The acquisition of verbal morphology in coclear-implanted and specific language impaired children

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CHAPTER 3

Background: The acquisition of agreement and tense

1. Introduction

In some languages, including Dutch, children go through a stage in which finite and infinite verbs co-occur in their speech. This has been called the Optional Infinitive stage. This stage is fairly well documented and several accounts have been put forward to explain this phenomenon. We elaborate on the acquisition of finiteness in section 2 of this chapter.

In section 3, we summarize the literature on the acquisition of tense. The early productions of infinitives seem to imply that these are temporally free, because these verbs lack overt tense morphemes. In subsection 3.1, we will outline how, although overt tense is missing, the infinitives are not completely temporally free, but interact with aspect. The influence of aspect is also visible in children's early production of the finite past tense. We will elaborate on this in subsection 3.2. The last paragraph is dedicated to the acquisition of the regular and irregular past tense. This is an important topic in this dissertation as it underlies the elicitation task presented in chapter 6.

Finally, in the last section of this chapter, we will elaborate on research demonstrating the relation between the development of Theory of Mind (ToM) and language in general and more specifically between ToM and the acquisition of tense. Under a modular view of the human mind (Fodor, 1983), there is a close relation between language and cognition. Language is one of the 'modules' of perception, i.e. a fast, informationally encapsulated domain-specific system that interacts with the central cognitive system to which ToM belongs. As such, there is reason to expect a relation between the development of tense and ToM.

2. From infinite to finite

2.1 The Optional Infinitive stage

For a number of languages, in early verbal morphological development, children allow two forms of declarative sentences: one with a finite verb (i.e. the target-like adult form) and one with a non-finite verb (i.e. deviating from the target grammar [1]). The use of non-finite declaratives in child speech has been documented for several languages:

(1) a. Die papegaai zo vliegen
That parrot so fly-INF
'That parrot flies like this'
b. Hij doet 't niet
He does it not
'He doesn't do it'

(Dutch, Haegeman 1995)

(2) a. Zahne pussen
Teeth brush-INF
b. Mein Hubsaube had Tiere din
My helicopter has animals in it

(German, Wexler 1994)

(3) a. Pas tomber bébé
Not fall-INF baby
b. Marche pas
Walks not

(French, Wexler 1994)

Depending on the theoretical point of view, this stage of development has been labeled either the Optional Infinitive stage (OI) (Wexler, 1994) or the Root Infinitive stage (Rizzi, 1993). Numerous accounts have been put forward to explain the so-called optional use of finiteness. These accounts are either based on a generative perspective on language development or usage-based perspective on language development. In this chapter we will only present the core-ideas of these accounts. It is beyond the scope of this dissertation to report the evidence of these accounts.

[1] Non-finite declarative sentences occur in adult grammar; however their use is more restricted than in child grammar (see Haegeman, 1995).

It has been claimed that Root Infinitives (henceforth RI) are not explained by a child's complete lack of inflection morphology. Poeppel & Wexler (1993) argue that inflection morphology is not randomly distributed among different types of subjects. In the longitudinal analysis of the German-speaking boy Andreas, they found that first and third person singular subjects always occurred with the correct inflection morpheme. In a detailed analysis of the Dutch-speaking girl Jasmijn, Jordens (1990) reports that at the age of 2 Jasmijn produced some errors in the use of first and second person singular inflection morphemes. However, a half year later these types of errors had disappeared.

Based on the analysis of longitudinal Italian child data (ages between 1;8 – 2;7), Guasti (1993) showed that children did not produce systematic agreement errors. The percentage of errors ranged between 1 and 3%. Moreover, Guasti shows that the target-like inflected verbs were not rote-learned; the same verbs occur with different inflection morphemes.

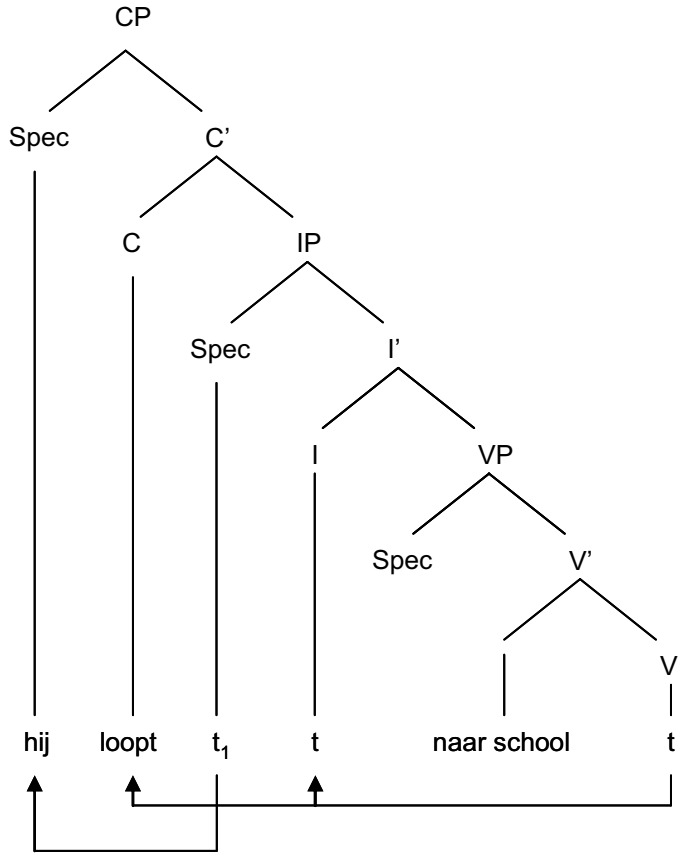
It is important to note that it is not claimed that children know *all* inflection morphemes by the age of 2 (see Poeppel & Wexler, 1993 p:9). For instance, Gillis & Schaerlaekens (2000) point out that number inflection (singular versus plural) is acquired after the age of 3. They report that, at this age, 30% of the utterances with a plural subject occur with singular inflection. This percentage has dropped to 14% at the age of 3;6. This indicates that the learning of agreement is a gradual process rather than a sudden burst of adult target-like inflection morphemes. With respect to the acquisition of the regular past tense, Brown (1984) has found that this morpheme is acquired well after the age of 3;6. An more detailed description of the acquisition of past tense is given in chapter 6.

