STUDIA LINGUISTICA HUNGARICA 36 (2024): 16–36. https://ojs.elte.hu/slh

THE ACQUISITION OF HUNGARIAN RECURSIVE POSSESSIVES

ÁGNES LANGÓ-TÓTH

HUN-REN Hungarian Research Centre for Linguistics
lango.toth.agnes@gmail.com
https://orcid.org/0009-0008-1473-3818

Abstract

The objective of this paper is to address two principal inquiries. The first question to be addressed is the age at which children begin to comprehend and produce recursive possessives in a manner that is consistent with the adult data. Secondly, what patterns of comprehension and production are observed prior to this age.

The acquisition of recursion tends to occur at a later age in the language learning process (Roeper 2011, Hollebrandse–Roeper 2014 and Roeper–Oseki 2018), and therefore the cross-linguistic literature indicates that the age of comprehension of recursive constructions is around 5–6 years and the age of production is around 7–9 years. The data will demonstrate that the acquisition of Hungarian recursive possessives can be dated earlier than previously thought. The experiments conducted indicate that comprehension of the structure under study reaches ceiling-level performance at the age of four, while the production of the full structure occurs at the age of six. In the event of an error, the target structure is typically only partially produced.

The structure of the paper is as follows: Section 1 describes linguistic recursion, Section 2 discusses the acquisition of recursion, Section 3 presents the syntactic features of recursive possessives. In Section 4, the previous cross-linguistic and Hungarian results on the structure under investigation are presented in detail. Section 5 presents the main experiments. Finally, Section 6 summarises the conclusions.

Keywords: recursion, comprehension, production, possessives, language acquisition

1. Linguistic recursion

In their 2002 publication, Hauser, Chomsky and Fitch posit that recursion represents a pivotal aspect of the faculty of language in a narrow sense (FLN). They make a crucial distinction between the faculty of language in a broad sense and the faculty of language in a narrow sense. The faculty of language in a broad sense (FLB) encompasses, for instance, the sensorimotor system (motoric and perceptual) and the conceptual-intentional system (i.e. the system of conceptual relations and intentions). The faculty of language in a narrow sense is a component of the faculty of language in a broad sense, which encompasses the mechanism of recursion.[1] Similarly to the genetic code, language is believed to be hierarchical, generative and recursive.

According to Chomsky, the operation of merge is responsible for generating recursive structures. This is an operation that creates larger units from smaller ones (Chomsky 1959, 1993; Freidin 2014; Gervain 2014; Watumull et. al. 2014; Mota 2017). That is to say, given units a and b, unit g can be created from them. G is thus generated by merging two elements, a and b, which are considered to be constituents of g. This operation can be described as follows: g = {d, {a, b}}, in which d defines the properties of g, i.e. d becomes the label of g. This is category-neutral recursion, so it is valid for any syntactic category. This is how linguistic structures are constructed in general.

However, there is also a more specific, narrower notion of recursion (1).

[1] Chomsky's idea of a category-neutral operation of *merge* is what is meant here.

DOI: 10.54888/slh.2024.36.16.36

(1) [*the* [*witch's* [*duck's apple*]]]

This sense is applicable to cases where a syntactic component of a given type of structure is a syntactic phrase of the same type, embedded as it were. This implies that there are recursive pre- or postpositional phrases, recursive possessives (1), and that the structure can be recursive at the level of CPs as well. In the following, the term 'recursion' will be used to refer to category-dependent recursion, that is, the acquisition of a more specific, narrowly defined recursion.

2. The acquisition of recursion: initial conjunctive reading

In the context of the theory of the acquisition of recursive structures, Hollebrandse–Roeper (2014) and Roeper (2011) claim that children begin the acquisition of recursive structures through a process of conjunctive reading. Thus, the sentence *John's sister's bike* is first interpreted as *John's and his sister's bike*.

In summary, the authors state that:

- At around two or three years of age, children are giving a purely conjunctive reading to recursive sentences.
- At the age of four or five, there is a transition to recursive reading, although at this age children still give predominantly conjunctive responses.
- The acquisition of recursive skills is observed to begin after the age of six.

The focus of most authors is on the comprehension of recursive structures rather than their production, but examples of both are presented in Section 4.

3. Syntactic features of the structure under study

The following subsections discuss the syntactic features of Hungarian possessive and recursive possessive structures.

3.1. Features of the Hungarian possessive structure

In accordance with the findings of Szabolcsi and Laczkó (1992, in: É. Kiss 2003), there are two distinct types of possessive structures in Hungarian: one with an unmarked possessor (Figure 1.) and the other with a marked -NAK possessor (Figure 2.).

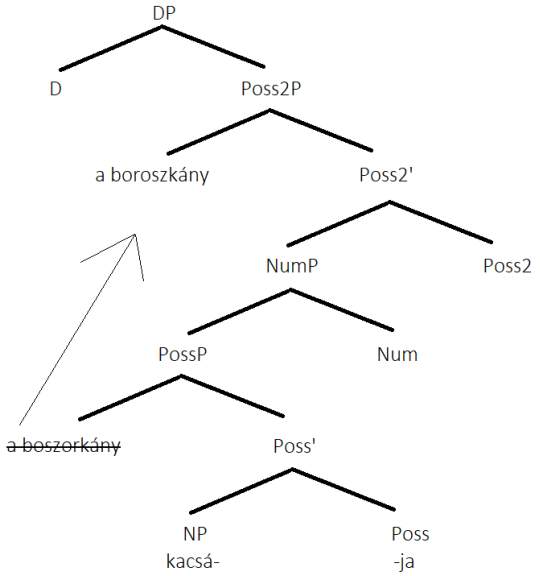

Figure 1. *a boszorkány kacsá-ja* (2a)
the witch duck-POSS
'the witch's duck'

