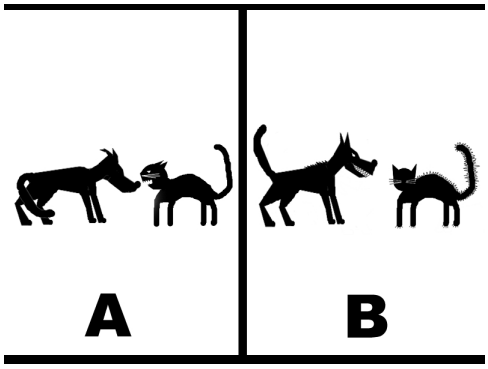
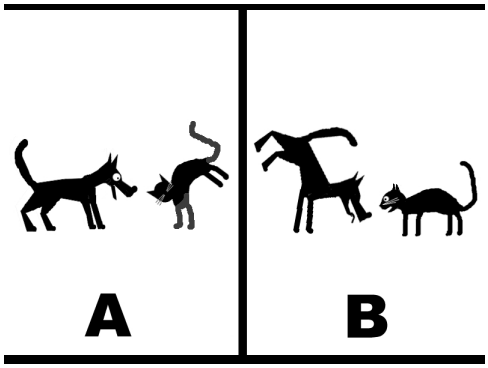
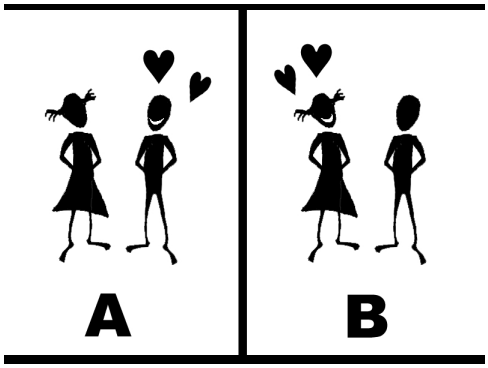
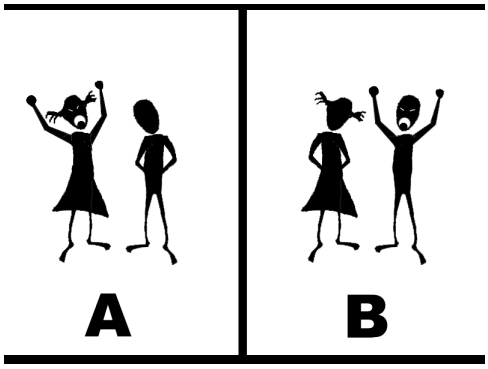
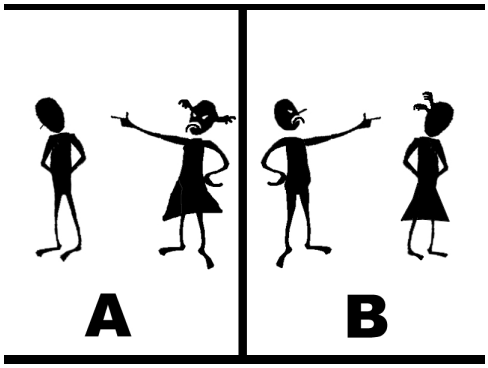
|---|---|
| 10. Drengen er inspireret af pigen<br>  <br> | 1. Drengen er inspireret af pigen<br>2. Pigen er inspireret af drengen |
| 11. Hunden er irriteret på katten<br>  <br> | 1. Hunden er irriteret på katten<br>2. Katten er irriteret på hunden<br>3. Hunden frygter katten<br>4. Katten frygter hunden<br>5. Katten frygtes af hunden<br>6. Hunden frygtes af katten |
| 12. Hunden er forbavset over katten<br>  <br> | 1. Hunden er forbavset over katten<br>2. Katten er forbavset over hunden |

| | |
|---|---|
| 13. Drengen elsker pigen<br>  <br> | 1. Drengen elsker pigen<br>2. Pigen elsker drengen<br>3. Pigen elskes af drengen<br>4. Drengen elskes af pigen<br>5. Drengen er begejstret for pigen<br>6. Pigen er begejstret for drengen<br>7. Drengen synes om pigen<br>8. Pigen synes om drengen<br>9. Drengen er interesseret i pigen<br>10. Pigen er interesseret i drengen<br>11. Drengen beundrer pigen<br>12. Pigen beundrer drengen<br>13. Pigen beundres af drengen<br>14. Drengen beundres af pigen |
| 14. Drengen hader pigen<br>  <br> | 1. Drengen hader pigen<br>2. Pigen hader drengen<br>3. Pigen hades af drengen<br>4. Drengen hades af pigen |
| 15. Drengen væmmes ved pigen<br>  <br> | 1. Drengen væmmes ved pigen<br>2. Pigen væmmes ved drengen<br>3. Drengen afskyr pigen<br>4. Pigen afskyr drengen<br>5. Pigen afskys af drengen<br>6. Drengen afskys af pigen |

# 12 Appendix B: Sentence Types and Tokens

| | |
|---|---|
| **1. Simple Active:**<br><br>**sub verb obj**<br>**Agent Theme** | 1. Pigen skubber drengen<br>2. Drengen skubber pigen<br>3. Pigen kysser drengen<br>4. Drengen kysser pigen<br>5. Hunden bider katten<br>6. Katten bider hunden<br>7. Pigen løfter drengen<br>8. Drengen løfter pigen<br>9. Pigen slår drengen<br>10. Drengen slår pigen |
| **sub verb prep obj**<br>**Agent Theme** | 11. Hunden snuser til katten<br>12. Katten snuser til hunden<br>13. Pigen peger på drengen<br>14. Drengen peger på pigen<br>15. Pigen griner ad drengen<br>16. Drengen griner ad pigen<br>17. Pigen smiler til drengen<br>18. Drengen smiler til pigen<br>19. Pigen vinker til drengen<br>Drengen vinker til pigen |
| **2. Sub-Sub Relative:**<br><br>**$sub_1$ [$sub_1$ verb obj]**<br>**Agent Theme** | 1. Pigen som skubber drengen er sur<br>2. Drengen som skubber pigen er sur<br>3. Pigen som kysser drengen er glad<br>4. Drengen som kysser pigen er glad<br>5. Hunden som bider katten er sort<br>6. Katten som bidder hunden er sort<br>7. Pigen som løfter drengen er glad<br>8. Drengen som løfter pigen er glad<br>9. Pigen som slår drengen er sur<br>10. Drengen som slår pigen er sur |
| **3. Obj-Sub Relative:**<br><br>**$obj_1$ [$sub_1$ verb obj]**<br>**Agent Theme** | 1. Vis mig pigen som skubber drengen<br>2. Vis mig drengen som skubber pigen<br>3. Vis mig pigen som kysser drengen<br>4. Vis mig drengen som kysser pigen<br>5. Vis mig hunden som bider katten<br>6. Vis mig katten som bider hunden<br>7. Vis mig pigen som løfter drengen<br>8. Vis mig drengen som løfter pigen<br>9. Vis mig pigen som slår drengen<br>10. Vis mig drengen som slår pigen |
| **4. Subject Cleft:**<br><br>**$N°_1$ [$sub_1$ verb obj]**<br>**Agent Theme** | 1. Det er pigen som skubber drengen<br>2. Det er drengen som skubber pigen<br>3. Det er pigen som kysser drengen<br>4. Det er drengen som kysser pigen<br>5. Det er hunden som bider katten<br>6. Det er katten som bider hunden<br>7. Det er pigen som løfter drengen<br>8. Det er drengen som løfter pigen<br>9. Det er pigen som slår drengen<br>10. Det er drengen som slår pigen |