2.2 Full *vs* Reduced Competence Hypothesis

The generative OI-accounts consider the use of RIs in declaratives as representative of a 'deficit' in children's syntax. From a generative perspective on language development, languages share an underlying syntactic representation of phrase structure, which is innate to humans. This is called Universal Grammar (UG). This syntactic representation is presented in Figure 2.

Language variation arises because elements in this representation can move or legally be omitted (e.g. subject-drop languages). These shifts in syntactic representation are language specific. An example of movement is the verb second (V2) phenomenon in Germanic languages. The (non-finite) verb is generated under VP and moves to C, picking up the inflection in I on the way. Therefore, the finite verb moves to the second position in the syntactic representation, whereas the non-finite verb remains in situ. This movement is illustrated in Figure 2.

Figure 2. The syntactic representation underlying sentences. The verb is generated under VP and inflection under IP. The verb moves from VP to IP to be inflected. In Germanic languages the verb moves to CP.



Poeppel & Wexler (1993) analyzed transcripts from a German-speaking boy Andreas at the age of 2;1. From the total of his 282 utterances, the finite verb occurred in second position (under CP) in 216 utterances and only 7 were produced sentence-final. In contrast, from the 51 RI utterances, 44 occurred sentence-final and 15 in second position. This shows that syntactic operations, such as movement, are known to the child already early in life [2].

[2] Children's knowledge of verb movement is also demonstrated by the use of negation in French. Children always place the negator *pas* correctly, i.e. post-verbally in finite contexts and pre-verbally in non-finite contexts (see Wexler's report (1994) of Pierce's data).

The OI accounts that have been proposed within a generative perspective on language development vary quite considerably as to the nature of this deficit in syntactic representation. Some accounts state that a child's syntactic representation is a reduced version of the adult's representation, i.e. some functional projections are lacking in a child's representation (see subsection 2.2.1). Other OI accounts depart from a full syntactic representation available in a child's grammar. This means that children in the OI stage have full knowledge of the universal principles and processes that underlie clause structure (Poeppel & Wexler, 1993) (see subsection 2.2.2).

2.2.1 The Reduced Competence Hypothesis

According to Radford (1990), child grammars are comprised of a set of lexical categories and projections, and lack functional categories and projections. The functional projection of IP is absent in child grammar. Therefore, the status of the verbal clause in child grammar is VP, whereas in adult grammar this status is IP. Evidence for this is found in the absence of modals in child speech. Radford argues that modals are base-generated in I. Consequently, if I is absent, modals are also lacking.

However, finite verbs do occur in early child speech (see examples 4a-c taken from Radford, 1990). Radford suggests that the past tense form in (4a) does not correspond with the adult past form. Rather, the context in which the form occurs indicates that the form in (4a) corresponds to the adult perfective/passive participles ('*I've lost it*'). The utterance in (4b) could be analyzed as carrying 3rd person singular inflection. However, Radford analyses this type of utterance as a formulaic expression, which is not representative of the range of productive structures that fall within a child's competence at the OI stage. Likewise, the production of the copula in (4c) is also not representative of the child's knowledge of the 3rd person singular morpheme (*-s*). According to Radford, these utterances are semiformulaic expressions.

(4) a. Lost it
b. Here it is!
c. Where's bee?

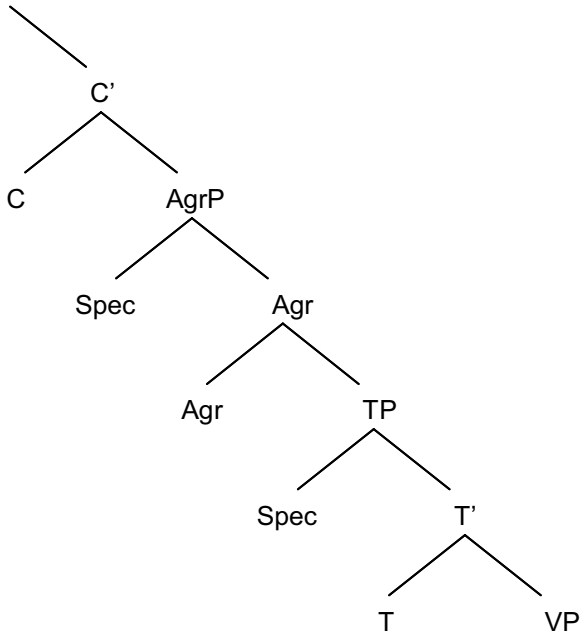
2.2.2 The Full Competence Hypotheses

Underspecification account

The IP in Figure 2 can be split into an Agreement node (AgrP) and a Tense node (TP), as in Figure 3. Wexler (1994) suggests that the TP is 'optional' for the child.

