

# Theoretical linguistics with clinical reach: Two case studies in morphological development in children with hearing loss

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## Abstract

This paper examines how theoretical linguistics and clinical research can inform one another through the study of language acquisition in children with hearing loss. It focuses on how perceptual constraints, such as reduced auditory input, shape the development of grammatical systems.

The first case study investigates Dutch-speaking children with cochlear implants and their acquisition of past tense morphology. It compares the single-route model (a frequency-driven learning mechanism) and the dual-route model (a rule-based and memory-based system). Data from spontaneous speech and elicited production show that these children lag behind their hearing peers and display patterns not fully explained by either model. This suggests the need for approaches that integrate perceptual and morphosyntactic factors.

The second case study explores determiner acquisition at the prosody–morphology interface. While typically developing children use prosodic cues to acquire indefinite articles, children with cochlear implants show a reversed pattern, producing definite articles earlier due to limited access to pitch cues.

Together, the findings demonstrate that combining theoretical and clinical perspectives improves our understanding of grammar and supports more effective assessment and intervention strategies.

## 1. Introduction

Language development has long been a testing ground for linguistic theory, offering a window into how abstract grammatical systems take root in the minds of children. From Brown's (1973) pioneering study of morpheme acquisition to more recent cross-linguistic accounts, research on child language has continually challenged adult-based models of grammar. A well-known example is provided by research on subject omission in early child language. Children acquiring non-null subject languages such as English frequently produce sentences without overt subjects (e.g., *want cookie, is raining*). This observation posed a challenge to the Null Subject Parameter in generative grammar and led to refinements of the theory, such as the proposal that early grammars allow root null subjects due to constraints on clause structure (Hyams 1986, Rizzi 1994). Another example comes from work on the acquisition of genitive and dative clitic pronouns in Romanian. Based on child language data, Avram and Coene argue that such clitics emerge relatively late and function as a “last resort” strategy in the developing grammar, suggesting that their use depends on the prior acquisition of the relevant syntactic licensing conditions (Avram and Coene 2002). Analyses of this type have been used to inform theoretical debates about the syntactic status of clitics and the interaction between case, agreement, and functional structure in the clause. At the same time, clinical populations such as children with hearing loss provide valuable opportunities to further refine these models of language acquisition, revealing how perceptual and cognitive constraints shape developmental trajectories.

We focus on children with hearing loss, a population for whom language acquisition is profoundly shaped by auditory limitations. Through two case studies, we examine how theoretical frameworks of morphology and prosody inform the study of this group. The first case study investigates the acquisition of past tense morphology in Dutch-speaking children with cochlear implants (CIs), putting two competing language acquisition models to the test. The second case study explores the interface of prosody and morphology in determiner acquisition, showing how fine-grained theoretical insights yield concrete implications for clinical audiology and educational practice.

Together, the two studies aim to demonstrate the productive dialogue between theoretical linguistics and clinical application – a dialogue that broadens our understanding of language while addressing real world communicative challenges.

To situate these investigations, it is crucial to understand how children with hearing loss experience language acquisition differently from their peers with typical hearing. The following section outlines the

auditory, cognitive, and linguistic constraints that shape their developmental trajectories, providing context for the empirical findings presented in the two case studies.

### *1.1. Introducing children with hearing loss*

Childhood hearing loss affects at least one in every 1000 children in developed nations (Davis, Davis, and Mencher 2009). Thanks to universal newborn hearing screening, diagnosis can occur early, allowing timely intervention. Mild to moderate hearing loss is typically addressed with hearing aids, while children born deaf or with severe loss often receive CIs. These devices transmit sound directly to the auditory nerve through electrical stimulation, bypassing the outer and middle ear. Although CIs restore auditory access, the signal remains qualitatively degraded compared to natural hearing.

Early auditory experience is crucial for language development. Children must first discriminate the speech sounds of their native language, which form building blocks for syllables, words, and phrases. Before CIs, many deaf children could not acquire spoken language at a level sufficient for full participation in an auditory-oral society. With early implantation, however, children often reach language levels comparable to peers with normal hearing (Nicholas and Geers 2007), facilitating social integration and mainstream education (Van der Straaten 2021).

Children with hearing loss acquire language under fundamentally different conditions. Reduced auditory input would intuitively be expected to mainly affect the acquisition of phonology, since limited access to the speech signal constrains children's ability to perceive and reproduce segmental contrasts. However, the consequences of degraded auditory input extend beyond phonology. Restricted access to the acoustic signal also reduces the availability of fine-grained phonetic and prosodic cues that signal grammatical structure, such as weak function words, morphological markers, and prosodic prominence. As a result, reduced auditory input affects all domains of language development, and its impact is often particularly visible in morphosyntax. The linguistic signal is impoverished relative to natural hearing (Coene and Govaerts 2014), limiting opportunities to extract regularities and build robust morphosyntactic representations. Longitudinal studies show that auditory limitations impact not just the rate but also the quality of language development, with effects persisting even after early implantation (Tomblin et al. 2005).