| | |
|---|---|
| **Lexical Passive:**<br><br>**sub verb prep obj**<br>**Experiencer Theme** | Drengen synes om pigen<br>Pigen synes om drengen<br>Drengen væmmes ved pigen<br>Pigen væmmes ved katten |
| **Adjectival Passive:**<br><br>**sub copula adj oblique**<br>**Experiencer Theme** | 1. Drengen er interesseret i pigen<br>2. Pigen er interesseret i drengen<br>3. Drengen er inspireret af pigen<br>4. Pigen er inspireret af drengen<br>5. Drengen er begejstret for pigen<br>6. Pigen er begejstret for drengen<br>7. Hunden er irriteret på katten<br>8. Katten er irriteret på hunden<br>9. Hunden er forbavset over katten<br>10. Katten er forbavset over hunden |
| **Psychological predicates:**<br><br>**sub verb obj**<br>**Experiencer Theme** | 1. Drengen beundrer pigen<br>2. Pigen beundrer drengen<br>3. Drengen elsker pigen<br>4. Pigen elsker drengen<br>5. Drengen hader pigen<br>6. Pigen hader drengen<br>7. Drengen afskyr pigen<br>8. Pigen afskyr drengen<br>9. Hunden frygter katten<br>10. Katten frygter hunden |
| **"*Blive*" Passive:**<br><br>**sub aux verb prep oblique**<br>**Theme Agent** | 1. Drengen bliver skubbet af pigen<br>2. Pigen bliver skubbet af drengen<br>3. Drengen bliver kysset af pigen<br>4. Pigen bliver kysset af drengen<br>5. Katten bliver bidt af hunden<br>6. Hunden bliver bidt af katten<br>7. Drengen bliver løftet af pigen<br>8. Pigen bliver løftet af drengen<br>9. Drengen bliver slået af pigen<br>10. Pigen bliver slået af drengen |
| **sub aux verb prep prep oblique**<br>**Theme Agent** | 11. Katten bliver snuset til af katten<br>12. Hunden bliver snuset til af katten<br>13. Drengen bliver peget på af pigen<br>14. Pigen bliver peget på af drengen<br>15. Drengen bliver grinet ad af pigen<br>16. Pigen bliver grinet ad af drengen<br>17. Drengen blivet smilet til af pigen<br>18. Pigen bliver smilet til af drengen<br>19. Drengen bliver vinket til af pigen<br>Pigen bliver vinket til af drengen |

| | |
|---|---|
| **Sub-Obj Relative:**<br><br>**$sub_1$ [$obj_1$ sub verb]**<br>**Theme Agent** | 1. Drengen som pigen skubber er høj<br>2. Pigen som drengen skubber er høj<br>3. Drengen som pigen kysser er glad<br>4. Pigen som drengen kysser er glad<br>5. Katten som hunden bider er sort<br>6. Hunden som katten bider er sort<br>7. Drengen som pigen løfter er glad<br>8. Pigen som drengen løfter er glad<br>9. Drengen som pigen slår er sur<br>10. Pigen som drengen slår er sur |
| **Obj-Obj Relative:**<br><br>**$obj_1$ [$obj_1$ sub verb]**<br>**Theme Agent** | 1. Vis mig drengen som pigen skubber<br>2. Vis mig pigen som drengen skubber<br>3. Vis mig drengen som pigen kysser<br>4. Vis mig pigen som drengen kysser<br>5. Vis mig katten som hunden bider<br>6. Vis mig hunden som katten bider<br>7. Vis mig drengen som pigen løfter<br>8. Vis mig pigen som drengen løfter<br>9. Vis mig drengen som pigen slår<br>10. Vis mig pigen som drengen slår |
| **Object cleft:**<br><br>**$N°_1$ [$obj_1$ sub verb]**<br>**Theme Agent** | 1. Det er drengen som pigen skubber<br>2. Det er pigen som drengen skubber<br>3. Det er drengen som pigen kysser<br>4. Det er pigen som drengen kysser<br>5. Det er katten som hunden bider<br>6. Det er hunden som katten bider<br>7. Det er drengen som pigen løfter<br>8. Det er pigen som drengen løfter<br>9. Det er drengen som pigen slår<br>10. Det er pigen som drengen slår |
| **Verbal Passive:**<br><br>**sub verb prep oblique**<br>**Theme Agent** | 1. Drengen skubbes af pigen<br>2. Pigen skubbes af drengen<br>3. Drengen kysses af pigen<br>4. Pigen kysses af drengen<br>5. Katten bides af hunden<br>6. Hunden bides af katten<br>7. Drengen løftes af pigen<br>8. Pigen løftes af drengen<br>9. Drengen slås af pigen<br>10. Pigen slås af drengen |
| **Psychological Passive:**<br><br>**sub verb prep oblique**<br>**Theme Experiencer** | 1. Pigen beundres af drengen<br>2. Drengen beundres af pigen<br>3. Pigen elskes af drengen<br>4. Drengen elskes af pigen<br>5. Pigen hades af drengen<br>6. Drengen hades af pigen<br>7. Pigen afskys af drengen<br>8. Drengen afskys af pigen<br>9. Katten frygtes af hunden<br>10. Hunden frygtes af katten |

# 13 Appendix C: Repetition Test: Structure Distribution

**Legend:**

| | | | |
|---|---|---|---|
| adj.pas: | Adjectival Passive | PAST_PF+: | Past Double Perfect |
| lex.pas: | Lexical Passive | PAST_PF: | Past Perfect |
| obj.clf: | Object Cleft | PAST: | Past |
| o_o.rel: | Object-Object Relative | PRES_PF+: | Present Double Perfect |
| o_s.rel: | Object-Subject Relative | PRES_PF: | Present Perfect |
| psy.pas: | Psychological Passive | PRES: | Present |
| psy.ver: | Psychological Verb | FUTURE: | Future |
| sim.pas: | Simple Active | | |
| sub.clf: | Subject Cleft | | |
| s_o.rel: | Subject-Object Relative | | |
| sim.pas: | Simple ("*blive*") Passive | | |
| s_s.rel: | Subject-Subject Relative | | |
| vrb.pas: | Verbal Passive | | |