In adult grammar, the AgrP selects a tensed clausal complement (TP). If TP is projected, the verb will rise, hence tense and agreement are present. If TP is not projected, then the sentence will be treated as an infinitival sentence, hence tense and agreement are lacking. The underspecification of tense means that it has no semantic role. Therefore, the value of TP (past-present) in the clausal structure does not have an effect on the interpretation of the sentence. Wexler (1994) points out that this does not mean that children have no understanding of time, *'the child may not know tense, but that says nothing about the understanding of time. Tense is a formal syntactic notion; time is not'* (Wexler, 1994 p:338).

Figure 3. The IP can be split into an Agreement node (AgrP) and Tense node (TP).



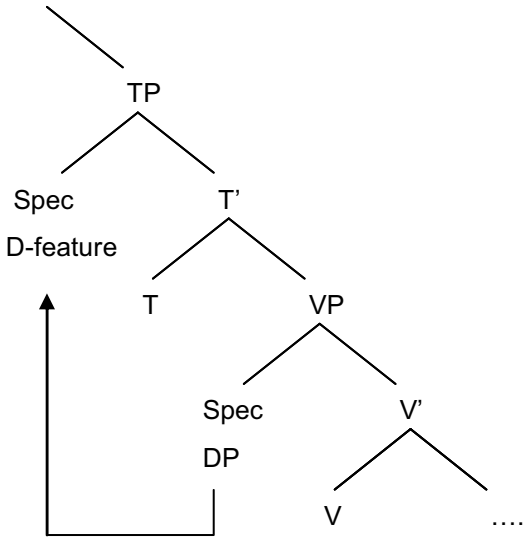
The OI account proposed by Rizzi (1993) converges with Wexler's account (1993) in that children allow tenseless clausal representations. In adult grammar, the clausal structure is always generated from the CP, as in Figure 2. According to Rizzi (1993), children can select any point of departure to generate a clausal structure. If the selected starting point is lower than the TP (see Figure 3) then an RI will occur. RIs are the result of truncated structures (see also Haegeman, 1995).

Schütze & Wexler (1996) argue that tense *and* agreement can be independently underspecified in a child's RIs, an argument which is called the

Agreement and Tense Omission Model (ATOM). Data of English children shows that between 4 and 30% of the past tense forms co-occur with default case marking (accusative in English) (e.g. her said no), which indicates that this is a grammatical option for children. Under the assumption that AgrP assigns/checks nominative case, these constructions are only possible when AgrP is underspecified. This explains the occurrence of RIs with nominative or accusative case assigned to the subject, such as *he cry* [-tense, +agreement] and *him cry/him cried* [+tense, -agreement].

The underspecification of either tense or agreement results from the Unique Checking Constraint (UCC), which operates at the OI stage (Wexler, 1998). The rationale behind this constraint is that both TP and AgrP have a D-feature, which must be eliminated by checking against the D-feature of a DP (i.e. subject) that rises up for checking. The UCC states that '*the D-feature of DP can only check against one functional category'* (Wexler, 1998 p:59). If the D-feature on TP attracts the subject DP, then the D-feature on tense will be checked off. The D-feature of AgrP can no longer be checked, as the UCC restricts the checking of D-features twice. This is illustrated in Figure 4.

Figure 4. The illustration of the Unique Checking Constraint as proposed by Wexler (1998). The subject is attracted by the TP to check off the D-feature. The constraint prohibits the checking off of the D-feature at AgrP, hence agreement is lacking.



According to Hoekstra & Hyams (1998), RIs result from the underspecification of number. In their view, finite clauses are grammatically anchored by a tense chain. This chain contains a Tense Operator (in C), a TP and the temporal location of the eventuality provided by the lexical verb (in VP). How the tense chain becomes visible depends on the morphological extensions a language uses. Finiteness can be expressed by a tense morpheme (e.g. Japanese), person morphology (e.g. Italian) or number morphology (e.g. Dutch). In languages where finiteness is only marked by number morphology, the underspecification of number leads to RIs. In an invisible tense chain, tense receives the status of a free pronoun that can be interpreted discursively.

The OI account put forward by Hoekstra & Hyams (1998) implies that not all languages allow for RIs and this seems to correspond with the child data. For instance, data on Italian children shows that between 0 and 16% of the analyzed utterances are RIs, whereas data on Dutch children shows that between 26 and 36% of the utterances are RIs (respectively Guasti 1994 and Weverink 1989 as reported by Hoekstra & Hyams, 1998). The difference can be explained by the expression of finiteness through person morphology in Italian and not number morphology.