Despite these constraints, children with hearing aids or CIs generally follow a delayed but broadly typical developmental trajectory. Preschoolers acquire early grammatical morphemes and sentence structures in the same order as peers with normal hearing, but later and with lower accuracy (Szagun 2002 2004). Vulnerabilities become more apparent with age: school-aged children and adolescents often struggle with verbal inflection (tense and agreement), function words (articles, auxiliaries), and complex syntactic constructions (Hammer 2010, Hammer and Coene 2016, Huysmans et al. 2017). Fine-grained analyses confirm ongoing morphosyntactic challenges and difficulties processing complex structures such as embedded clauses and syntactic ambiguities (Coene and Govaerts 2014, Nittrouer and Lowenstein 2021; 2023).

Individual outcomes of children with hearing loss vary widely, influenced by factors such as age at diagnosis, timing and consistency of amplification, residual hearing (i.e. remaining auditory functioning, with or without hearing aids or cochlear implants), intervention quality (type and frequency of intervention), and the linguistic environment (the quantity and quality of language input) (Nicholas and Geers 2007, Tomblin et al. 2005). Children implanted before 12 months generally show more favourable morphosyntactic outcomes, highlighting sensitive periods for language acquisition. Vocabulary growth is closely linked to grammatical development: larger vocabularies often support more advanced morphosyntax, whereas early lexical delays can cascade into later grammatical difficulties (Marchman and Bates 1994, Coene et al. 2011).

Importantly, morphosyntactic difficulties in children with hearing loss do not simply reflect a uniform developmental delay but often show systematic patterns of weakness. For instance, children with hearing loss have been shown to produce less complex syntax in spontaneous speech than hearing peers (Werfel et al. 2021), while difficulties are particularly pronounced for low-salience grammatical morphology, such as finite verb inflection (Hammer and Coene 2016). Such findings support the view that morphosyntactic

development in this population is selectively shaped by the perceptual accessibility of grammatical cues in the input, rather than being uniformly delayed across the grammatical system.

In sum, children with hearing loss show systematic morphosyntactic deviations rather than uniform delays, highlighting how auditory limitations shape grammar acquisition. The following case studies on past tense marking and determiners illustrate this interaction. The first study examines past tense morphology, a domain where language acquisition models make contrasting predictions. By analyzing how children with cochlear implants acquire past tense forms, we can test the validity of dual-route versus single-route accounts in a population subject to atypical auditory input.

## 2. Case study I – Putting language acquisition models to the test: Past tense acquisition

### 2.1. Introduction

Our first case study examines the development of past tense in children with hearing loss. The results are an adapted version of Chapter 6 of the first author's doctoral dissertation (Hammer 2010). The production of past tense is a well studied phenomenon in (typical) language development. Particularly errors such as 'comed', 'falled' and 'maked', observed in the Brown corpus (1973), have attracted the attention of researchers. These innovative past tense forms do not occur in the linguistic input, but rather reflect children's own creative processes. Their emergence suggests that children have identified a morphological rule or regularity, which they then overextend to irregular verbs. Such forms are therefore classified as overgeneralizations.

These so-called overgeneralizations, instances in which irregular past tense forms are regularized, offer important insights into the mechanisms underlying the acquisition of past tense morphology. On a theoretical level, two accounts have been advanced to explain the emergence of such errors. The first, the dual-route model (Pinker 1999), posits that overgeneralizations arise once children acquire the rule-based mechanism responsible for past tense marking. According to this model, the onset of overgeneralizations coincides with the mastery of the rule for past tense formation (Marcus et al. 1992). The dual route model assumes two distinct mental pathways for past tense formation: a rule-based route, in which regular forms are generated through morphological concatenation (verb stem + *-ed*), and a memory-based route, in which irregular forms are stored and retrieved as whole lexical items. The second pathway is a memory-based route, where irregulars are stored as whole items in memory (Pinker 1999). By contrast, the single-route model contends that regular and irregular past tenses are processed within the same associative network. As the child's lexicon expands, the increasing dominance of regular verbs reshapes the network's connection strengths. This shift produces temporary overgeneralizations, as the network extends the newly reinforced regular pattern to irregular verbs already presented in memory (Rumelhart and McClelland 1986).

The models diverge in their assumptions regarding the role of input in the acquisition of regular and irregular past tense forms. The single-route model proposes that children acquire the regular past tense pattern due to the predominance of regular verbs in the linguistic input relative to irregulars. Supporting this view, Rumelhart and McClelland (1986) demonstrated with their connectionist model that increased exposure to regular verbs led to overgeneralization of irregular forms. However, the increased exposure of regulars does not correspond well to the child's linguistic environment. Analyses of the Brown corpus by Marcus et al. (1992) revealed no significant change in the proportion of regular verbs in the input before and after the onset over overgeneralizations. This raises the question of whether and to what extent linguistic input serves as a primary trigger in children's acquisition of past tense morphology? To answer this question, children with hearing loss provide a valuable test case, as they have reduced access to the speech around them.

The present study aims to examine the acquisition of past tense morphology in Dutch-speaking children with cochlear implants. In Dutch, the regular past tense morphemes are /-de/ and /-te/. The distributions of these morphemes are phonologically conditioned. The former morpheme attaches to a stem ending in a voiced consonant (e.g., *spelen* – *speelde* (sg), *speelden* (pl) 'to play'), the latter to an unvoiced

consonant (e.g., *werken* – *werkte* (sg), *werkten* (pl) ‘to work’). The irregulars involve a vowel change (e.g., *komen* – *kwam* (sg), *kwamen* (pl) ‘to come’) (Booij and Van Santen 1998).