| | |
|---|---|
| adj.pas FUTURE | Hunden bliver temmelig irriteret på katten |
| adj.pas PAST | Hunden var ret forbavset over katten |
| adj.pas PAST_PF | Pigen havde nok været inspireret af drengen |
| adj.pas PRES_PF | Pigen har ofte været begejstret for drengen |
| adj.pas PRESENT | Drengen er meget begejstret for pigen |
| | |
| lex.pas FUTURE | Drengen vil nok synes om pigen |
| lex.pas PAST | Pigen væmmedes nok ved drengen |
| lex.pas PAST_PF | Pigen havde nok syntes om drengen |
| lex.pas PAST_PF+ | Drengen havde nok haft syntes om pigen |
| lex.pas PRES_PF | Pigen har nok væmmedes ved drengen |
| lex.pas PRES_PF+ | Pigen har nok haft syntes om drengen |
| lex.pas PRESENT | Drengen synes vist om pigen |
| | |
| o_o.rel FUTURE | Vis mig katten som hunden sikkert vil bide |
| o_o.rel PAST | Vis mig drengen som pigen vredt skubbede |
| o_o.rel PAST_PF | Vis mig pigen som drengen ofte havde slået |
| o_o.rel PAST_PF+ | Vis mig pigen som drengen vredt havde haft slået |
| o_o.rel PRES_PF | Vis mig pigen som drengen sikkert har kysset |
| o_o.rel PRES_PF+ | Vis mig pigen som drengen sikkert har haft kysset |
| o_o.rel PRESENT | Vis mig drengen som pigen tit kysser |
| | |
| o_s.rel FUTURE | Vis mig hunden som først vil bide katten |
| o_s.rel PAST | Vis mig drengen som vredt skubbede pigen |
| o_s.rel PAST_PF | Vis mig pigen som vredt havde slået drengen |
| o_s.rel PAST_PF+ | Vis mig pigen som vist havde haft slået drengen |
| o_s.rel PRES_PF | Vis mig pigen som nemt har løftet drengen |
| o_s.rel PRES_PF+ | Vis mig pigen som jo har haft løftet drengen |
| o_s.rel PRESENT | Vis mig drengen som blidt kysser pigen |

| | |
|---|---|
| obj.clf FUTURE | Det er katten som hunden nok vil bide |
| obj.clf PAST | Det er drengen som pigen vist slog |
| obj.clf PAST_PF | Det var pigen som drengen vist havde skubbet |
| obj.clf PAST_PF+ | Det var pigen som drengen vist havde haft skubbet |
| obj.clf PRES_PF | Det er pigen som drengen nok har løftet |
| obj.clf PRES_PF+ | Det er pigen som drengen nok har haft løftet |
| obj.clf PRESENT | Det er drengen som pigen tit kysser |
| | |
| psy.pas FUTURE | Hunden vil sikkert blive frygtet af katten |
| psy.pas PAST | Drengen elskedes sikkert af pigen |
| psy.pas PAST_PF | Drengen var vist blevet beundret af pigen |
| psy.pas PRES_PF | Pigen er nok blevet beundret af drengen |
| psy.pas PRESENT | Pigen elskes jo af drengen |
| | |
| psy.ver FUTURE | Katten vil sikkert frygte hunden |
| psy.ver PAST | Drengen elskede nok pigen |
| psy.ver PAST_PF | Pigen havde nok elsket drengen |
| psy.ver PAST_PF+ | Pigen havde nok haft elsket drengen |
| psy.ver PRES_PF | Pigen har vist afskyet drengen |
| psy.ver PRES_PF+ | Pigen har vist haft afskyet drengen |
| psy.ver PRESENT | Drengen afskyr vist pigen |
| | |
| s_o.rel FUTURE | Katten som hunden sikkert vil bide er sort |
| s_o.rel PAST | Drengen som pigen vredt slog er sur |
| s_o.rel PAST_PF | Pigen som drengen ofte havde skubbet var sur |
| s_o.rel PAST_PF+ | Pigen som drengen ofte havde haft skubbet var sur |
| s_o.rel PRES_PF | Pigen som drengen vist har kysset er glad |
| s_o.rel PRES_PF+ | Pigen som drengen vist har haft kysset er glad |
| s_o.rel PRESENT | Drengen som pigen gerne kysser er glad |
| | |
| s_s.rel FUTURE | Hunden som jo vil bide katten er sort |
| s_s.rel PAST | Drengen som jo skubbede pigen er sur |
| s_s.rel PAST_PF | Pigen som nok havde slået drengen var sur |
| s_s.rel PAST_PF+ | Pigen som nok havde haft slået drengen var sur |
| s_s.rel PRES_PF | Pigen som tit har kysset drengen er glad |
| s_s.rel PRES_PF+ | Pigen som nok har haft kysset drengen er glad |
| s_s.rel PRESENT | Drengen som tit kysser pigen er glad |
| | |
| sim.act FUTURE | Drengen vil sikkert slå pigen |
| sim.act FUTURE | Pigen vil ikke løfte drengen |
| sim.act PAST | Drengen pegede vist på pigen |
| sim.act PAST | Pigen kyssede ikke drengen |
| sim.act PAST_PF | Hunden havde nok snuset til katten |
| sim.act PAST_PF | Pigen havde ikke vinket til drengen |
| sim.act PAST_PF+ | Hunden havde nok haft snuset til katten |
| sim.act PAST_PF+ | Pigen havde ikke haft vinket til drengen |
| sim.act PRES_PF | Drengen har tit smilet til pigen |
| sim.act PRES_PF | Pigen har ikke skubbet drengen |
| sim.act PRES_PF+ | Drengen har tit haft smilet til pigen |
| sim.act PRES_PF+ | Pigen har ikke haft skubbet drengen |
| sim.act PRESENT | Drengen kysser gerne pigen |
| sim.act PRESENT | Katten snuser ikke til hunden |

| | |
|---|---|
| sim.pas FUTURE | Drengen vil sikkert blive slået af pigen |
| sim.pas FUTURE | Pigen vil ikke blive peget på af drengen |
| sim.pas PAST | Drengen blev ofte peget på af pigen |
| sim.pas PAST | Pigen blev ikke kysset af drengen |
| sim.pas PAST_PF | Hunden var nok blevet bidt af katten |
| sim.pas PAST_PF | Pigen var ikke blevet smilet til af drengen |
| sim.pas PRES_PF | Drengen er sikkert blevet smilet til af pigen |
| sim.pas PRES_PF | Pigen er ikke blevet slået af drengen |
| sim.pas PRESENT | Drengen bliver tit grinet ad af pigen |
| sim.pas PRESENT | Katten bliver ikke bidt af hunden |
| | |
| sub.clf FUTURE | Det er hunden som sikkert vil bide katten |
| sub.clf PAST | Det er drengen som vredt skubbede pigen |
| sub.clf PAST_PF | Det var pigen som vist havde skubbet drengen |
| sub.clf PAST_PF+ | Det var pigen som vist havde haft skubbet drengen |
| sub.clf PRES_PF | Det er pigen som nemt har løftet drengen |
| sub.clf PRES_PF+ | Det er pigen som jo har haft løftet drengen |
| sub.clf PRESENT | Det er drengen som gerne kysser pigen |
| | |
| vrb.pas PAST | Drengen kyssedes gerne af pigen |
| vrb.pas PAST | Drengen skubbedes jo af pigen |
| vrb.pas PRESENT | Drengen løftes tit af pigen |
| vrb.pas PRESENT | Hunden bides vist af katten |