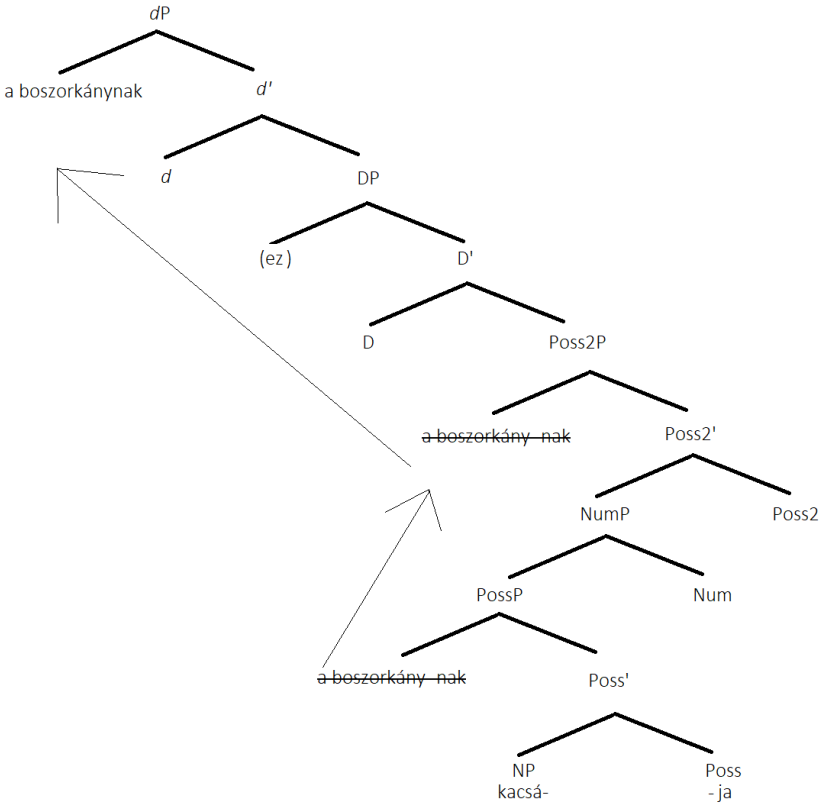

Figure 2. *a boszorkány-nak a kacsá-ja* (2b)
the witch-DAT the duck-POSS
'the witch's duck'

As demonstrated by Dékány (2021), the unmarked possessor is positioned below D (Figure 1), whereas the possessor with the (-NAK) case-marker is situated above D in the structure (Figure 2). The two figures presented here are based on Dékány's theory, with the example used being my own.

3.2. Structural properties of Recursive Possessives

This section examines the structural characteristics of multiple (recursive) possessives as previously outlined by Szabolcsi and Laczkó (1992). The authors note that X-bar Theory predicts the existence of these structures. In the case of a possessor in the DP, a possessive structure with a possessor in a specifier position can be placed in it. It is proposed that a total of four possible recursive possessive structures can be imagined in Hungarian, as illustrated in (3a–d).

(3a) *?a maci* *doboz-a* *szalag-ja*
the teddy bear box-Poss ribbon-Poss

(3b) *?a maci-nak* *a doboz-á-nak* *a szalag-ja*
the teddy bear-DAT the box-Poss-DAT the ribbon-Poss

(3c) **a maci-nak* *a doboz-a* *szalag-ja*
the teddy bear-DAT the box-Poss ribbon-Poss

(3d) *a maci* *doboz-á-nak* *a szalag-ja*
the teddy bear box-Poss-DAT the ribbon-Poss
'The teddy bear's box's ribbon'

The authors posit that while structures (3a and 3b) are indeed unusual, they are not ungrammatical. Two additional structures are observed containing the three possessive structures: 3e and 3f.

(3e) *a maci* *doboz-a* *szalag-já-nak* *az ár-a*
the teddy bear box-Poss ribbon-Poss-DAT the price-Poss

(3f) *a maci* *doboz-á-nak* *a szalag-já-nak* *az ár-a*
the teddy bear box-Poss-DAT the ribbon-Poss-DAT the price-Poss
'The teddy bear's box's ribbon's price.'

Szabolcsi and Laczkó (1992) propose that structure (3c) is not a grammatical structure. In contrast, structures (3a and 3b) can be part of other constructions (3e and 3f). Sentence (3d) represents the most acceptable case of recursive possessives in Hungarian.

The three possible recursive possessive constructions based on the theory of Szabolcsi and Laczkó (1992) are presented in Figures 3–5, accompanied by illustrative examples.