## 2.2. Past tense production in spontaneous speech

Our first analysis examined the spontaneous speech of 30 children with CI, aged between five and seven years, in order to gain preliminary insights into their use of past tense morphology. Previous research has shown that children acquiring Dutch tend to prefer past participles when referring to past events (e.g. *Gisteren heb ik een taart gebakken* ‘Yesterday I have baked a cake’ vs. *Gisteren bakte ik een taart* ‘Yesterday I baked a cake’) (see De Houwer 1997), a pattern that is also observed in the speech of Dutch adults. Moreover, children pass through a developmental phase in which they refer to past events using present tense forms (Kuczaj 1977).

The data for this study were drawn from a corpus of spontaneous language samples specifically compiled to investigate the grammatical development of children with CI (see Coene 2005–2010). Each child was recorded for a period of 15 to 30 minutes. During these recordings, children were encouraged to talk about daily activities and events outside the here and now. All recordings were made in a quiet room at the audiology centre or at the schools the children attended. The resulting samples were transcribed following the CHAT conventions (MacWhinney 2000). From each transcript, the first 50 utterances were extracted for analysis. Pure repetitions (echoes of adult speech), unintelligible utterances, idioms (e.g. *weet ik niet* ‘I don’t know’), and elliptical answers were excluded. Within this subset, all instances of grammatically encoded past tense forms were identified and examined.

Results revealed that the overall number of past tense productions among children with CI was found to be very low. The median number of past tense tokens in a sample of 50 utterances amounted to 2, 3, and 1 for the five-, six-, and seven-year-olds, respectively. Notably, all the past tense productions involved irregular forms. The most frequently produced forms were the auxiliaries *zijn* ‘to be’ and *hebben* ‘to have’, alongside more than ten tokens of *gaan* ‘to go’ and *moeten* ‘must’. These verb forms are among the most frequent items in the input. Furthermore, a significant positive correlation was observed between past tense tokens in the speech of children with CI and that of adults (Pearson  $r = .534$ ,  $p = .018$ ).

However, our analysis also revealed that children with CI exhibit preferences for particular verbs and constructions in reference to past events that cannot be accounted for solely by input frequency. For example, the past tense productions of *gaan* ‘to go’ and *moeten* ‘must’ do not occur relatively more often in the language input than other past tense types such as *zullen* ‘shall’ and *vinden* ‘to find’. Interestingly, the past tense of *gaan* ‘to go’ occurred most often in the construction of *gingen* ‘went’ + infinitive, as is shown in the following example.

- (1) En toen ging de kapitein zijn hoed aan Berend geven.  
*and then went the captain his hat to Berend give*  
 ‘And then the captain gave his hat to Berend.’

This construction is not highly frequent in adult speech and may, in fact, reflect a delay in past tense formation. De Jong (1999) demonstrated that children with developmental language disorder (DLD) also produce this construction more often than their typically developing peers. He proposed that the use of ‘*gaan*’ (to go) in such contexts functions as an alternative strategy for marking tense; the auxiliary carries the tense maker while contributing minimal semantic content to the main predicate.

Overall, the findings of this study suggest that children with CI exhibit delayed development of past tense morphology. Their spontaneous speech contained neither regular past tense forms nor overgeneralizations, and the production of irregular forms was largely restricted to high-frequency verbs with minimal semantic content. It should be noted, however, that the conversational context may have constrained opportunities for the use of past tense forms. To address this limitation, we subsequently designed an elicitation task.



Figure 1: Screenshot from the Bob & Boris movie to elicit the past tense forms.

### 2.3. Past tense elicitation

In this study, we examined children within the same age range as in our first study (5–7 years). This age group was chosen for two reasons: first, children need sufficient cognitive and linguistic maturity to perform an elicited production task reliably; second, in Germanic languages, the production of past tense morphology around this age is a well-established clinical marker of language delay (Krok and Leonard 2015). We included a control group of children with normal hearing and typical language development (N=71), matched in age to the 14 children with CI who participated in this study (5-year-olds N=14, 6-year-olds N=8, 7-year-olds N=9). To assess past tense knowledge, we designed an elicitation task modelled on Berko's (1958) well known Wug experiment. In this task, children were prompted to produce the past tense of a nonce verb. The experimenter would say '*This is a man who knows how to spow. He is spowing. He did the same thing yesterday. What did he do yesterday? Yesterday he...*'. Berko showed that English-speaking children as young as four years old already exhibit knowledge of regular past tense formation.

In our elicitation task, we produced a short movie in which two characters, Bob and Boris, are building a sandcastle, see figure 1. The task included six regular and six irregular verbs, equally divided into items for which past tense forms are relatively high- versus low-frequent in adult speech. Additionally, four nonce verbs were created by altering the onset of the first syllable while preserving the rhyme (e.g. [b]otsen – [w]otsen). Our analysis focused on two primary questions: 1) the ability of children with CI to produce regular past tense forms and to inflect novel verb forms and 2) the extent to which they overgeneralize regular past tense formation to irregulars.