Excluded due to ungrammaticality:

| | |
|---|---|
| adj.pas PAST_PF+ | *Pigen havde nok haft været inspireret af drengen |
| adj.pas PRES_PF+ | *Pigen har vist haft været begejstret for drengen |
| psy.pas PAST_PF+ | *Drengen havde vist været blevet beundret af pigen |
| psy.pas PRES_PF+ | *Pigen har nok været blevet beundret af drengen |
| sim.pas PAST_PF+ | *Hunden havde nok været blevet bidt af katten |
| sim.pas PRES_PF+ | *Drengen har sikkert været blevet smilet til af pigen |
| vrb.pas FUTURE | *Drengen vil senere kysses af pigen[14] |
| vrb.pas PAST_PF | *Drengen havde haft skubbedes jo af pigen |
| vrb.pas PAST_PF+ | *Hunden havde vist haft bides af katten |
| vrb.pas PRES_PF | *Drengen har løftes tit af pigen |
| vrb.pas PRES_PF+ | *Hunden har vist bides af katten |

Extra added to reach 100 sentences:

| | |
|---|---|
| sim.act PAST | Drengene jagtede tit pigerne |
| sim.act PAST | Pigerne drillede ofte drengene |
| sim.act PAST | Drengene kyssede gerne pigerne |
| sim.act PAST | Pigerne slog ofte drengene |
| sim.act PAST | Hundene knurrede vredt af kattene |
| sim.act PAST | Kattene væsede vredt af hundene |

[14] The sentence is grammatical if the meaning of "*vil*" (will) is volition instead of future.

# 14 Appendix D: TJ's Comprehension Test Data

| Type | Order +1000 | Token | Picture >=correct | | Performace *=fail | |
|---|---|---|---|---|---|---|
| adj.passive | 1015. | Hunden er irriteret på katten | [A] | >B] | [ ] | [*] |
| adj.passive | 1018. | Drengen er interesseret i pigen | >A] | [B] | [ ] | [ ] |
| adj.passive | 1041. | Hunden er forbavset over katten | >A] | [B] | [ ] | [ ] |
| adj.passive | 1043. | Pigen er begejstret for drengen | [A] | >B] | [ ] | [ ] |
| adj.passive | 1060. | Pigen er inspireret af drengen | [A] | >B] | [ ] | [*] |
| adj.passive | 1085. | Drengen er begejstret for pigen | >A] | [B] | [ ] | [ ] |
| adj.passive | 1097. | Katten er forbavset over hunden | [A] | >B] | [ ] | [ ] |
| adj.passive | 1102. | Katten er irriteret på hunden | >A] | [B] | [ ] | [ ] |
| adj.passive | 1128. | Pigen er interesseret i drengen | [A] | >B] | [ ] | [ ] |
| adj.passive | 1144. | Drengen er inspireret af pigen | >A] | [B] | [ ] | [ ] |
| lex.passive | 1033. | Pigen væmmes ved drengen | >A] | [B] | [ ] | [ ] |
| lex.passive | 1036. | Drengen synes om pigen | >A] | [B] | [ ] | [ ] |
| lex.passive | 1131. | Drengen væmmes ved pigen | [A] | >B] | [*] | [*] |
| lex.passive | 1137. | Pigen synes om drengen | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1031. | Det er drengen som pigen skubber | >A] | [B] | [ ] | [*] |
| obj.cleft | 1042. | Det er pigen som drengen slår | >A] | [B] | [ ] | [*] |
| obj.cleft | 1052. | Det er drengen som pigen løfter | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1055. | Det er pigen som drengen løfter | >A] | [B] | [ ] | [ ] |
| obj.cleft | 1075. | Det er hunden som katten bider | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1083. | Det er pigen som drengen kysser | >A] | [B] | [ ] | [ ] |
| obj.cleft | 1084. | Det er drengen som pigen slår | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1092. | Det er drengen som pigen kysser | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1107. | Det er pigen som drengen skubber | [A] | >B] | [ ] | [ ] |
| obj.cleft | 1118. | Det er katten som hunden bider | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1008. | Vis mig katten som hunden bider | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1011. | Vis mig pigen som drengen slår | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1019. | Vis mig pigen som drengen løfter | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1035. | Vis mig drengen som pigen løfter | [A] | >B] | [ ] | [ ] |
| obj.obj.relative | 1088. | Vis mig drengen som pigen slår | [A] | >B] | [ ] | [ ] |
| obj.obj.relative | 1105. | Vis mig pigen som drengen kysser | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1113. | Vis mig drengen som pigen kysser | [A] | >B] | [ ] | [ ] |
| obj.obj.relative | 1132. | Vis mig pigen som drengen skubber | [A] | >B] | [ ] | [ ] |
| obj.obj.relative | 1135. | Vis mig drengen som pigen skubber | >A] | [B] | [ ] | [ ] |
| obj.obj.relative | 1139. | Vis mig hunden som katten bider | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1005. | Vis mig drengen som slår pigen | >A] | [B] | [ ] | [ ] |
| obj.sub.relative | 1022. | Vis mig pigen som kysser drengen | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1040. | Vis mig hunden som bider katten | >A] | [B] | [ ] | [ ] |
| obj.sub.relative | 1048. | Vis mig drengen som skubber pigen | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1063. | Vis mig drengen som kysser pigen | >A] | [B] | [ ] | [ ] |
| obj.sub.relative | 1069. | Vis mig pigen som skubber drengen | >A] | [B] | [ ] | [ ] |
| obj.sub.relative | 1079. | Vis mig pigen som løfter drengen | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1100. | Vis mig katten som bider hunden | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1120. | Vis mig pigen som slår drengen | [A] | >B] | [ ] | [ ] |
| obj.sub.relative | 1126. | Vis mig drengen som løfter pigen | >A] | [B] | [ ] | [ ] |
| psych.passive | 1001. | Hunden frygtes af katten | [A] | >B] | [*] | [ ] |
| psych.passive | 1020. | Pigen afskys af drengen | [A] | >B] | [ ] | [ ] |
| psych.passive | 1027. | Drengen elskes af pigen | [A] | >B] | [ ] | [ ] |
| psych.passive | 1056. | Katten frygtes af hunden | >A] | [B] | [ ] | [*] |
| psych.passive | 1059. | Pigen hades af drengen | [A] | >B] | [ ] | [ ] |
| psych.passive | 1064. | Drengen beundres af pigen | [A] | >B] | [ ] | [ ] |
| psych.passive | 1101. | Pigen elskes af drengen | >A] | [B] | [ ] | [ ] |
| psych.passive | 1133. | Drengen hades af pigen | >A] | [B] | [ ] | [ ] |
| psych.passive | 1140. | Drengen afskys af pigen | >A] | [B] | [ ] | [ ] |
| psych.passive | 1141. | Pigen beundres af drengen | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1004. | Drengen hader pigen | [A] | >B] | [ ] | [ ] |
| psych.predicate | 1017. | Pigen elsker drengen | [A] | >B] | [→] | [ ] |
| psych.predicate | 1026. | Hunden frygter katten | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1032. | Katten frygter hunden | [A] | >B] | [ ] | [ ] |
| psych.predicate | 1045. | Pigen beundrer drengen | [A] | >B] | [→] | [ ] |
| psych.predicate | 1047. | Drengen elsker pigen | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1077. | Drengen beundrer pigen | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1086. | Pigen afskyr drengen | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1094. | Pigen hader drengen | >A] | [B] | [ ] | [ ] |
| psych.predicate | 1103. | Drengen afskyr pigen | [A] | >B] | [ ] | [ ] |
| sim.active | 1007. | Pigen løfter drengen | [A] | >B] | [ ] | [ ] |
| sim.active | 1013. | Pigen griner ad drengen | >A] | [B] | [ ] | [ ] |
| sim.active | 1016. | Drengen griner ad pigen | [A] | >B] | [ ] | [ ] |
| sim.active | 1024. | Drengen vinker til pigen | >A] | [B] | [ ] | [ ] |