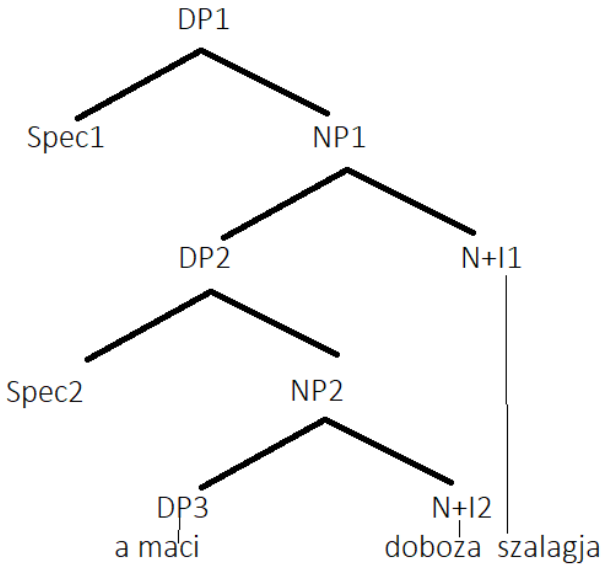

Figure 3. *A maci doboza szalagja* (3a)
The teddy bear's box's ribbon

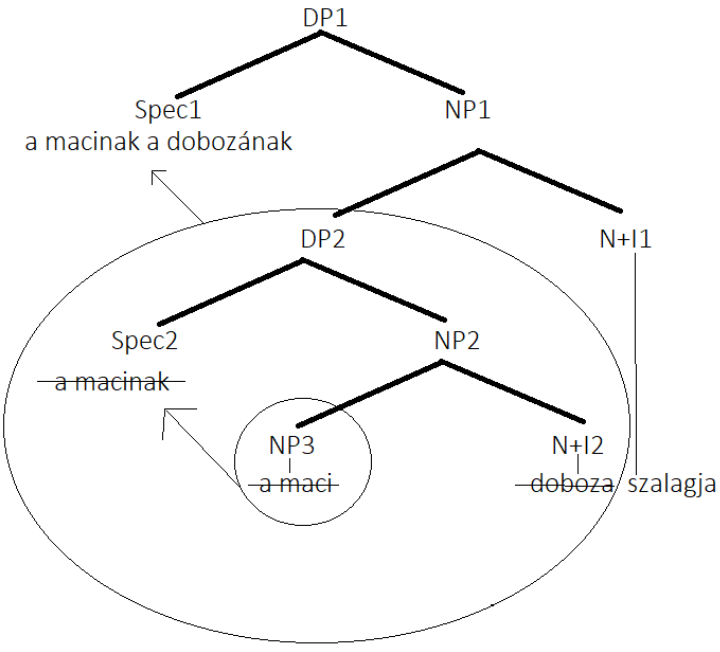

Figure 4. *A macinak a dobozának a szalagja* (3b)
The teddy bear's box's ribbon

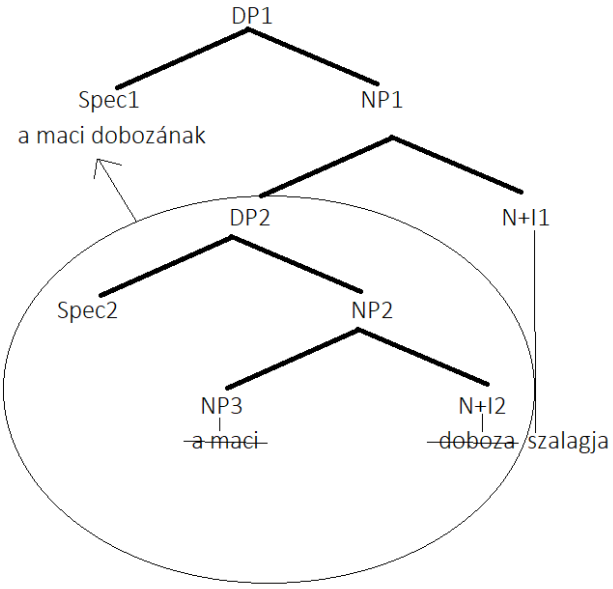

Figure 5. *A maci dobozának a szalagja* (3d)
The teddy bear's box's ribbon

In their theoretical framework, SpecDP is also considered to be an operator position. As the aforementioned possessors are not operators, it is optional to transfer them to the specifier position. However, if they were to be relocated there, they would effectively become operators themselves.

4. Previous research on the acquisition of Recursive Possessives

This chapter presents a framework for the study of recursive possessive structures, beginning with cross-linguistic data and subsequently introducing Hungarian evidence.

4.1. Cross-linguistic data

Roeper and Hollebrandse (2014) aimed to investigate how and when children begin to correctly interpret recursive possessive constructions, and to what extent this is preceded by the use of conjunctive reading. The children were presented with a series of tasks designed to assess their ability to interpret recursive possessive structures. The tasks included sentence completion and picture matching tasks.

In their respective works, Roeper (2011) and Hollebrandse and Roeper (2014) cite Sarah Gentile's 2003 experiment as a pivotal precedent. In this experiment, children were presented with three images: one depicting the Cookie Monster, one depicting the Cookie Monster with his sister, and one depicting his sister alone. Upon inquiring whether the children could present a picture of Cookie Monster's sister, one-third of the 3- to 4-year-olds selected the image of Cookie Monster and his sister together, indicating a conjunctive interpretation. The authors posit that this experiment offers further evidence to support the assertion that preschool children associate a form of conjunctive interpretation with recursive constructions.

The primary hypothesis put forth by Limbach mentioned by Roeper (2011) as well as Hollebrandse and Roeper (2014) is that German-speaking children are capable of acquiring recursive possessive structures, which are acquired in a manner analogous to other languages. It has been postulated that German children will also commence the use of possessive structures at an early age and will be capable of creating embedded possessive structures. The study included a range of age groups of German children (aged 3–5 years) who were presented with tasks designed to

assess their comprehension and production of recursive possessive structures. The findings indicated that German children were capable of comprehending and producing recursive possessive structures at an early developmental stage. The younger children made more frequent errors, but their accuracy in the use of these structures improved with their cognitive development. The present study is of interest insofar as the recursive possessive structures (with the -s possessive suffix) are not well-formed in German. For example, the phrase **Mein Vater-s Bruder-s Haus* (my father's brother's house) is not correctly formed, whereas the phrase *Mein Vater-s Bruder* (my father's brother) is.

In his 2011 study, Roeper references an experiment conducted by Fujimora (2010), which focused on Japanese possessives. In this experiment, images were presented to children aged between two and a half and six years. Each image depicted a person, a dog, and its ball. Subsequently, the children were posed increasingly complex questions, for example, *What colour is Mika's ((brother's (friend's)) dog's) ball?* The results of the experiment demonstrated that the youngest children (aged between two and four years) were able to attach a correct meaning to the single possessors. Children aged five years demonstrated correct understanding of the double possessor. However, they exhibited difficulty with the triple possessor, and were unable to comprehend the fourfold possessor. The authors of the experiment conclude that the acquisition of recursion is not an immediate process, but that if a child has already learned to utilise recursive operations, there will be no difference in the rate of acquisition of the threefold and fourfold possessives.

In a study reported by Hollebrandse and Roeper (2014), an experiment was conducted with Japanese children. The children were presented with images and subsequently posed a series of embedded recursive inquiries, such as *What colour is the umbrella of Shiro's father's eldest brother's rabbit?* or *What colour are Ieroo's eldest brother's rabbit's shoes*? A total of 35 subjects were tested, comprising 15 three-year-olds and seven six-year-olds, as well as 13 adults. The younger children interpreted the presented pictures in a conjunctive manner, while the six-year-olds demonstrated a 50-75% success rate in task completion. Thus, the findings indicate that at the age of three, children still attribute conjunctive meaning to recursive constructions, whereas at the age of six, they have typically mastered the recursive meaning.

A study by Perez-Leroux et al. (2018) tested the hypothesis that children are capable of acquiring recursive modification in noun phrases (NPs), particularly in possessive structures. The authors postulated that children would be capable of comprehending and producing embedded possessive structures, exemplified by *the boy's dog's hat*. The researchers conducted experiments in which they inquired children of varying age groups (3–5 years old) regarding sentences that contained recursive possessive structures. The findings indicated that children were capable of comprehending and employing recursive possessive structures accurately, although younger children exhibited a higher frequency of errors. The experiments demonstrated that children's cognitive development is a continuous process, with the acquisition of recursive structures occurring in a gradual manner.