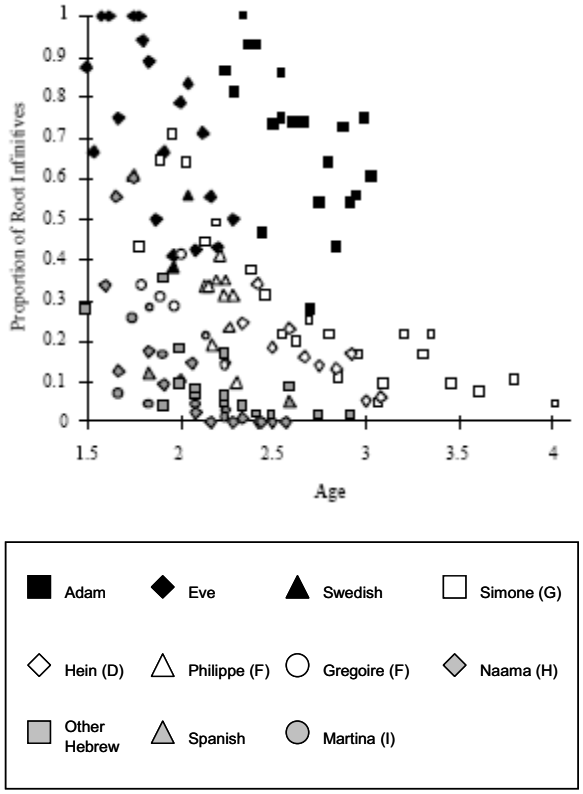
The mixed competence- performance model

Phillips (1995) shows that there is a correlation between the richness of the inflectional paradigm and the occurrence and time period in which children use RIs. His correlation graph is presented in Figure 5. This graph shows that children acquiring a highly inflected language produce small proportions of RIs (at the bottom of the graph) and children acquiring a poorly inflected language produce higher proportions of RIs.

Phillips (1995, 1996) argues that RIs arise as children have difficulties in connecting the verb with inflection syntactically. The assessment of the inflectional paradigms is an overlearned process for adults. In contrast, this is not an automatic process for children. RIs occur when the costs of accessing a morphological form are greater than failing to realize it. A rich inflectional paradigm facilitates the rapid automatization of inflectional access.

As the child's process of accessing morphological knowledge moves from controlled to automatized, the number of RIs will decrease gradually. This is in accordance with child production data. The RIs are not given up once finiteness is acquired, rather a gradual transition takes place from the OI stage towards finiteness only (Behrens, 1993).

Figure 5. The proportion of RIs across languages (Phillips, 1995, reprinted with permission from the author).



The null auxiliary/modal hypothesis

Boser, Lust, Santelmann & Whitman (1992) observe that RIs are not the only non-finite forms that occur in the OI stage, but also participial forms occur. This is also observed by Behrens (1993). Moreover, Behrens found that the transition from infinite to finite only holds for main verbs, the other categories (modals, auxiliaries, copulas) appear as finite right away. Boser et al. (1992) argue that the RIs and participles are selected by a non-overt tensed auxiliary. The CP is occupied by a phonetically null auxiliary moved from its position in IP. This is called the Null Auxiliary Hypothesis.

In the same vein as Boser et al. (1992), Ferdinand argues that RIs have a modal or aspectual meaning as they are preceded by a null-element (auxiliary or modal). In a study of four French-speaking children, Ferdinand (1996) shows

that RIs were exclusively eventive and finite verbs were stative. The modal only selects eventive verbs.

The distinction between eventive and stative verbs follows the classification of Vendler, as outlined by Shirai & Anderson (1995). Four classes of verbs are distinguished according to their inherent temporal features. The temporal features are telicity (having an inherent endpoint), punctuality (having no duration), and dynamicity (energy is required). The verb classes are achievements [+telic], [+punctual] and [+dynamic], accomplishments [+telic], [+dynamic], activities [+dynamic] and states, which has none of the temporal features. Eventive verbs denote eventualities with the temporal properties of [+dynamic]. Static verbs are atelic and without duration, i.e. static verbs do not relate to a specific point in time.

The distinction between eventive RIs and stative finite verbs has also been found for Germanic languages, however less stringent as compared to the data of the French-speaking children (Jordens, 1990; Ingram & Thompson 1996; Blom, 2003). For Germanic languages it has been observed that the eventive RIs receive a modal interpretation, which needs to be inferred from the discourse (see examples, taken from Hoekstra & Hyams 1998).

(5) a. Eerst kaartje kopen!
First ticket buy-INF
'*We must first buy a ticket"*

b. Niekje buiten spelen
Niekje outside play-INF
'Niek (=speaker) wants to play outside'

The modal interpretation of RIs has also been interpreted in terms of the presence of deontic modality and the absence of epistemic modality in young children. I will return to this in subsection 4.1 of this chapter.