All responses were classified as either target-like or non-target-like. Target-like responses corresponded to the adult past tense forms. In the pie charts below, the proportion of target-like responses is indicated by the dark grey shading. For nonce verbs, responses of adult informers were obtained in a pilot study. The non-target-like responses were further analyzed according to a set of pre-defined categories, which varied slightly depending on the type of verb (i.e. regular, irregular or nonce). A description of the categories is provided in the figures.

Analysis of the responses to *regular verbs* (see figure 2) reveals that children with normal hearing and typical language development demonstrate a steady increase in the production of target-like regular past tense forms, which largely replaces the use of present tense forms. In contrast, children with CI exhibit a substantially different pattern, predominantly producing present tense form or null responses, with minimal evidence of target-like regular past tense production.

Two response categories are particularly noteworthy for *irregular verbs*: target-like responses and overgeneralizations, the latter represented by the wave pattern in the pie charts in figure 3. Interestingly,

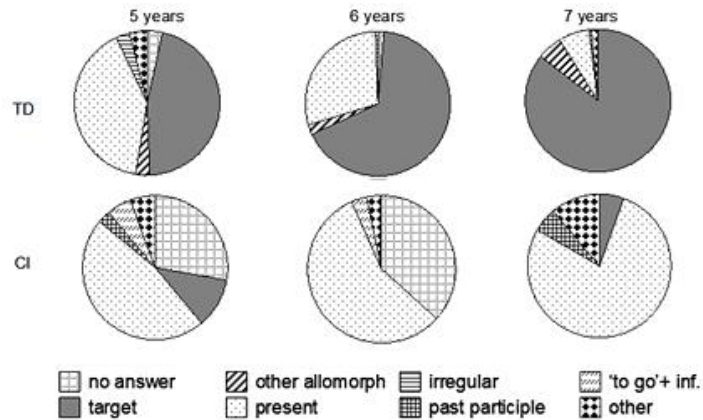


Figure 2: Proportion of target-like responses and non-target-like responses from the total number of regular verbs (i.e. 6).

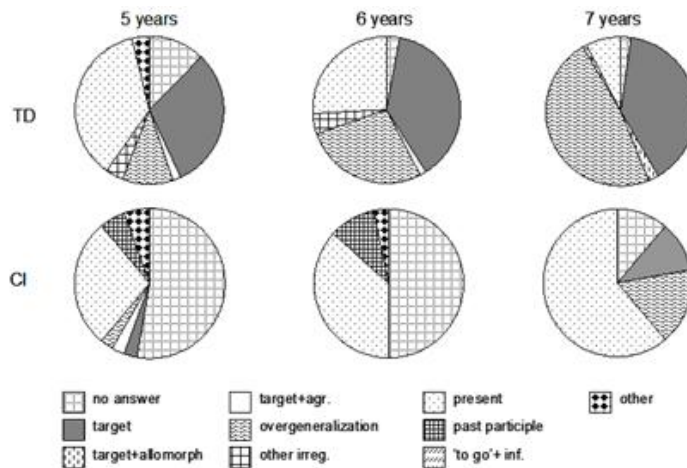


Figure 3: Proportion of target-like responses and non-target-like responses from the total number of irregular verbs (i.e. 6).

children in the control group show both an increase in target-like irregular forms and a simultaneous rise in overgeneralizations. Interestingly, children in the control group show an increase in both target-like irregular forms and overgeneralizations, consistent with the early phase of the U-shaped developmental trajectory described in previous research (e.g. Cazden 1968, Marcus et al. 1992). In contrast, an early phase of a U-shaped trajectory is not observed in the data of children with CI. Similar to the pattern observed for regular past tense, they predominantly produce null responses or present tense forms. Nevertheless, by age seven, some overgeneralizations emerge at a rate roughly equivalent to target-like past tense forms, suggesting the initial stages of mastery of the regular past tense rule.

So far, our results indicate that children in the control group are in the process of acquiring past tense morphology between the ages of five and seven. Children with CI on the other hand appear to initiate this process only around age seven, and even at this age, their production of target-like past tense forms remains lower than that of five-year-old children with normal hearing. *Nonce verbs* provide a particularly informative test of past tense acquisition, as these items cannot be retrieved as unanalyzed lexical wholes;

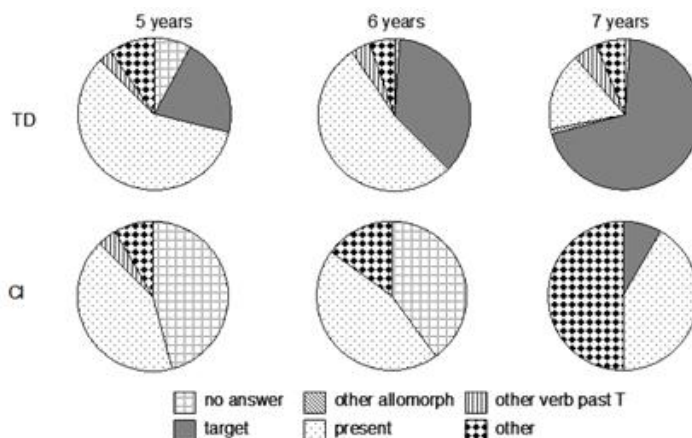


Figure 4: Proportion of target-like responses and non-target-like responses from the total number of nonce verbs (i.e. 4).

successful inflection requires application of morphological rules or analogical reasoning. Results for the nonce verbs are presented in figure 4.