In a previous experiment, Perez-Leroux, Castilla-Earls, Bejar and Massam (2012) investigated both recursive PPs and recursive possessives. The objective was to address three principal questions: firstly, to examine the distinctions between NP recursion and NP coordination in the context of language acquisition. Secondly, the researchers sought to determine whether the acquisition of different levels of embedding could be described as a discrete process, that is to say, whether one follows from the other or once children have mastered the basic mechanisms, they acquire single and multiple embeddings simultaneously. The third main question concerns the potential differences in the acquisition of possessive and PP recursion. A total of 46 monolingual English-speaking children and 11 adults were recruited for the experiment. The group of children was further divided into three-, four-, and five-year-old groups. In the experiment, the authors observed that the younger participants, aged 3–4 years, attempted to avoid recursive responding (they typically failed to identify a referent – NP), but demonstrated no difficulty with the coordinative task, as did the five-year-olds. The adult participants' responses were predominantly recursive, whereas the children's responses exhibited a greater diversity, falling into several categories. Embedding noun phrases (NPs) in each other was a rare occurrence among three-year-old children. Multiple embeddings were more prevalent

among adults and older children aged five. The distinction between single and double embedding, as well as that between recursive types (i.e., prepositions and possessives), was not statistically significant for the adult participants. However, a significant difference was observed for the children. The data indicated that PP recursion was significantly more accessible to children than recursive possessive structure.

The data presented here demonstrate several significant aspects of the acquisition of recursive possessives. Primarily, they indicate that this process is gradual, commencing with a conjunctive interpretation that subsequently evolves into a recursive one. This trajectory is evident in both comprehension and production. It is noteworthy that the accurate comprehension of recursive possessives may precede correct production by a period of approximately one to two years.

4.2. Hungarian data

This section presents two experiments on the comprehension of recursive possessives. The first experiment involved a colouring task. The second experiment involved a sentence–pictures matching task.

These were deemed necessary due to the findings of cross-linguistic studies, which indicated that children commence learning recursive structures with a conjunctive interpretation (shown in 4.1.). A number of researchers have employed visual stimuli to gain insight into the process of acquisition. Consequently, we elected to utilize this methodology to ascertain whether this is the manner in which the comprehension process occurs in Hungarian.

4.2.1. Colouring task

The present experiment addresses several key questions regarding recursive possessives. The first research question concerns the interpretation of recursive possessives by Hungarian children, as proposed by Roeper (2011) and Hollebrandse and Roeper (2014). This hypothesis suggests that younger children ascribe a conjunctive meaning to complex structures, which transforms into a recursive one at an older age. The second research question was to ascertain whether there were any differences in the interpretation of recursive possessive structures by children and adult native speakers. The third question was to investigate whether the presence of a visible functional head (-NAK) facilitated children's interpretation of recursive possessive structures to a ceiling-level performance. In this experiment, test sentences were constructed according to three structural types, as illustrated in (3a), (3b), and (3d). The initial hypothesis was that an increase in the frequency of the case marker in the structure would facilitate children's interpretation of recursive possessives to a ceiling-level performance.

Di Sciullo's work (2015) examines the interface between morphology and syntax. The author posits that functional elements, which play a pivotal role in sentence structure, can manifest in varying degrees of overt or covert realisation across languages. In some languages, specific grammatical features are explicitly marked (overt), whereas in others, these features are understood implicitly (covert). Overt functional heads presumably help children learn recursive structures more effectively than covert functional heads. Overt functional heads appear explicitly in language, making it easier for children to recognise and learn rules. In contrast, covert functional heads remain hidden and therefore provide less explicit support for understanding and applying grammar rules.

A total of 31 children (second-graders and 6 pre-schoolers) and 24 adults participated in the experiment. The mean age of the kindergarten children was 5 years and 6 months, the mean age of the school children was 8 years and 3 months, and the mean age of the adults was 41 years. Pinto and Zuckermann's (2019) Colouring Task was used. Both groups of children and adults were asked to colour pictures in front of a computer screen following the instructions given in the task. The images were created using the software program Paint, and the participants were asked to colour them in accordance with the instructions provided in the experiment (3a–d). Three lists were created for each test sentence.

Instructions: The participants were asked to colour the images according to the following sentences:

(3a) *a maci* *doboz-a* *szalag-ja* *piros*
the teddy bear box-POSS ribbon-POSS red

(3b) *a maci-nak* *a doboz-á-nak* *a szalag-ja* *piros*
the teddy bear-DAT the box-POSS-DAT the ribbon-POSS red

(3d) *a maci* *doboz-á-nak* *a szalag-ja* *piros*
the teddy bear box-POSS-DAT the ribbon-POSS red
'The teddy bear's box's ribbon is red'

The participants were presented with all three types of sentences (3a, b and d), but the order of the test sentences differed between the three lists. The same sentence that reflected structure (3a) in List A was presented as structure (3b) in List B and as structure (3c) in List C. This was also true for all the test sentences, with each list containing all three types of structures. In other words, each participant was presented with only one of the three lists, yet all three types of recursive possessives. Each list consisted of eight test sentences and eight filler sentences. Subsequently, the images were created according to a number of potential interpretations, including the suggestion that the teddy bear and box were adorned with a ribbon.

The rationale behind my primary focus on older children is that the extant literature posits that the shift from a conjunctive to a recursive interpretation occurs between the ages around five or six. This is corroborated by the findings of the second-grade participants, who coloured the ribbon on the box red significantly more often than any other item. As the teddy bear also had a ribbon, there was always another possibility. This phenomenon was also observed in the kindergarten children. Among the conjunctive responses, for the unmarked possessor, the ribbon on the teddy bear and the box and the ribbon on the box were red. In contrast, for the -NAK possessors (3b and 3d), it was mainly the ribbons on the teddy bear and the box that were red. The unmarked possessor may be interpreted as representing the middle possessor and the possessee being juxtaposed. This is evidenced by the fact that the box and ribbon (either the teddy bear's or the box's) are red. In the case of the -NAK possessor, the conjunctive responses largely represent the scenario in which the two ribbons were coloured red. This implies that in this case, the possessee was coloured by the participants.

The test sentences were interpreted recursively by children of both age groups with an accuracy rate exceeding 80%. The use of conjunctive interpretation was minimal across the two age groups of children.

The other main question was how children's interpretation differed from that of adults. In the case of -NAK possessives, children tended to come up with multiple solutions, while adults tended to stick to the recursive interpretation. Interestingly, it was not children, but rather adults, who were helped by the use of the -NAK suffix (single and double -NAK possessives) to interpret the test sentences according to a recursive reading. Adults also mentioned several times that the unmarked possessive structure is not a well-formed, rather an agrammatical structure. On this basis, they tried to associate a different interpretation with these test sentences and this led them towards a conjunctive interpretation.

4.2.2. The rearrangement of possessors and possessee

In light of Langó-Tóth's (2018) findings regarding the discrepancy between the order of appearance of pictorial items in PP recursion and the comprehension success of recursive structures, it was crucial to ascertain whether the sequence in which possessives and possessee are presented in recursive possessives exerts an influence on processing.