2.3 An input bias?

A usage-based view on language development argues that the predominance of early infinitival forms is related to children's patterns of language input and speech processing mechanisms. It has been argued that children's language learning is strongly biased to lexical elements that occur in sentence-final position (Slobin, 1973). As such, the RIs of young children mirror the infinitival part of the frequently used composed verbal predicates (i.e. finite auxiliary or modal + lexical infinitive) in child-directed speech. Due to the sentence-final processing constraint, lexical infinitives in sentence-final position are picked up, but finite verbs are not. For example, the English utterance *Can he go* results in

the RI *he go*, or for Dutch, *wil hij spelen* (Wants he play-INF) results in the RI *hij spelen* (Freudenthal, Pine, Aguado-Orea & Gobet, 2007).

Wijnen, Kempen & Gillis (2001) have shown that the sentence-final infinitives are more informative than finite verbs in child-directed speech. They observed that the type-token ratio (a measure for lexical diversity) was considerably higher for infinitives than for the finite verbs. This means that to determine if there is a difference in meaning between two arbitrarily selected sentences, sentence-final infinitives are most informative. Therefore, Wijnen et al. (2001) argue that RIs reflect the combined effect of the sentence-final processing bias of young children and the high information load of the lexical infinitives in composed verbal predicates.

In Freudenthal et al. (2007) and Freudenthal, Pine & Gobet (2009), RIs are simulated with the MOSAIC computer model, which is based on the sentence-final processing bias in learning. This processing bias leads to the production of partial sentences that were present as sentence-final phrases in the input. With respect to RIs, this means that the sentence-final part of composed verbal predicates is reproduced. Gradually the model produces longer sentence-final phrases as a function of the input. Modals and auxiliaries appear, which replace the RIs with composed verbal predicates.

Interestingly, MOSAIC is able to mimic the cross-linguistic differences in the use of RIs because of the different distributional characteristics of the input. For instance, RIs occur frequently in the speech of Dutch children but not in the speech of Spanish children. The input of both languages contain equal percentages of utterances with composed verbal predicates. However, as Spanish is an SVO language, the complement occurs in sentence-final position rather than the infinitive. This contrasts with Dutch, which is an SOV language. In Dutch, the complement precedes the infinitive and thus the infinitive always appears in sentence-final position. The low rate of RIs when the model is exposed to Spanish language input is a direct consequence of the model that processes the input from the right edge of the utterance (Freudenthal et al., 2007).

3. The acquisition of tense

3.1 Temporal reference of RIs

Cross-linguistic data shows that for some languages the temporal reference of RIs correlates with telicity (lexical aspect) and perfectivity (grammatical aspect). English bare verbs (English analogue for RI) denote present or past events. Past reference appears most often with telic verbs and present reference with atelic verbs. See examples, taken from Hyams (2007).

(6) a. Child: He fall-INF down.
Mother: He did?
past reference

b. Mother: What's she doing with the tiger now?
Child: Play # play-INF ball with him
present reference

In (6a), the mother interprets the telic RI as denoting a past event. In (6b), the child responds with atelic RI denoting an ongoing event.

In Russian and Polish, past reference is predominantly perfective (completed) and present reference is imperfective (ongoing). Consider the following examples from Russian as mentioned by Hyams (2007), from Brun (1999).

(7) a. Mama maslo kupit'
Mommy butter-buy-INF
'Mommy has bought the butter'
past reference

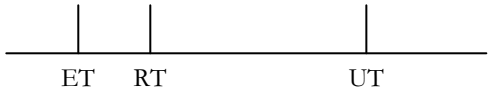
b. Kupat'sya
bath-INF
(He) is bathing.'
present reference

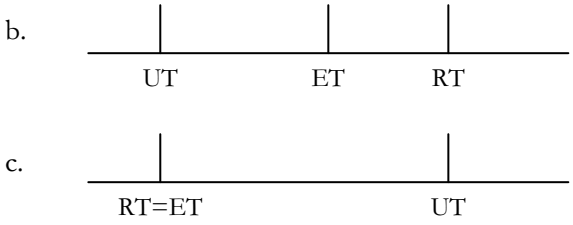
Tense relates the event denoted in the utterance (ET) to the time at which the utterance was uttered (UT), or to the reference time (RT). The RT is the time point or time interval which is mentioned in the preceding context (Klein, 1994). Consider the following sentences.

(8) a. [When Mary came to the party RT], [John had left ET]
b. [Tomorrow at four o'clock RT], [John will have left ET]
c. [Last year RT], [John left Surbiton ET]

In (8a), the ET 'John's leaving', occurred before the RT, which are both before UT. This is schematized in (9a). In (8b), the ET occurs before RT, which both occur after UT (9b). In the last example, (8c), ET and RT overlap and are prior to UT.

(9) a.





The relation between ET and RT becomes different when we compare (8b) with (10).

(10) [Tomorrow at four o'clock $_{RT}$], [John will be leaving $_{ET}$]

In (10), the ET coincides with RT because of the use of the progressive form (*–ing)*. In (8b), the event is seen as completed (=perfective), and in (10) as ongoing (=imperfective). The perspective a speaker takes with regard to the temporal course of some event is called grammatical aspect (Klein, 1994).

With respect to RIs, Hyams (2007) argues that the temporal reference of RIs is assigned according to the topological property of the event closure. This is called the Closed Event Hypothesis. The event can either be closed by telicity, where the end state or result (telos) is linked to the UT. Another event closure mechanism is perfectivity. Perfective verbs are linked to UT by the insertion of a null modal. How these options are manifested in child language depends on the aspectual system of the language.