For the control group, there is an increase in target-like responses accompanied by a corresponding decrease in present tense forms, mirroring the pattern observed with existing regular verbs and confirming that normal hearing children are beginning to acquire past tense morphology. This pattern is not evident in children with CI. As with familiar verbs, they predominantly produce null responses or present tense forms. However, by age seven, some target-like responses begin to emerge. At this stage, null responses largely disappear, and children instead produce alternative stems without past tense suffixes (categorized as ‘other’; e.g. *grammen* as a past tense of the nonce verb *grallen*). This may reflect the impact of their hearing loss, which could render them uncertain about their perception of unfamiliar verbs.

Did frequency of occurrence influence the production of past tense forms? For children in the control group, no effect of frequency was observed for regular past tense forms. That is, children with normal hearing were not more accurate in producing high-frequency regular forms compared to low-frequency ones. However, for irregular verbs, target-like responses were significantly higher for high-frequency items relative to low-frequency items at ages five and six. By age seven, this frequency effect was no longer evident. Among children with CI, no significant effects of frequency were observed, probably caused by the low number of target-like responses in the elicitation task.

#### 2.4. Implications for theory and practice

The results of this study indicate that children from a clinical population may exhibit patterns of past tense acquisition that deviate from predictions derived from models of language development based on data from typically developing children. In the elicitation task, children with normal hearing produced results consistent with the dual-route model, which predicts frequency effects only for irregular past tense forms and not for regular forms, which is precisely the pattern observed in our data. This contrasts with the single-route model, in which the acquisition of both regular and irregular past tense is assumed to be frequency driven.

The performance of children with CI, however, is not readily accounted for by either model. From a connectionist perspective, the acquisition of past tense is closely linked to the size of the child’s verb lexicon, with generalization of past tense rules occurring once a critical mass of verbs has been reached (Marchman and Bates 1994). Although children with CIs generally show relatively strong vocabulary skills (Walker, Redfern, and Oleson 2019), they may reach this critical mass later than their hearing peers, contributing to delayed past tense acquisition. However, their deficits go beyond a simple delay: while children with DLD have been shown to perform similarly to typically developing children about two years

younger, the 7-year-old children with CIs in our study performed below 5-year-old controls. One possible reason is that children with CI have difficulty perceiving the low-salient past tense morpheme, a hypothesis previously suggested to account for language delays in children with DLD (Leonard et al. 2003). Notably, the children in our study were perfectly able to discriminate between a verb's present tense form and regular past tense form (e.g. *werk* – *werkte* 'work – worked'), suggesting that perceptual discrimination alone cannot account for the observed difficulties.

Taken together, input-based accounts like the single-route model are insufficient to explain the outcomes of children with CI. Generative accounts such as the dual-route model similarly fail to clarify why these children encounter persistent challenges in acquiring morphosyntactic structures. These findings underscore the need for models of language development that integrate perceptual, lexical, and morphosyntactic factors to account for acquisition in populations with atypical auditory experience.

It is now well established that morphosyntactic difficulties represent a core feature of the language challenges experienced by children with hearing loss. For speech-language therapists and special education professionals, linguistic evidence such as that provided in the present study is essential in identifying the relative strengths and weaknesses in the language development of children with hearing loss. Such evidence informs the design of targeted interventions and supports the implementation of individualized therapy programs within educational settings.

Building on insights from past tense acquisition, we turn to another domain where theoretical linguistics intersects with clinical relevance: the acquisition of determiners at the morphology–prosody interface. Just as auditory input shapes morphosyntactic development, limitations in pitch perception affect prosody-driven grammatical cues, offering a parallel lens through which to study language acquisition in children with hearing loss.

### **3. Case study II – From comparative linguistics to audiological practice: Determiners at the morphology-prosody interface**

#### *3.1. Introduction*

The present case study builds upon our first demonstration of how theoretical linguistic inquiry can have direct and far-reaching consequences for applied domains. Once again, we aim to show that what may initially appear to be highly abstract pursuits in formal linguistics ultimately provide crucial insights for understanding child language development, and by extension, for shaping both clinical audiology and technological design. The specific empirical domain under investigation here is the prosody–morphology interface.

Prosody is commonly defined as the suprasegmental structure of speech, encompassing rhythm, intonation, stress, and phrasing (Selkirk 1984, Nespor and Vogel 1986). It constitutes the “melody of speech”, but far from being a merely ornamental layer, prosody interacts systematically with other components of the grammar. In particular, it plays a central role in organizing morphosyntactic units into prosodic phrases and in signaling discourse-related distinctions such as focus, topic, and information status (Gussenhoven 2004). A growing body of research has established that prosody is not autonomous but tightly integrated with syntax and morphology in shaping linguistic meaning and communicative function.