In the 2018 article, two distinct types of PP order were employed. The subject-PP-verb (4a) and the PP-subject-verb order (4b).

(4a)	*Az oroszlán*	*a zsiráf*	*előtti*	*majom*	*alatt*	*üldögél!*
	the lion	the giraffe	in front of	monkey	under	sit-3sg

(4b)	*A zsiráf*	*előtti*	*majom*	*alatt*	*oroszlán*	*üldögél!*
	the giraffe	in front of	monkey	under	lion	sit-3sg

'The lion sits under the monkey in front of the giraffe.'

A mere 27.2% of preschool-age children and 38.6% of eight-year-old children provided a recursive interpretation for the subject-PP-verb sequence. Conversely, 61.3% of the former and 75.7% of the latter provided a recursive interpretation for the PP-subject-verb sequence. It can therefore be concluded that the order of the components is of consequence in the processing of the information. It was thus appropriate to examine the two orders in this experiment as well.

The objective of the experiment was to ascertain which word order is more easily comprehensible to children: (5a) or (5b).

(5a)	*A bácsi*	*feleség-é-nek*	*a bicikli-je*	*piros.*
	the man	wife-POSS-DAT	the bicycle-POSS	red
			(possessor1–possessor2–possessee)	

(5b)	*A bicikli-je*	*a bácsi*	*feleség-é-nek*	*piros.*
	the bicycle-POSS	the man	wife-POSS-DAT	red
			(possessee–possessor1–possessor2)	

'The man's wife's bicycle is red.'

In sentences like (5a), the two possessors are positioned after the possessee, while in sentences like (5b), the two possessors are positioned before the possessee. This is possible because the unmarked possessor *bácsi* (which cannot move away from the possessee) follows another possessor, *feleség-é-nek*. The noun in question is marked with both a possessive marker and a case marker. The bicycle in question is now the property of the man's wife. The suffix -NAK, borne by the possessee *feleség* permits its occurrence at any point in the sentence with its possessor. In the experiment, both structures of type (5a) and (5b) were subjected to testing. It was not hypothesised which order might prove easier for children, and thus no prior assumption was made about whether a structure with one or the other order might be easier to comprehend.

A total of 105 participants were included in the experiment. The sample consisted of 60 adults, with an average age of 28. In the five-year-old age group, 13 individuals participated in the trial, with an average age of five years and two months. The youngest child was four years and one month old, while the oldest was six years and two months old. The group of six-year-old schoolchildren included fourteen participants with an average age of six years and four months. The youngest participant was six years of age, while the oldest was seven years and four months. Eighteen of the eight-year-olds were included in the experiment, with an average age of eight years and one month. The youngest subject was seven years and eight months of age, while the oldest was eight years and seven months of age.

Two distinct lists were compiled, based on the two word orders. All participants were presented with both word orders, each list comprised eight test sentences and eight filler sentences. The two lists were essential for ensuring that each sentence was tested an equal number of times for both word orders and to guarantee that a participant would encounter a sentence only once during the experiment. Consequently, sentences that appeared in one list with the possessor preceding the possessee were to be read in the other list with the possessor following the possessee.

Each test sentence was followed by a filler sentence in the lists. The participants viewed the images on a computer screen, the sentences were read aloud to the children, and the adults read the written presentation themselves. Subsequently, participants were required to select the image that most closely aligned with the sentence. One of the images corresponded to the recursive interpretation (Figure 6) and the other to the conjunctive interpretation (Figure 7). The image in Figure 6 may be interpreted as an illustration of the recursive structure of the sentence, as it depicts only the bicycle belonging to the wife as red. Conversely, Figure 7 may be considered an illustration of the conjunctive interpretation of the sentence, as it depicts the bicycle that is shared by the man and the wife as red.

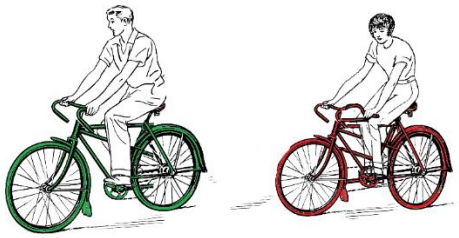

Figure 6. *The man's wife's bicycle is red.*

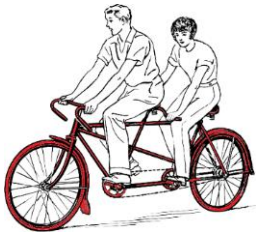

Figure 7. *The man's and his wife's bicycle is red.*

The order of the images was pseudo-randomized, which in this experiment means that for one test sentence, the recursive image was presented on the left and the conjunctive on the right, while for the following test sentence, the order was reversed so that the recursive image was presented on the right and the conjunctive on the left. A total of eight test sentences and eight filler sentences were employed in the experiment. The participants were instructed to listen to the sentences one at a time and then select the corresponding image. The task was completed in a time frame of no more than ten minutes, with no participant encountering more than one of the two lists.

In the experiment, the youngest group demonstrated a preference for the recursive image in their choices, while the performance of the other age groups could be described as more guesswork. In contrast to the children, the adults did not resort to guesswork and instead interpreted the test sentences in accordance with the recursive picture. The two orders (5a and 5b) had no discernible impact. The participants interpreted the orders recursively to a similar extent. Thus, order has no effect in this respect.

In the subsequent experiment, an attempt was made to eliminate the possibility that the children were merely guessing rather than processing the test sentences in detail. This necessitated the implementation of an act-out task, which can also be applied to possessives. As the younger age group (4–5 year olds) also appeared to interpret recursive constructions in a manner consistent with that of adults in these experiments, it became necessary to investigate what would occur if the confounding, conjunctive factor was removed from the test task and the acquisition of recursive possessives were observed in isolation. To this end, an act-out task will be presented in Section 5.

5. The experiment

The following subsections present the details of the participants, the methodology of the experiment, the results obtained, the conclusions to be drawn from them, and finally, a summary of the main data.

It is crucial to highlight that this experiment represents a departure from our previous methodological approaches. Consequently, we have excluded the conjunctive solution image from the stimuli, as we hypothesized that it was a potential distractor for children. Furthermore, the absence of a confounding default image may have resulted in the diminished frequency of the conjunctive interpretation schema or conjunctive production. In light of these considerations, it became imperative to devise a novel act-out type method to gain insights into children's processing patterns.