| | | | | | | |
|---|---|---|---|---|---|---|
| sim.active | 1044. | Katten bider hunden | [A] | >B] | [ ] | [ ] |
| sim.active | 1046. | Drengen smiler til pigen | >A] | [B] | [ ] | [ ] |
| sim.active | 1051. | Katten snuser til hunden | [A] | >B] | [ ] | [ ] |
| sim.active | 1068. | Pigen slår drengen | [A] | >B] | [ ] | [ ] |
| sim.active | 1076. | Hunden snuser til katten | >A] | [B] | [ ] | [ ] |
| sim.active | 1078. | Pigen peger på drengen | >A] | [B] | [ ] | [ ] |
| sim.active | 1080. | Pigen smiler til drengen | [A] | >B] | [ ] | [ ] |
| sim.active | 1095. | Pigen kysser drengen | [A] | >B] | [ ] | [ ] |
| sim.active | 1096. | Hunden bider katten | >A] | [B] | [ ] | [ ] |
| sim.active | 1098. | Drengen løfter pigen | >A] | [B] | [ ] | [ ] |
| sim.active | 1106. | Drengen peger på pigen | [A] | >B] | [ ] | [ ] |
| sim.active | 1108. | Pigen skubber drengen | >A] | [B] | [ ] | [ ] |
| sim.active | 1109. | Pigen vinker til drengen | [A] | >B] | [ ] | [ ] |
| sim.active | 1111. | Drengen slår pigen | >A] | [B] | [ ] | [ ] |
| sim.active | 1117. | Drengen skubber pigen | [A] | >B] | [ ] | [ ] |
| sim.active | 1138. | Drengen kysser pigen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1014. | Hunden bliver bidt af katten | [A] | >B] | [ ] | [ ] |
| sim.passive | 1025. | Drengen bliver løftet af pigen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1053. | Drengen bliver skubbet af pigen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1057. | Drengen blivet smilet til af pigen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1058. | Pigen bliver løftet af drengen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1065. | Pigen bliver kysset af drengen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1066. | Pigen bliver smilet til af drengen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1071. | Pigen bliver vinket til af drengen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1087. | Drengen bliver grinet ad af pigen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1090. | Katten bliver snuset til af hunden | >A] | [B] | [ ] | [ ] |
| sim.passive | 1104. | Pigen bliver skubbet af drengen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1110. | Pigen bliver slået af drengen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1114. | Katten bliver bidt af hunden | >A] | [B] | [ ] | [ ] |
| sim.passive | 1115. | Hunden bliver snuset til af katten | [A] | >B] | [ ] | [ ] |
| sim.passive | 1116. | Pigen bliver grinet ad af drengen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1125. | Pigen bliver peget på af drengen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1127. | Drengen bliver vinket til af pigen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1129. | Drengen bliver peget på af pigen | >A] | [B] | [ ] | [ ] |
| sim.passive | 1134. | Drengen bliver slået af pigen | [A] | >B] | [ ] | [ ] |
| sim.passive | 1142. | Drengen bliver kysset af pigen | [A] | >B] | [ ] | [ ] |
| sub.cleft | 1002. | Det er katten som bider hunden | [A] | >B] | [ ] | [ ] |
| sub.cleft | 1006. | Det er drengen som løfter pigen | >A] | [B] | [ ] | [ ] |
| sub.cleft | 1030. | Det er drengen som skubber pigen | [A] | >B] | [ ] | [*] |
| sub.cleft | 1054. | Det er pigen som kysser drengen | [A] | >B] | [ ] | [ ] |
| sub.cleft | 1067. | Det er drengen som slår pigen | >A] | [B] | [ ] | [ ] |
| sub.cleft | 1081. | Det er hunden som bider katten | >A] | [B] | [ ] | [ ] |
| sub.cleft | 1082. | Det er pigen som skubber drengen | >A] | [B] | [ ] | [ ] |
| sub.cleft | 1099. | Det er pigen som løfter drengen | [A] | >B] | [ ] | [ ] |
| sub.cleft | 1124. | Det er drengen som kysser pigen | >A] | [B] | [ ] | [ ] |
| sub.cleft | 1136. | Det er pigen som slår drengen | [A] | >B] | [ ] | [ ] |
| sub.obj.relative | 1009. | Pigen som drengen løfter er glad | >A] | [B] | [ ] | [ ] |
| sub.obj.relative | 1028. | Pigen som drengen skubber er sur | [A] | >B] | [*] | [*] |
| sub.obj.relative | 1034. | Drengen som pigen løfter er glad | [A] | >B] | [*] | [ ] |
| sub.obj.relative | 1050. | Drengen som pigen kysser er glad | [A] | >B] | [ ] | [*] |
| sub.obj.relative | 1061. | Pigen som drengen kysser er glad | >A] | [B] | [ ] | [ ] |
| sub.obj.relative | 1072. | Drengen som pigen slår er sur | [A] | >B] | [ ] | [ ] |
| sub.obj.relative | 1089. | Hunden som katten bider er sort | [A] | >B] | [*] | [ ] |
| sub.obj.relative | 1091. | Pigen som drengen slår er sur | >A] | [B] | [ ] | [ ] |
| sub.obj.relative | 1093. | Katten som hunden bider er sort | >A] | [B] | [ ] | [*] |
| sub.obj.relative | 1112. | Drengen som pigen skubber er sur | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1003. | Hunden som bider katten er sort | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1010. | Pigen som løfter drengen er glad | [A] | >B] | [ ] | [ ] |
| sub.sub.relative | 1021. | Drengen som løfter pigen er glad | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1023. | Drengen som slår pigen er sur | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1029. | Drengen som skubber pigen er sur | [A] | >B] | [ ] | [ ] |
| sub.sub.relative | 1038. | Pigen som slår drengen er sur | [A] | >B] | [ ] | [ ] |
| sub.sub.relative | 1039. | Pigen som kysser drengen er glad | [A] | >B] | [ ] | [ ] |
| sub.sub.relative | 1049. | Pigen som skubber drengen er sur | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1062. | Drengen som kysser pigen er glad | >A] | [B] | [ ] | [ ] |
| sub.sub.relative | 1122. | Katten som bider hunden er sort | [A] | >B] | [ ] | [ ] |
| verbal.passive | 1012. | Drengen kysses af pigen | [A] | >B] | [ ] | [ ] |
| verbal.passive | 1037. | Katten bides af hunden | >A] | [B] | [ ] | [ ] |
| verbal.passive | 1070. | Pigen slås af drengen | >A] | [B] | [ ] | [ ] |
| verbal.passive | 1073. | Drengen skubbes af pigen | >A] | [B] | [ ] | [ ] |
| verbal.passive | 1074. | Drengen slås af pigen | [A] | >B] | [ ] | [ ] |
| verbal.passive | 1119. | Hunden bides af katten | [A] | >B] | [ ] | [ ] |
| verbal.passive | 1121. | Pigen løftes af drengen | >A] | [B] | [ ] | [ ] |
| verbal.passive | 1123. | Pigen kysses af drengen | >A] | [B] | [ ] | [ ] |
| verbal.passive | 1130. | Pigen skubbes af drengen | [A] | >B] | [ ] | [ ] |
| verbal.passive | 1143. | Drengen løftes af pigen | [A] | >B] | [ ] | [ ] |