The goal of this case study is to trace a structured argumentative trajectory: beginning with fundamental linguistic insights from cross-linguistic studies of the prosody–morphology interface (with special attention to Dutch and Romanian), proceeding to developmental data that reveal how prosody guides the early acquisition of determiners in children, and culminating in clinical applications that demonstrate how deficits in pitch perception – most notably in children with CIs – lead to altered acquisition trajectories. By following this path, we illustrate how fine-grained theoretical analysis not only enriches our understanding of the human language faculty but also generates practical knowledge that directly informs clinical intervention and technological innovation, thereby addressing specific communicative challenges faced by hearing-impaired populations.

### 3.2. *Encoding discourse information and the nominal left periphery*

Human communication encodes information structure through multiple channels, of which prosody and word order are among the most salient. Cross-linguistic research highlights a typological divide in how languages encode focus. In many Romance languages, focus is often associated with syntactic movement to the left periphery of the clause, a region that Rizzi (1997) formalizes through the functional projection FocusP. Here, constituents in focus are fronted to occupy the specifier of FocusP, signaling their discourse prominence, while prosody typically plays a secondary, demarcative role (Zubizarreta 1998, Cinque 1993). By contrast, in Germanic languages such as English and Dutch, focused constituents tend to remain in situ, and focus is primarily marked through prosodic prominence, particularly pitch accents (Selkirk 1995). In these languages, word order is less directly involved in encoding focus. The contrast becomes clear in the following examples.

- (2) a. I have [+FOCUS INSTRUCTIONS] to leave. (Newman 1946)  
 b. Ho [+FOCUS istruzioni] di LASCIARE. (Cinque 1993)

The concept of a nominal left periphery mirrors the more widely studied clausal left periphery. Analogous to the CP, the DP can host functional projections such as FocusP and TopicP, which serve to encode discourse-related roles (Giusti 1996, Bernstein 2001, Cornilescu 2011, Corver and van Koppen 2006). This functional layering within the DP provides a mechanism through which determiners can interact with pragmatic and prosodic information, effectively linking morphology, syntax, and discourse in a unified framework.

Prosodic focus marking can also apply to presentational focus. Unlike contrastive focus, presentational focus introduces discourse-new material without any opposing element, and is pragmatically defined as either not c(ontext)-construable (Rochemont 1986) or D(iscourse)-delinked (Pesetsky 1987).

There is a well-established link between the prosodic structure of DPs and the information status of the nominal referent. Discourse-given items tend to be deaccented, whereas discourse-new items are typically made intonationally prominent, with a rising pitch on the stressed syllable of the noun. Perception studies show that listeners are highly sensitive to such local intonation cues: for instance, Terken and Noteboom (1987) demonstrate that Dutch listeners respond significantly faster to accented, discourse-new items.

At the same time, morphosyntactic factors also correlate with information status. Discourse-new items are more likely to bear the theme role, occupy object positions, and appear as full DPs introduced by an indefinite determiner. This suggests an indirect connection between determiner choice and prosodic marking: in many cases, pitch-accented nouns co-occur with indefinite articles, reflecting the discourse-new status of the referent:

- (3) Yesterday, I saw [<sub>FocP</sub> a black CAT] in our garden. The cat was trying to catch a bird that had fallen from the nest.

### 3.3. *From child-directed speech to the acquisition of determiners*

From a theoretical perspective, these findings suggest that the highest projections of the DP involve at least three interacting interfaces: morphosyntactic, pragmatic, and prosodic. Overgeneralizing slightly, one could say that the choice of D is influenced both by intonational patterns and by discourse information. This raises a crucial question for language acquisition: to what extent are prosodic features accessible to children as they acquire their mother tongue? In particular, how closely are acoustic correlates of discourse prominence linked to determiner choice in child-directed speech? And finally, does it also correlate with the acquisition of determiners by young children?

To answer these questions, a corpus of Dutch child-directed speech was analyzed consisting of 1,930 minimal pairs of definite and indefinite DPs. The acoustic analysis was done by means of Praat, a software program designed for detailed speech analysis (Boersma et al. 2023). A comparison of the fundamental frequencies (F0) at the start, the middle and the end of the noun showed that whereas at the start of the noun F0 did not differ between indefinite and definite article contexts (Md Indef: 247 HZ, Def: 250 Hz,  $p = .92$ ),

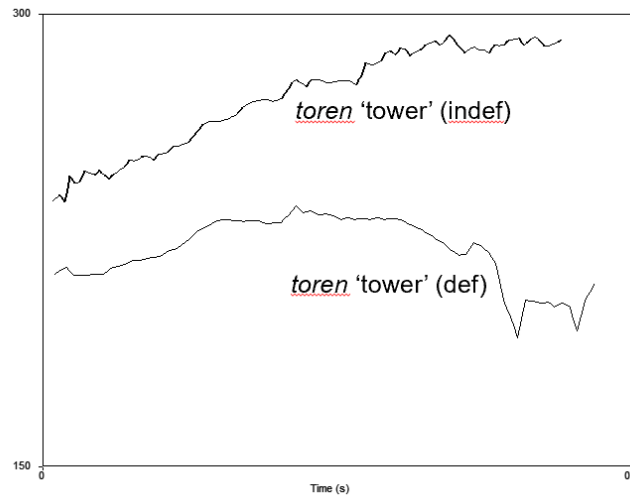


Figure 5: Pitch contour for the noun *toren* ‘tower’ in (4). Horizontal axis: time (s); vertical axis: F0 (Hz).

a statistically significant difference was found for F0 at the middle of the noun (Md Indef: 306 Hz, Def: 234 Hz,  $p = .02$ ) and at the end of the noun (Md Indef: 340 Hz, Def: 236 Hz,  $p = .002$ ).