5.1. Participants

A total of 72 children participated in the experiment, divided into five age groups, with each group comprising children between the ages of 4 and 8 years old.

	number of participants	D1	D2	Mean age	SD
4-year-olds	13	7	6	4;4	0,65
5-year-olds	10	5	5	5;8	0,36
6-year-olds	16	8	8	6;5	0,24
7-year-olds	14	6	8	7;8	0,36
8-year-olds	19	10	9	8;5	0,29

Table 1. Participants

The order of the comprehension – production tasks is designated as D1, while the order of the production – comprehension tasks is designated as D2. Once parental consent had been obtained, individual sessions with each child were conducted, which lasted between 15 and 25 minutes, depending on their age. The responses were recorded on camera for subsequent review and analysis.

It is pertinent to inquire as to why there is no adult control group in this experiment. There are two main reasons for this decision. Firstly, the focus of this study is on the developmental aspects of language acquisition and cognitive processing that are unique to children. Including adults could introduce variables that are irrelevant to this developmental focus. Secondly, we have already collected data on adults from previous studies (shown in 4.2.1. and 4.2.2.). While it is not possible to employ this data for complete comparative purposes, it does, nevertheless, provide some insight into the performance of adults. However, in future studies, we plan to include an adult control group, as we did in the previous experiments.

5.2. Methods

Two distinct methodologies were employed to assess the comprehension and production of recursive possessive structures. In both cases, the participants were presented with a playhouse, paper story characters and their animals and food.

5.2.1 Methodology of the comprehension task

In a wooden house, a variety of fairy-tale creatures, their animals, and different foods were placed. The setting was that it was a plush doll's birthday, so we decided to bake a cake for him. In order to do this, we had to request the ingredients for the cake from the inhabitants of the house. I informed the children that we were going to traverse the entirety of the house from the uppermost to the lowest point.

Figure 8.

As illustrated in Figure 8, a 13-storey residential building was utilized for the experiment. Each floor exhibited two or three apartments that were visible from the exterior. Each apartment had a fairy tale character, an animal, and the corresponding ingredient. The upper two floors served as a training ground, as only two characters (a narrative figure and a fundamental ingredient) resided there.

The representation of the possessive relationship was solely indicated by the positioning of the actors to the right of each other. To illustrate, in the case of the witch's duck's apple, the witch was positioned on the left, the duck in the middle, and the apple on the right (see Figure 9a).

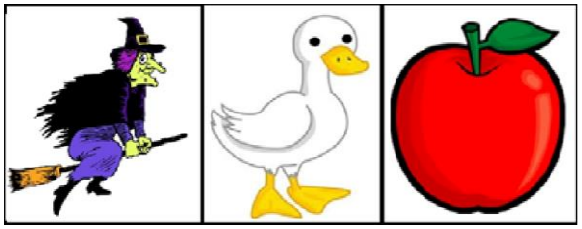

Figure 9a.

Consequently, only simple possessives could be constructed as fillers (6a).

(6a)	*Tegyük*	*a kosár-ba*	*a bohóc*	*keksz-é-t!*
	let's put	the basket-ILL	the clown	biscuit-Poss-ACC
	'Let's put the clown's biscuit into the basket.'			

The participants were required to select the appropriate ingredient associated with the designated character or animal. Two practice exercises were conducted, during which participants were required to select between two potential solutions. In the aforementioned example (6a), the participants were presented with a scenario in which a clown and a mermaid were both in possession of biscuits. These were followed by recursive possessives, as exemplified by (6b).

(6b)	*Tegyük*	*a kosár-ba*	*a boszorkány*	*kacsá-já-nak*	*az alma-já-t*
	let's put	the basket-ILL	the witch	duck-Poss-DAT	the apple-Poss-ACC
	'Let's put the witch's duck's apple into the basket.'				

In this instance, the stimulus material was required to present potential variations with respect to the first and second possessors. Based on this, it was possible to identify variants of test sentence (6b) in pictures displayed throughout the house. These triplets were not employed as supplementary test sentences but rather as image stimuli in the experiment.

(6c) possible answers:
a hercegnő *kacsá-já-nak* *az alma-já-t*
the princess duck-Poss-DAT the apple-Poss-ACC
'The princess's duck's apple.'
(differs in respect of the first possessor)

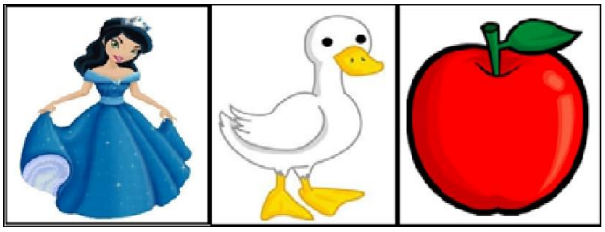

Figure 9b.

a boszorkány *tehen-é-nek* *az alma-já-t*
the witch cow-Poss-DAT the apple-Poss-ACC
'the witch's cow's apple'
(differs in respect of the second possessor)

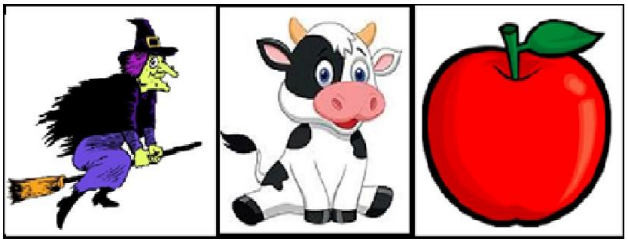

Figure 9c.

a hercegnő *tehen-é-nek* *az alma-já-t*
the princess cow-Poss-DAT the apple-Poss -ACC
'the princess's cow's apple'
(differs in respect of the first and the second possessor)

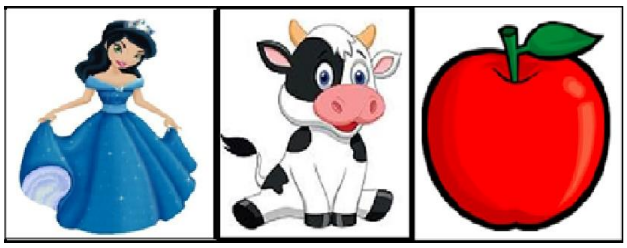

Figure 9d.

The question thus arises as to how these images can be said to represent the recursive possessive relation. It is evident that the images themselves do not represent this relation; rather, they function as prompts to elicit interpretations from the children. Previous studies on similar topics have successfully employed isolated images to investigate linguistic recursion without detailed visual hierarchies (e.g. Section 4.1.). This method ensures that the children rely on their syntactic and semantic understanding rather than visual cues alone.