# 15 Appendix E: TJ's Production Test Data

**Legend:**

| | | | |
|---|---|---|---|
| AP: | Adjectival Passive | PAST infl. | 1: Past Double Perfect |
| LP: | Lexical Passive | | 2: Past Perfect |
| OC: | Object Cleft | | 3: Past |
| OO: | Object-Object Relative | PRES. infl. | 4: Present Double Perfect |
| OS: | Object-Subject Relative | | 5: Present Perfect |
| PP: | Psychological Passive | | 6: Present |
| PV: | Psychological Verb | | 7: (Present) Future |
| SA: | Simple Active | | |
| SC: | Subject Cleft | | |
| SO: | Subject-Object Relative | | |
| SP: | Simple ("*blive*") Passive | | |
| SS: | Subject-Subject Relative | | |
| VP: | Verbal Passive | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences" (Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | | | SA | 3 | SA | 3 | *Drengene jagtede tit pigerne*<br>"Drengene jagtede tit pigerne" | | | | |
| 01 | P | | SA | 3 | SA | 3 | *Kattene hvæsede vredt af hundene*<br>"Kattene hvæsede vredt af hundene" | | | | |
| 02 | P | | LP | 7 | LP | 7 | *Drengen vil nok synes om pigen*<br>"Drengen vil nok synes om pigen" | | | | OK |
| 03 | | | VP | 6 | VP | 6 | *Hunden bides vist af katten*<br>"Hunden bides vist af katten" | | | | OK |
| 04 | | | SA | 3 | SA | 3 | *Pigerne slog ofte drengene*<br>"Pigerne slog ofte drengene" | | | | OK |
| 05 | P | | AP | 6 | AP | 6 | *Drengen er meget begejstret for pigen*<br>" Drengene er meget begejstret for pigerne" | | | | |
| 06 | P | | SA | 3 | SA | 3 | *Hundene knurrede vredt af kattene*<br>"Hundene knurrede vredt af kattene" | | | | |
| 07 | | | PV | 7 | PV | 7 | *Katten vil sikkert frygte hunden*<br>"Katten vil ææh … øh katten vil øh måske frygte hunden" | | | | |
| 08 | | | PV | 6 | PV | 6 | *Drengen afskyr vist pigen*<br>"Drengen afskyr vist pigen" | | | | |
| 09 | | | OC | 6 | OC | 6 | *Det er drengen som pigen tit kysser*<br>"Det er drengen som pigen tit kysser" | | | | |
| 10 | | | OO | 5 | OO | 5 | *Vis mig pigen som drengen sikkert har kysset*<br>" Vis mig pigen som drengen har kysset" | | | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11 | P | | AP | 5 | AP | 6 | *Pigen har ofte været begejstret for drengen*<br>"Pigen er ofte begejstret for drengene" | -1 | | | |
| 12 | | | OC | 5 | OC | 3 | *Det er pigen som drengen nok har løftet*<br>"Det er pigen øh ööh drengen øh øh sikkert løftede" | -1 | | | |
| 13 | P | | SA | 1 | SA | 5 | *Hunden havde nok haft snuset til katten*<br>"Hunden har ofte øh snuset til hunden" | -1 | | | |
| 14 | | | OS | 6 | ? | ? | *Vis mig drengen som blidt kysser pigen*<br>"Vis mig drengen som ööh … … ööh øh ja det er jeg kan ikke huske det drengen som ofte … … ja det kan jeg ikke huske"<br>(Vis mig drengen som ofte) ❷ | | -1 | | |
| 15 | | | SO | 4 | ? | ? | *Pigen som drengen vist har haft kysset er glad*<br>"Pigen som ofte har … øh døhdøhdøh drengen"<br>(Pigen som ofte har _ drengen) ❻ | -1 | -1 | | |
| 16 | P | | SP | 6 | SP | 6 | *Drengen bliver tit grinet ad af pigen*<br>"Drengen bliver tit grinet ad pigen" | | | -U | |
| 17 | | N | SP | 5 | SP | 5 | *Pigen er ikke blevet slået af drengen*<br>"Pigen er ikke blevet slået af drengen" | | | | |
| 18 | | | SS | 1 | SO | 5 | *Pigen som nok havde haft slået drengen var sur*<br>"Pigen som ööh måske har øh blevet slået af drengen øh og det kan jeg ikke huske det sidste"<br>(Pigen som måske er blevet slået af drengen [var sur]) | -1 | | | |
| 19 | | | PP | 5 | PP | 5 | *Pigen er nok blevet beundret af drengen*<br>"Pigen er øh er ööh ofte blevet beundret af drengen" | | | | |
| 20 | | N | SA | 5 | SP | 5 | *Pigen har ikke skubbet drengen*<br>"Pigen har ikke blevet skubbet af drengen"<br>(Pigen er ikke blevet skubbet af drengen) | | | | |
| 21 | P | | SA | 4 | SA | 5 | *Drengen har tit haft smilet til pigen*<br>"Drengen øh har tit smilet til pigen" | -1 | | | |
| 22 | | | OS | 3 | OS | 3 | *Vis mig drengen som vredt skubbede pigen*<br>"Vis mig drengen som vredt skubbede med pigen" | | | +G | |
| 23 | | | OS | 2 | OS | 3 | Vis mig pigen som vredt havde slået drengen<br>"Vis mig pigen som vredt slåede drengen" | -1 | | | |
| 24 | | | SC | 6 | SC | 6 | *Det er drengen som gerne kysser pigen*<br>"Det er drengen som gerne kysser pigen" | | | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | P | | SA | 5 | SA | 5 | *Drengen har tit smilet til pigen*<br>"Drengen har tit smilet til pigen" | | | | |
| 26 | | | PV | 1 | PV | 4 | *Pigen havde nok haft elsket drengen*<br>"Pigen har nok øh haft elsket drengen" | | | | |
| 27 | | | SS | 7 | SS | 3 | *Hunden som jo vil bide katten er sort*<br>"Hunden som ville bide katten var sort" | | | | |
| 28 | | | SA | 7 | SA | 7 | *Drengen vil sikkert slå pigen*<br>"Drengen vil sikkert slå pigen" | | | | |
| 29 | | | OC | 3 | SC | 6 | *Det er drengen som pigen vist slog*<br>"Det er drengen som vist slår pigen" | | | | |
| 30 | | | PV | 5 | PV | 5 | *Pigen har vist afskyet drengen*<br>"Pigen øh har vist afskyet drengen" | | | | |
| 31 | P | | AP | 2 | SP | 5 | *Pigen havde nok været inspireret af drengen*<br>"Pigen ööh har ofte ööh … har ofte ööh … kigget på pigen" | | | +G | |
| 32 | | | SC | 3 | SC | 3 | *Det er drengen som vredt skubbede pigen*<br>"Drengen som vredt skubbede pigen"<br>((Det er) drengen som vredt skubbede pigen) | | | | |
| 33 | | | SO | 2 | AP | 3 | *Pigen som drengen ofte havde skubbet var sur*<br>"Pigen var dööh … ofte … skrækket af … drengen"<br>(Pigen var ofte forskrækket over drengen) | | | +G | |
| 34 | | | OO | 7 | OO | 3 | *Vis mig katten som hunden sikkert vil bide*<br>"Vis mig katten som øh … bed øh hunden" | -1 | | | |
| 35 | P | | LP | 1 | ? | ? | *Drengen havde nok haft syntes om pigen*<br>"Drengen øh … har ofte øh … døhdøh kvinden"<br>(Drengen har ofte bla-bla kvinden) ❸ | -1 | -1 | | -1 |
| 36 | P | | SP | 3 | SP | 3 | *Drengen blev ofte peget på af pigen*<br>"Drengen blev ofte peget på af pigen" | | | | |
| 37 | | | SP | 7 | SP | 7 | *Drengen vil sikkert blive slået af pigen*<br>"Drengen vil ööh … øh ööh måske blive slået af pigen"<br>(Drengen vil måske blive slået af pigen) | | | | |
| 38 | | | OO | 1 | OS | 3 | *Vis mig pigen som drengen vredt havde haft slået*<br>"Vis mig pigen som ööh vredt slog slåede drengen" | -2 | | | |
| 39 | P | | AP | 3 | AP | 3 | *Hunden var ret forbavset over katten*<br>"Hunden var ret forbavset over katten" | | | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | | | PV | 2 | SA | 3 | *Pigen havde nok elsket drengen*<br>"Pigen var ofte øh nej pigen ææh elskede ofte drengen"<br>(Pigen elskede ofte drengen) | -1 | | | |
| 41 | | N | SA | 4 | SA | 5 | *Pigen har ikke haft skubbet drengen*<br>"Pigen har ikke skubbet drengen" | -1 | | | |
| 42 | | | VP | 6 | VP | 6 | *Drengen løftes tit af pigen*<br>"Drengen løftes tit af pigen" | | | | OK |
| 43 | P | | LP | 4 | ? | ? | *Pigen har nok haft syntes om drengen*<br>"Pigen har ofte ææh … ææh … ikke tænke men pigen er ofte … … … … ofte øh ja det ka du ka j' ikke huske det sidste"<br>(Pigen har ofte) ❺ | -1 | -1 | | -1 |
| 44 | P | | LP | 3 | ? | 3 | *Pigen væmmedes nok ved drengen*<br>"Pigen vænnede sig ofte øh øh af drengen"<br>(pigen vænnede sig ofte [ACTIVE REFLEXIVE] af drengen [PASSIVE]) | | | | -1 |
| 45 | | | SS | 4 | SS | 3 | *Pigen som nok har haft kysset drengen er glad*<br>"Pigen som øh ofte øh kyssede drengen er døhdøh"<br>(Pigen som ofte kyssede drengen er bla-bla) | -2 | | | |