The following example from spontaneous Dutch adult speech illustrates how this indefinite vs definite distinction is reflected intonationally. In minimal pairs where the same noun appears with either an indefinite or a definite article, the indefinite DP is marked by a rise in F0 on the stressed syllable of the noun:

- (4) a. Hier, we gaan een toren maken.  
*here we go a tower make-INF*  
 ‘Look, we’re going to make a tower.’
- b. We kunnen ook gewoon de toren een beetje afbreken.  
*we can also just the tower a little break-INF*  
 ‘We can also just deconstruct the tower a little.’

The difference between the rising pitch on the stressed syllable of an indefinite noun and the absence thereof in the context of its definite counterpart, is depicted for example (4) in figure 5.

An important question is whether the observed prosodic prominence of discourse-new items in child directed speech influences child language acquisition. We propose that pitch marking on the noun affects the acquisition of determiner morphology, in the sense that it influences the order in which indefinite and definite determiners are acquired.

Several studies in first-language acquisition have suggested that young children use prosodic cues to bootstrap morphosyntactic information (Höhle 2009). Building on this, our hypothesis is that prosodic prominence directs the child’s attention to discourse-new referents. Since new referents are typically introduced with indefinite DPs, children are expected to attend to indefinite rather than definite determiners during the early stages of language development. Evidence from the literature further suggests that the order of determiner acquisition reflects differences in how specificity is encoded. The observed pattern of indefinite determiners appearing before definite ones in children’s speech has been linked to a stepwise feature valuation, in which the /number/ feature of noun phrases is acquired before the /person/ feature (see Coene for a comparative study of 4 Romance languages).

From these combined insights, we predict that indefinite articles will emerge in the child’s grammar before definite articles. In other words, the natural order of determiner acquisition is influenced, at least in part, by the prosodic prominence of the DP.

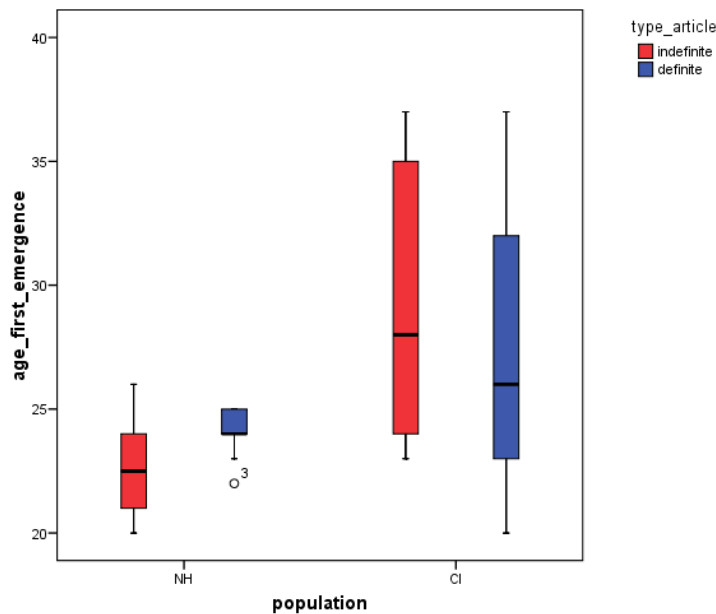


Figure 6: Age at first emergence (in months) of indefinite and definite articles in children with CIs.

This prediction is supported by a longitudinal corpus study of 12 typically developing Dutch-speaking monolingual children. For each child, we examined monthly recordings of spontaneous speech and compared the age of first emergence of indefinite and definite articles across three consecutive months. The median age for the first use of the indefinite article was 22.5 months, whereas the definite article appeared roughly 1.5 months later.

### 3.4. *Determiner acquisition in children with cochlear implants*

Unlike hearing aids, which amplify sound, CIs bypass damaged hair cells and convert acoustic signals into electrical impulses transmitted to the auditory nerve. Despite their transformative role, CIs have important limitations. They provide reduced spectral resolution and limited transmission of fundamental frequency (F0), the main acoustic correlate of pitch. As a result, CI users often struggle with fine-grained pitch discrimination, intonational contrasts, and musical tones. Studies indicate that they frequently perform at near-chance levels when asked to distinguish rising from falling pitch contours in connected speech.

These limitations have significant implications for prosody-driven aspects of grammar acquisition. In line with this expectation, a striking difference emerges when comparing determiner acquisition in normally hearing children and children with CIs. Analysis of a longitudinal dataset of spontaneous speech from 10 Dutch-speaking children with CIs revealed that at the group level, definite determiners appeared at a mean age of 26 months, whereas indefinite determiners emerged later, around 28 months. A paired analysis confirmed that this order of acquisition is generally held at the level of individual children (see figure 6).