For Germanic languages, no temporal reference exists for RIs, i.e. lexical or grammatical aspect does not determine past, present or future reference for RIs (Dutch, Wijnen, 1998; German, Behrens, 1993). According to Hyams, (2007) this is due to the lack of perfectivity of Dutch verbs. Therefore, the past reference for Germanic RIs is excluded, and the insertion of a null modal becomes a free option.

3.2 The aspect – tense interface

It is hypothesized that verbal morphology initially marks aspect rather than tense. This is called the Aspect First Hypothesis (Wagner, 2001). According to the strong version of this hypothesis, a child's early production of past tense/perfective is *restricted* to closed events [+telic] (*achievement* and *accomplishment*) and the imperfective (e.g. progressive in English) to open events [-telic] (*activity*).

The cross-linguistic data seems to be in accordance with a relative rather than an absolute version of the Aspect First Hypothesis, i.e. past tense is *predominantly* used with closed events[3]. The production data of three English children, aged between 1;6 and 2;4, showed that the production of past tense morphology was initially restricted to achievement verbs [+telic] and extended later to other verb types. The progressive */-ing/* was predominantly used for activity verbs and achievement verbs denoting action in progress (Shirai & Anderson, 1995; see also Johnson & Fey, 2006).

The correlation between telicity and past tense marking was also found for Polish children. Telic verbs emerge in the past perfective at the age of 2;2, whereas atelic verbs in past perfective emerge at 3. The correlation between progressive (imperfective) and atelic predicates was much less prominent for English speaking children. Progressive aspect with atelic verbs emerged at the age of 3 and with telic predicates at 3;1 (Weist, Pawlak & Carapalla, 2004).

German children also start to use past participles and/or perfect predominantly with telic verbs. Past tense marking on atelic verbs becomes more frequent in the course of development (Behrens, 1993).

A prototype theory is also proposed to account for the interaction between telicity and grammatical aspect/past tense (Shirai & Anderson 1995, Anderson & Shirai 1996). In prototype theory, categories are formed with good members (or prototypes) and marginal members. Some lexical aspects correspond better with the prototypical meaning of verb morphemes than others. For instance, they argue that the lexical aspects of [+telic], [+punctual] and [+result] correspond with the prototypical meaning of the past tense morpheme. The expansion of the past tense morpheme to other lexical aspects follows a hierarchy. This is also demonstrated for progressive aspect.

> deictic past (achievement → accomplishment → activity → state → habitual or iteratative past) → counterfactual or pragmatic softener
>
> (Anderson & Shirai, 1996 p:557)
>
> process (activity → accomplishment) → iterative → habitual or futurate→ stative progressive
>
> (Anderson & Shirai, 1996 p:558)

According to Shirai & Anderson (1995), the hierarchy in past tense and progressive can be attributed to maternal input. Distributional analysis of maternal speech showed that between 55 and 66% of the past tense inflections occurred on achievement verbs and between 61 and 65% of progressive inflection on activity verbs.

[3] For an overview of the crosslinguistic evidence see Anderson & Shirai, 1996.

3.3 Regular and irregular past tense

The literature on past tense acquisition has been dominated by the debate on how children learn the productive process of regular past tense. The debate is centered around two models of past tense acquisition, which diverge on the role they attribute to the frequency of past tense forms occurring in the speech input to acquire the regular and irregular past tense and the contribution of memory in this process. In the following subsections we will give an overview of the essential characteristics of the dual-route and single-route models. It is our aim to highlight the most relevant aspects of the acquisition of regular and irregular past tense.

3.3.1 The dual-route model

The dual-route model is embedded in a theory that postulates an innate capacity for language learning. The child is assumed to be equipped with the overall structure of the grammar and its universal rules. The universal rules contain parameters whose values differ from one language to another. Parameter setting is influenced by the input, although in limited ways: to avoid large amounts of computation, the child does not use all sentences heard to build up grammar, but rather sets up hypotheses based on a limited set of utterances (Pinker, 1984).

According to Pinker (1998), the basic design of human language is comprised of a memory mechanism (e.g. the lexicon) and a symbolic computational mechanism (e.g. syntax). These two psychological mechanisms treat past tense formation differently, resulting in irregular and regular past tense. The irregular past tense forms are stored in memory. This memory mechanism is partly associative, thereby explaining the family resemblance categories within the class of irregular verbs (e.g. keep-kept, sleep-slept and feel-felt) and the occasional generalization of irregular patterns to new verbs by adults. The regular past tense form is generated by a standard symbol-concatenation rule, such as → add *–ed* to the verb. This suffixation rule can apply to any instance of the symbol 'verb' without access to the contents of memory. Therefore, the symbolic computational mechanisms afford unlimited productivity (Prasada & Pinker, 1993). The interplay between both psychological mechanisms in past tense inflection is formulated in the blocking principle, which states that if a verb can provide its own past tense form from memory, the regular rule is blocked (Pinker, 1998 p:6). The mechanisms encompassing memory (or the lexicon) and the rule for past tense inflection has been called the dual-route model.