| 46 | | N | SA | 7 | SA | 7 | *Pigen vil ikke løfte drengen*<br>"Pigen vil ikke løfte drengen" | | | | |
| 47 | P | N | SA | 6 | SA | 6 | *Katten snuser ikke til hunden*<br>"Katten snuser ikke til hunden" | | | | |
| 48 | | | SC | 2 | SC | 3 | *Det var pigen som vist havde skubbet drengen*<br>"Det var pigen som ææh … skubbede til drengen" | -1 | | +G | |
| 49 | | | OO | 3 | OO | 3 | *Vis mig drengen som pigen vredt skubbede*<br>"Vis mig pigen som drengen skubbede … vredt skubbede"<br>(Vis mig pigen som drengen vredt skubbede) | | | | |
| 50 | | | PP | 6 | PP | 3 | *Pigen elskes jo af drengen*<br>"Pigen elskede jo af drengen" | | | | -1 |
| 51 | | N | SP | 3 | SP | 3 | *Pigen blev ikke kysset af drengen*<br>"Pigen blev ikke kysset af drengen" | | | | |
| 52 | P | | LP | 2 | ? | ? | *Pigen havde nok syntes om drengen*<br>"Pigen har ofte øh … af drengen . Pigen … øh nej det kan jeg ikke"<br>(Pigen har ofte _ af drengen) ❹ | | -1 | | -1 |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 53 | | | SC | 1 | SC | 3 | *Det var pigen som vist havde haft skubbet drengen*<br>"Det var pigen som ofte skubbede drengen" | -2 | | | |
| 54 | | | SO | 7 | OS | 3 | *Katten som hunden sikkert vil bide er sort*<br>"Katten ville bide hunden som var sort" | | | | |
| 55 | P | | LP | 5 | ? | ? | *Pigen har nok væmmedes ved drengen*<br>"Pigen var of' nej … væmmede drengen. Pigen øøh var ofte nej. Pigen ofte øøh væmmede drengen"<br>(Pigen ofte væmmede drengen) ❼ | -1 | | -G | -1 |
| 56 | | | SA | 6 | SA | 6 | *Drengen kysser gerne pigen*<br>"Drengen kysser gerne pigen" | | | | |
| 57 | | | SA | 3 | SA | 6 | *Pigerne drillede ofte drengene*<br>"Pigerne drillede ofte drengene" | | | | |
| 58 | | | SS | 5 | SS | 3 | *Pigen som tit har kysset drengen er glad*<br>"Pigen som tit kyssede drengen var glad" | -1 | | | |
| 59 | | | PV | 4 | PV | 5 | *Pigen har vist haft afskyet drengen*<br>"Pigen har vist øøh har vist øøh afskyet nej var vist afskyet drengen"<br>(Pigen har vist afskyet drengen) | -1 | | | |
| 60 | P | | AP | 7 | AP | 7 | *Hunden bliver temmelig irriteret på katten*<br>"Hunden bliver temmelig irriteret på katten" | | | | |
| 61 | | | PV | 3 | PV | 3 | *Drengen elskede nok pigen*<br>"Drengen elskede nok pigen" | | | | |
| 62 | P | N | SP | 2 | SP | 2 | *Pigen var ikke blevet smilet til af drengen*<br>"Pigen var ikke blevet smilet af drengen" | | | -G | |
| 63 | | | PP | 3 | PP | 3 | *Drengen elskedes sikkert af pigen*<br>"Drengen elskedes vist af pigen" | | | | OK |
| 64 | P | | SA | 3 | SA | 3 | *Drengen pegede vist på pigen*<br>"Drengen pegede vist på pigen" | | | | |
| 65 | | | OO | 2 | OS | 3 | *Vis mig pigen som drengen ofte havde slået*<br>"Vis mig pigen som ofte slåede drengene drengen" | -1 | | | |
| 66 | | | SC | 7 | SC | 7 | *Det er hunden som sikkert vil bide katten*<br>"Det er hunden som sikkert vil bide katten" | | | | |
| 67 | | | OO | 4 | OS | 3 | *Vis mig pigen som drengen sikkert har haft kysset*<br>"Vis mig pigen som vist øøh kiggede efter drengen" | -1 | | +G | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | *Target sentences*<br>**"Produced sentences"**<br>**(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | | | SO | 3 | S-rel | 3 | *Drengen som pigen vredt slog er sur*<br>"Drengen … øh som vist … øh øh kiggede efter pigen"<br>(Drengen som vist kiggede efter pigen) [NP [Sub-rel] | | | +G | |
| 69 | | | SS | 2 | SS | 2 | *Pigen som nok havde slået drengen var sur*<br>"Pigen som øh ofte havde slået drengen var sur" | | | | |
| 70 | P | | SP | 5 | SP | 3 | *Drengen er sikkert blevet smilet til af pigen*<br>"Drengen øh blev smilet af pigen nej nej det kan jeg ikke huske"<br>(Drengen blev smilet af pigen) | -1 | | -G | |
| 71 | | | SO | 5 | ? | ? | *Pigen som drengen vist har kysset er glad*<br>"Pigen som …mem mem … ti pige drengen som ret glad. Jeg kan ikke huske det midterste" ❽ | -1 | -1 | | |
| 72 | | | OC | 1 | SC | 2 | *Det var pigen som drengen vist havde haft skubbet*<br>"Det var pigen som vist havde skuffet skubbet"<br>(Det var pigen som vist havde skubbet) [INTRANS] | -1 | | | |
| 73 | | | OC | 4 | OC | 5 | *Det er pigen som drengen nok har haft løftet*<br>"Det er ret pigen som drengen of' øøøh … har skubbet"<br>(Det er pigen som drengen ofte har skubbet) | -1 | | | |
| 74 | P | | LP | 6 | LP | 6 | *Drengen synes vist om pigen*<br>"Drengen synes vist om pigen" | | | | OK |
| 75 | | | OS | 4 | OS | 5 | *Vis mig pigen som jo har haft løftet drengen*<br>"Øh vis mig pigen som har løftet drengen" | -1 | | | |
| 76 | P | N | SP | 7 | SP | 7 | *Pigen vil ikke blive peget på af drengen*<br>"Pigen vil ikke blive peget af drengen" | | | -G | |
| 77 | | N | SP | 6 | SP | 6 | *Katten bliver ikke bidt af hunden*<br>"Katten bliver ikke bidt af hunden" | | | | |
| 78 | P | N | SA | 2 | SA | 2 | *Pigen havde ikke vinket til drengen*<br>" Pigen havde ikke vinket a' drengen"<br>(Pigen havde ikke vinket ad drengen) | | | | |
| 79 | | | SA | 3 | SA | 3 | *Drengene kyssede gerne pigerne*<br>"Drengene kyssede gerne pigerne" | | | | |
| 80 | | | SS | 6 | SS | 3 | *Drengen som tit kysser pigen er glad*<br>"Drengen som tit kyssede pigen er glad" | | | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 | | | VP | 3 | SA | 3 | *Drengen kyssedes gerne af pigen*<br>"Drengen kyssede gerne pigen" | | | | -1 |
| 82 | | | SP | 2 | SP | 2 | *Hunden var nok blevet bidt af katten*<br>"Hunden var nok bidt af katten"<br>(Hunden var nok [blevet] bidt af katten) | -1 | | | |
| 83 | P | | SA | 2 | SA | 2 | *Hunden havde nok snuset til katten*<br>"Hunden havde nok snuset at katten"<br>(Hunden havde nok snuset til katten) | | | | |
| 84 | | N | SA | 3 | SA | 3 | *Pigen kyssede ikke drengen*<br>"Pigen kyssede ikke drengen" | | | | |
| 85 | | | VP | 3 | VP | 3 | *Drengen skubbedes jo af pigen*<br>"Drengen skubbede jo af pigen" | | | | -1 |
| 86 | | | SS | 3 | SS | 3 | *Drengen som jo skubbede pigen er sur*<br>"Drengen som skubbede pigen er sur" | | | | |
| 87 | | | SC | 5 | SC | 3 | *Det er pigen som nemt har løftet drengen*<br>"Det er pigen som løftede drengen" | -1 | | | |
| 88 | | | SO | 6 | SO | 3 | *Drengen som pigen gerne kysser er glad*<br>"Drengen som pigen kyssede er gerne glad" | | | | |
| 89 | | | SO | 1 | SS | 3 | *Pigen som drengen ofte havde haft skubbet var sur*<br>"Pigen som ofte ööh skubbede øh drengen var sur"<br>(Pigen som ofte skubbede drengen var sur) | -2 | | | |
| 90 | | | OS | 7 | OS | 3 | *Vis mig hunden som først vil bide katten*<br>"Vis mig hunden som ööh ofte ööh bed hunden" | -1 | | | |
| 91 | | | PP | 2 | PP | 2 | *Drengen var vist blevet beundret af pigen*<br>"Drengen var vist blevet beundret af af hunden nej jo … eller pigen. Det kan jeg ikke huske"<br>(Drengen var vist blevet beundret af pigen) | | | | |
| 92 | | | OC | 7 | OC | 7 | *Det er katten som hunden nok vil bide*<br>"Det er katten som hunden nok vil bide" | | | | |
| 93 | | | OO | 6 | OO | ? | *Vis mig drengen som pigen tit kysser*<br>"Vis mig drengen som pigen ofte ööh ja det kan jeg ikke huske det sidste ord"<br>"Vis mig drengen som pigen ofte [VERB]) ❶ | | -1 | | |
| 94 | | | PP | 7 | PV | 3 | *Hunden vil sikkert blive frygtet af katten*<br>"Hunden vil sikkert blive øh … frygtet katten. Øh hunden ville sikkert ööh frygte katten"<br>(Hunden ville sikkert frygte katten) | | | | |