This reversed trajectory likely reflects the absence of reliable pitch information in CI auditory input. The findings confirm that prosody acts as a bootstrapping mechanism in typical acquisition: without prosodic cues, children with CIs are more likely to attend to forms that are less dependent on pitch marking.

Controlled experiments support this conclusion. We tested 32 CI users and 52 hearing controls on two prosodic reception tasks. The first task involved 16 pairs of low-pass filtered words differing in F0 patterns, mimicking natural speech intonation (see Heeren et al. 2010 and Schauwers et al. 2012 for more details).

The second task presented unfiltered nouns bearing rising or falling pitch accents corresponding to definite and indefinite article contexts (see Coene et al. 2010). Whereas hearing participants achieved above 80% accuracy, CI users often performed near chance. Across both tasks, CI children consistently underperformed relative to controls, confirming a general deficit in pitch perception that shapes their grammar acquisition.

Because children with CIs cannot reliably access the prosodic cues linking indefinite determiners to presentational focus, they miss out on the prosodic bootstrapping mechanisms typically available to hearing children during language development.

### 3.5. *Implications for therapy, education and technology*

First and foremost, the results of this case study underscore fundamental theoretical and developmental principles. They point to the potential presence of discourse-related projections in the DP, such as FocusP, and illustrate how prosodic prominence serves as a bootstrapping mechanism for grammatical acquisition. In hearing children, prosody guides attention toward new referents and shapes determiner emergence, whereas in children with CI's, the absence of these cues forces reliance on alternative strategies, fundamentally altering the developmental path. This interplay between prosody, syntax, and discourse suggests that prosody is an important factor in shaping the child's acquisition of lexical elements with morphosyntactic significance (i.e., functional elements), with its influence on broader grammatical organization being indirect rather than structural.

These linguistic insights have clear implications for both therapy and education. Traditional approaches often rely on the child's sensitivity to prosody, but for CI users, alternative strategies are necessary. Therapists and educators can emphasize syntactic and pragmatic cues – such as word order or contextual markers of focus – that are less dependent on pitch. Visual signals, including gestures and facial expressions, can also act as supplementary markers of discourse prominence, providing children with additional pathways to recognize new referents. Furthermore, explicit contrastive practice with definite and indefinite determiners can help compensate for the lack of prosodic guidance, supporting children in mastering distinctions that are naturally cued through intonation in hearing peers.

The findings also point toward directions for technological innovation. Cochlear implants could be optimized to better convey the pitch and intonational contours that underpin prosody-driven grammar acquisition. Enhanced pitch coding algorithms, hybrid electro-acoustic devices, and training software that simulates natural prosodic variation could all help CI users access cues that are crucial for language development. By bridging the gap between technological design and linguistic insight, these innovations offer a way to support children in acquiring grammar in a manner closer to typical developmental trajectories.

Ultimately, this case study demonstrates the power of an interdisciplinary perspective, linking theoretical linguistics, developmental psycholinguistics, clinical audiology, and biomedical engineering. By tracing how subtle theoretical constructs – prosodic bootstrapping, DP left periphery, and focus marking – manifest in real-world acquisition, we see that linguistics can inform practical interventions, technological solutions, and educational strategies. In doing so, it bridges the gap between fundamental research and the lived experiences of children with hearing loss, offering a roadmap for improving communication, therapy, and overall quality of life.

## 4. Conclusion

The two case studies presented here illustrate how developmental and clinical linguistics can fruitfully inform one another. In the domain of past tense morphology, we saw that data from children with cochlear implants do not neatly align with either single-route or dual-route accounts, underscoring the need for models that integrate perceptual, lexical, and morphosyntactic factors. At the morphology–prosody interface, we showed how prosodic prominence shapes determiner acquisition in typically developing children, and how prosodic perception deficiency in cochlear implant users alters developmental trajectories in systematic ways.

Taken together, these findings highlight two key insights. First, theoretical constructs – whether morphosyntactic rules or prosodic bootstrapping mechanisms – provide indispensable tools for understanding the particular difficulties faced by children with hearing loss. Second, clinical data in turn challenge, refine, and extend our models of language development, reminding us that these must ultimately account for the full diversity of human linguistic experience.

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This perspective resonates strongly with the intellectual spirit celebrated in this volume. Johan Rooryck's work exemplifies a broad and open-minded approach to linguistics: it not only advances formal theory but also explores how linguistic insights can illuminate applied domains, ranging from language disorders to technological applications.

More broadly, this reciprocal movement between theory and application reflects the spirit of his scholarship. Throughout his career, he has combined a commitment to formal precision with a keen interest in how language is acquired, used, and sometimes impaired. His expansive view of linguistics consistently bridges domains – across languages, theoretical frameworks, and applied settings.

It is in this spirit that the present contribution is offered: as an illustration of how fundamental linguistic analysis, when extended to new empirical and clinical contexts, not only advances our scientific understanding but also has meaningful implications for real-world communication and care.

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