3.3.2 The single-route model

The connectionist view challenges the need for symbolic rules underlying language. Rumelhart & McClelland (1986) argue that the psychological mechanism underlying language is *characterizable by rules, but that the rules themselves are not written in explicit form anywhere in the mechanism* (p:2). The basic tenet of their alternative past tense model is that regular and irregular past tense arises from one single mechanism, hence is referred to as the single-route model.

This model is based on a usage-based view of language learning. This view assumes that syntax and grammar are created out of concrete utterances, rejecting the hypothesis of language being innate. The learning of grammar involves processes of functional reanalysis of the language input and analogy by using general cognitive abilities. Straightforwardly, frequency of occurrence in the input plays an important role in language acquisition (Tomasello, 2003).

The single-route model of Rumelhart & McClelland (1986) is based on computer simulations of language development. Their simulation consists of a simple pattern-associater network, which learns the relationship between the base form (i.e. phonological form of the stem) and the past tense form, and a decoding network that converts featural representation of the past tense form into a phonological representation. The pattern associater connects each input unit to each output unit by a simple neuron-like activation process. The connections are strengthened through the process of learning. The input units represent each phoneme, together with its predecessor and its successor, from the word form (e.g. _he, hel, elp and lp_). If the stem ends in an unvoiced sound (like the /p/ in help), the past tense will be formed by adding the unvoiced /t/. Because the pattern-associater will be exposed to regular past tenses, positive connections will be built up between the input unit of unvoiced stem phonemes and the output units by adding the unvoiced suffix. The irregular past tense is formed in exactly the same way as the regular past tense. The input units of these irregulars are connected to units that code for exceptional aspects of inflection. These connections are strengthened by exposure to these irregular forms (Rumelhart & McClelland, 1986; McClelland & Patterson, 2002).

4. Tense and cognitive maturation

4.1 Deontic and epistemic modality in RIs

In subsection 2.2.1, it was mentioned that Germanic RIs receive a modal interpretation. Modal verbs are ambiguous between epistemic and deontic readings. Epistemic modality refers to the knowledge of possibility or necessity and deontic modality to the necessity, desire and permission of the speaker. The choice between the modalities is triggered by the complements with which

the modal verb combines. According to Hoekstra & Hyams (1998), a stative verb + modal triggers an epistemic reading (see 11a) and an eventive verb + modal a deontic reading (see 11b). Consider the following examples in (11) of the modal *must* combined with two different complements:

(11) a. John must know the answer → *must* + stative 'know'
b. John must read this book → *must* + eventive 'read'

Hoekstra & Hyams (1998) argue that the restricted use of eventive verbs in RIs is the consequence of the fact that children in the OI stage only have deontic modality at their disposal. In a longitudinal analysis of a French child, Bassano (1996) observed that deontic modality was already expressed before the age of 2. The first epistemic utterances, however, occurred in the second half of the third year. Papafragou (1998) reports that after the age of 4, epistemic utterances become more frequent and appear in a larger number of modal items. Around the age of 5, children begin to grasp the distinctions between epistemic modality and unmodalized declaratives.

Blom (2003) attributes the absence of epistemic modality in children in the OI stage to cognitive immaturity, more specifically, lack of ToM. ToM refers to the ability to attribute mental states, such as beliefs, whishes and intentions to both oneself and others. Blom argues that as epistemic modality is concerned with knowledge of belief, children will not use this modality before they have a ToM. Papafragou (1998) and Blom (2003) show in their overview of the literature on both topics that there is a strong correlation between the use of epistemic modality and the emergence of a representational model of the mind.

4.2 Theory of Mind and complementation

It is demonstrated that ToM and language are closely related. Propositional attitudes such as beliefs, whishes and intentions are often expressed by means of verbs related to mental state that take complements. Complementation is unique in that it allows us to express truth and falsity in someone else's mind as being different from our own. For example, we know that the embedded statement in (12) is false (the world being flat). However, as the false statement is embedded in a true matrix clause, the whole statement is true, i.e. the belief that the world is flat is attributed to John's mind.

(12) John thinks that the world is flat

The production of mental states and their complements emerge at the age of 3 and 4, which roughly coincides with children's successful performance of False Belief (henceforth FB) tasks which test the ability to attribute FB to another individual (De Villiers & Pyers, 2002). An example of such an FB task is to

show a child a familiar candy container, which unexpectedly contains pencils instead of the familiar candy. Another puppet is brought into the room and the child is asked what the puppet will think is in the box. Three-year-olds are prone to say that pencils are in the box, therefore failing to attribute FB to the other person.

De Villiers and Pyers (2002) hypothesize that the emergence of FB understanding rests on a child's mastery of the grammar of complementation. They tested 28 children aged between 3 and 5 years for four consecutive years on several FB tasks and language mastery. Language mastery was tested with the IPsyn, the index for the range and complexity of the grammatical forms used by the child, which includes a measure for complements. Memory for complements was tested with a picture task accompanied by a story which included a falsely embedded proposition, e.g. *he thought he found his ring (first picture), but it was really a bottle cap. (second picture). What did he think?* It has been shown that such questions are difficult for young children to answer.