| Order | Governed P | Negation | Target Type | Target Tense | Produced Type | Produced Tense | ***Target sentences*** **"Produced sentences"** **(Interpretation by analyzer)** | Aux Verb Drop | Main Verb Drop | Prep. Drop | Passive morph. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | | | OS | 1 | OS | 5 | *Vis mig pigen som vist havde haft slået drengen*<br>"Vis mig pigen som vist slåede drengen nej vist har slået drengen"<br>(Vis mig pigen som vist har slået drengen) | -1 | | | |
| 96 | P | N | SA | 1 | SA | 5 | *Pigen havde ikke haft vinket til drengen*<br>"Pigen har ikke vinket til drengen" | -1 | | | |
| 97 | | | OC | 2 | OC | 3 | *Det var pigen som drengen vist havde skubbet*<br>"Det var pigen som drengen vist skubbede" | -1 | | | |
| 98 | | | SC | 4 | SC | 5 | *Det er pigen som jo har haft løftet drengen*<br>"Det var det er pigen som har løftet drengen vist har løftet drengen"<br>(Det er pigen som vist har løftet drengen) | -1 | | | |
| 99 | | | OS | 5 | OS | 3 | *Vis mig pigen som nemt har løftet drengen*<br>"Vis mig pigen som øh nemt løftede drengen" | -1 | | | |