The comprehension task comprised two warm-up exercises and eight test sentences. As each warm-up task had a possible pair and each test sentence had four possible solutions (6 b and c),

the total number of flats was 36. Once all the ingredients had been gathered together in a box, we proceeded to simulate the mixing and baking of a cake.

5.2.2. Methodology of the production task

In the production test, the children were informed that another puppet had a birthday that day and were instructed to bake a cake for him. In this instance, however, the experimenter proceeded to take the ingredients and place them in the basket, subsequently instructing the participant to identify the items removed from the house and subsequently placed in the basket. In the two preliminary tasks, the children were required to be guided as to their next course of action. In other words, the participants were expected to observe the items in the basket as well as respond to the question, *What did we put in the basket*? The response was *milk*. It should be noted that the experimenter was also permitted to pose supplementary inquiries during the test phase. In order to ensure that the child did not hear possessives in the help questions, we attempted to provide them with assistance in a manner similar to that described in example (7).

(7) E: So, tell me what we took!
P: The apple.
E: OK, but who does the apple belong to?
P: The duck.
E: And who does the duck belong to?
P: To the witch.
E: Then what did we take?
P: The witch's duck's apple.

In this instance, the house depicted in Figure 8 was utilized. Once all the requisite ingredients had been gathered, the cake was baked (once more).

5.3. Main results

The data were evaluated using the R software (R Core Team, 2020/21) and subjected to chi-square tests. As illustrated in Chart 1, there is no discernible difference in the performance of the various age groups in terms of the number of correct answers.

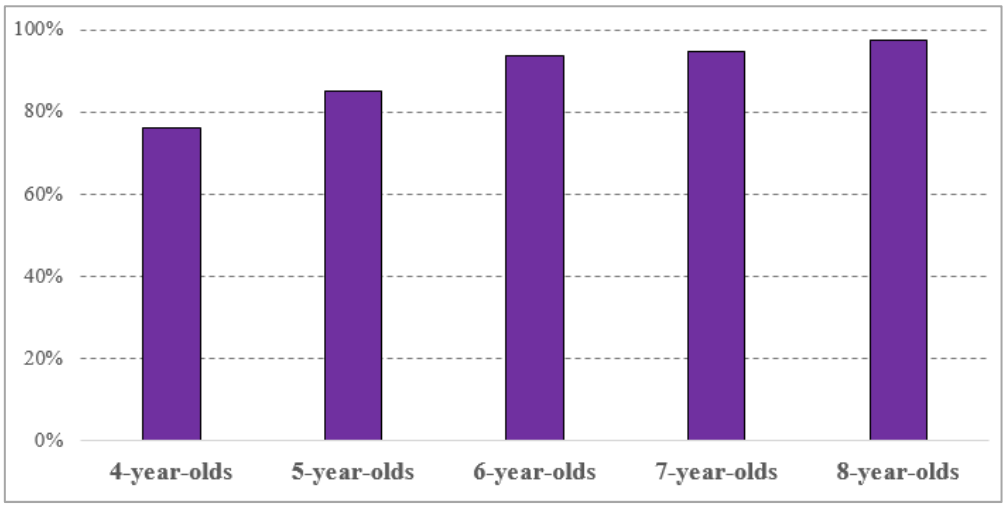

Chart 1. Correct answers in the comprehension task

Table 2 presents the correct and incorrect responses to the comprehension task, along with the corresponding corrections. Corrections are when the participant first selects the wrong ingredient, then puts it back and finally adds the correct ingredient to the basket. If this correction does not take place, it is considered an error, thus an incorrect answer. The percentages obtained for the three types of responses were compared within each group, namely the proportion of correct, incorrect and corrected responses.

	Correct	Incorrect	Correction	Σ
4-year-olds	**79 (76%)**[2]	2 (1.9%)	23 (22.1%)	104
5-year-olds	**68 (85%)**[3]	1 (1.3%)	11 (13.7%)	80
6-year-olds	**120 (93.8%)**[4]	1 (0.8%)	7 (5.4%)	128
7-year-olds	**106 (94.6%)**[5]	-	6 (5.4%)	112
8-year-olds	**148 (97.3%)**[6]	-	4 (2.7%)	152

Table 2. Overall results of comprehension task

In all cases, members of each age group demonstrated a significantly higher level of accuracy in interpreting the test sentences than they did in making mistakes or corrections.

The subsequent step is to compare the data obtained in Design 1 and Design 2 (Chart 2).

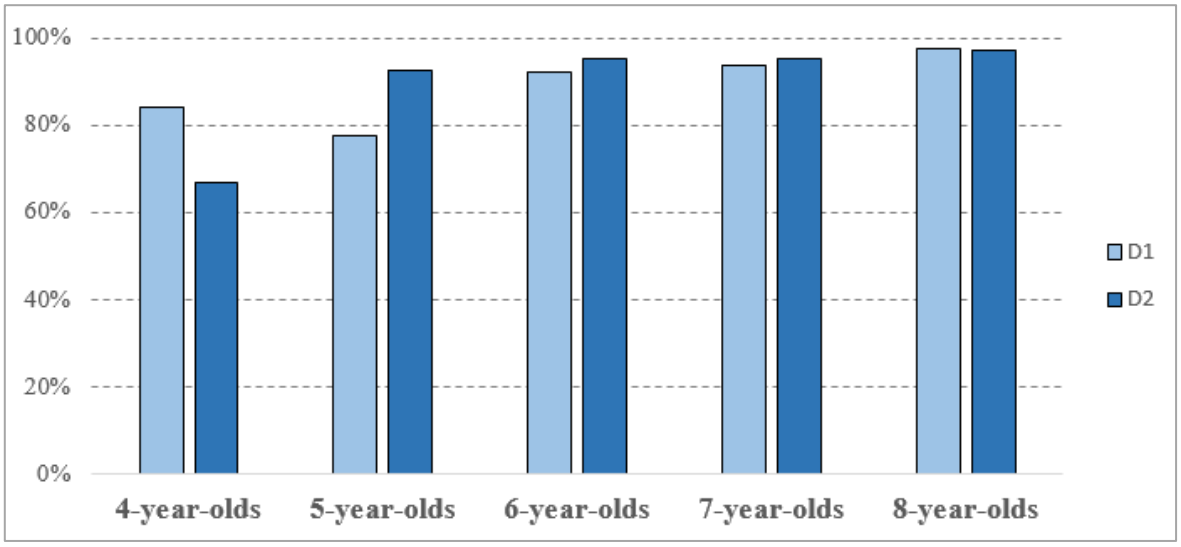

Chart 2. D1 and D2 order in the comprehension task

There is no discernible difference in the performance of children in the two designs, with the majority of children solving the test tasks correctly in both designs.[7]