Results showed that the language measures pertaining to complementation predicted the FB performance of children in the next round. The prediction was not reciprocal, i.e. the FB performance did not predict complementation measures in the next round. De Villiers and Pyers (2002) conclude that a child who fails to retain the appropriate syntactic representation for a complement construction will not have it available as a form of mediating representation for FB understanding.

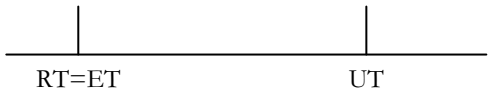
4.3 Sequence of Tense and Theory of Mind

Hollebrandse (1998) has shown that the acquisition of complementation is also a prerequisite for the understanding of sequence of tense, just as it is for ToM. Sequence of tense means that the tense form in the complement must equal the tense form in the matrix clause, i.e. when the verb in the matrix clause is in the past or past perfect, the verb in the complement *must* be in the past or past perfect. This restricts the temporal interpretation of complements. Consider the following sentence:

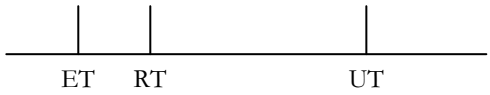
(13) [Koekiemonster zei $_{RT}$] [dat hij een rood bordje had $_{ET}$]
Cookie Monster said that he a red plate had
'*Cookie Monster said that he had a red plate'*

The sentence in (13) has two temporal readings, both RT and ET are simultaneous, (14a) or the ET occurs before RT, (14b).

(14) a.

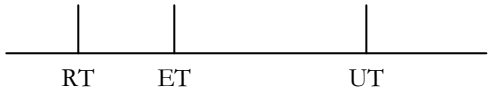


b.



The dependency between the tenses in complements prohibits the occurrence of the ET just before the UT (see 15), i.e. Cookie Monster has a red plate just before uttering the sentence (such a reading is possible in a relative clause cf. *Cookie Monster saw a men who had a red plate*).

(15)



The hypothesis of Hollebrandse is that children who fail to understand complementation allow the interpretation of (14a), (14b) *and* (15), whereas children who understand complementation only allow (14a) and (14b). Hollebrandse assumes that a child's understanding of complementation reflects the pass on FB tasks.

In his experiment, he tested 62 Dutch children in the age range 2;7 to 7;2. The FB task resembled the task described in subsection 4.2. To test the Sequence of Tense, a truth value judgment task was given. See the example:

(16) B: Zal ik eens kijken of ik een banaan voor je kan vinden, Koekiemonster?
(*Let me have a look whether I can find a banana for you, CM?)*
CM: Ja Bert, ik wil een banaan op mijn bordje hebben.
(*Yes Bert, I will have a banana on my plate*)
Action: B puts the banana on CM's plate

Exp: Zei Koekiemonster dat hij een banaan op zijn bordje had?
(*Did Cookie Monster say that he had a banana on his plate?)*

If a child fails to understand Sequence of Tense, he/she will answer yes.

Results showed that an adult-like interpretation of Sequence of Tense correlates with the point at which they start to understand ToM. Hollebrandse argues that children who lack complementation also lack RT, i.e. they take their temporal point of reference at UT. The acquisition of RT rests on a child's awareness that different references can be made to the same element depending on the point of view. Therefore the child needs to know the difference between direct speech (17a) and indirect speech (17b), which both refer to the same thing.

(17) a. Cookie Monster: 'I am at the store'
(view of Cookie Monster)
b. Cookie Monster said that he went to the store
(speaker's view)

This is in the same vein as Weist, Wysocka and Lyytinen (1991), who argue that the transition from an absolute tense system (ET linked to UT) to a relative tense system (ET is linked to RT) is explained by a conceptual development based on the general process of decentration, which occurs at the age of 4;6. They showed that children aged between 2;6 and 3;6 fail to comprehend sentences including a RT, which are solved by children aged 5;6 and 6;6.

5. Summary

In early language development, children go through a stage in which they use infinite (Root Infinitives) and finite verbs. This is called the Optional Infinitive (OI) stage. The OI stage cannot be attributed to a lack of knowledge of the verbal paradigm, as subject-verb agreement errors in this stage are rare. Rather, this stage has been attributed to a 'deficit' in the child's syntax. According to some, this deficit implies that children lack functional projections. Others argue that the full syntactic structure is in place, but functional projections are optionally presented, truncated or not overtly expressed. It has also been argued that RIs occur because young children's language learning is strongly biased to lexical elements that occur in sentence-final position.

In some languages, RIs receive temporal reference from the discourse. Events can be closed via telicity (e.g. English) or perfectivity (e.g. Russian), depending on the aspectual system of the language. Between the ages of 2 and 4, a child's use of past tense morphology is predominantly applied with telic verbs, leading to the hypothesis that children use past tense morphology to mark aspect rather than tense. Much of the literature on past tense acquisition has been directed to the acquisition of regular versus irregular past tense forms. Two models have emerged. In the dual-route model, irregular past tense forms are stored in an associative memory-- the regular past tense forms are generated by a standard symbol-concatenation rule. In the single-route model, irregular and regular past tense forms are stored in an associative memory.

The ability to mark tense is bound to the transition from an absolute tense system to a relative system. The development towards a full understanding of the verbal system interacts with the development of mental representations, such as ToM.