[2] χ^2 (2) = 88.041, p < 0.001***
[3] χ^2 (2) = 122.43, p < 0.001***
[4] (χ^2 (2) = 164.85, p < 0.001***
[5] (χ^2 (1) = 79.566, p < 0.001***
[6] (χ^2 (1) = 89.492, p < 0.001***
[7] Even at age 4, there is no significant difference between the two designs (χ2 (1) = 1.9644, p = 0.161 n.s.), as for the other age groups: 5-year-olds (χ2 (1) = 1. 3235, p = 0.25 n.s.), 6-year-olds (χ2 (1) = 0.051253, p = 0.8209 n.s.), 7-year-olds (χ2 (1) = 0.011898, p = 0.9131 n.s.) and 8-year-olds (χ2 (1) = 0.00046225, p = 0.9828 n.s.)

Chart 3 illustrates the total number of correct responses to the production task. A significant difference is observed when the correct answers of the five age groups are compared.[8]

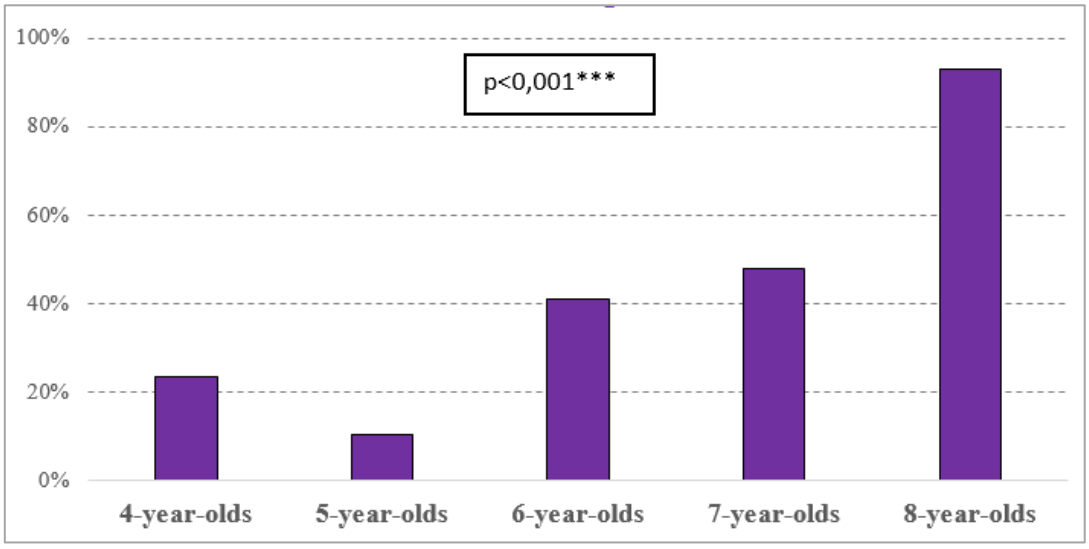

Chart 3. Correct answers in the production task

The data indicates that eight-year-olds were more successful at producing recursive possessives than six- and seven-year-olds[9]. This is in contrast to the six- and seven-year-old age groups[10], which produced more recursive possessives than the four- and five-year-old groups.[11]

Chart 4 illustrates the proportion of instances in which children produced a variant of the recursive possessives when both the first and second possessor bear the -NAK suffix (double -NAK suffix) and when only the second possessor bears this suffix (single -NAK suffix).

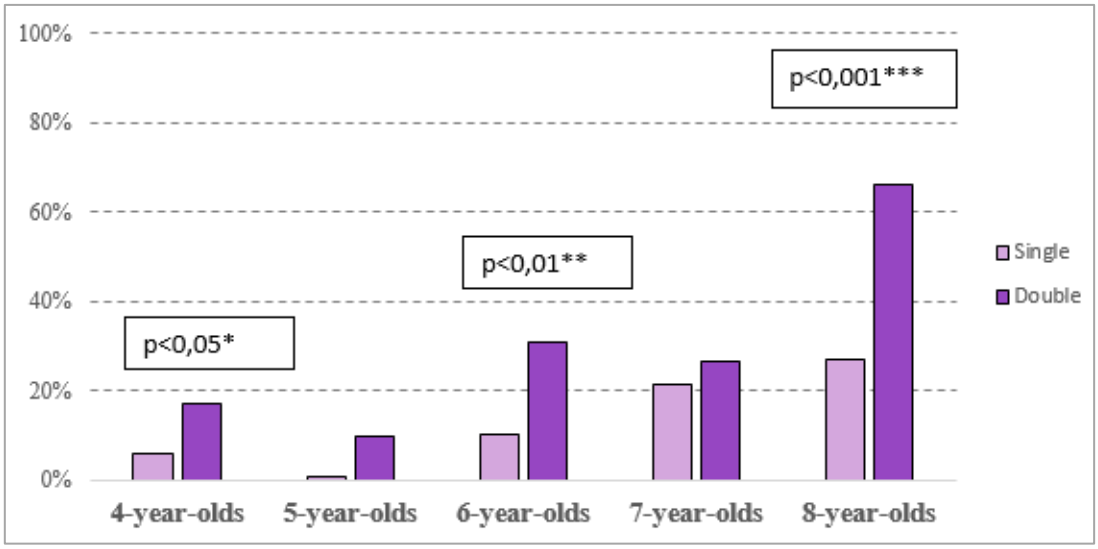

Chart 4. Single and double -NAK possessives

[8] χ^2 (4) = 91,795, p < 0,001***
[9] χ^2 (2) = 26.161, p < 0.001***
[10] χ^2 (3) = 28.293, p < 0.001***
[11] χ^2 (4) = 91.795, p < 0.001***

A greater proportion of double than single -NAK suffix possessive structures were produced by participants at the ages of four[12], five, six[13] and eight[14].

	Correct	Omission of some components of the structure	Other	Σ
4-year-olds	42 (23.5%)	**125 (69.8%)[15]**	12 (6.7%)	179
5-year-olds	16 (10.4%)	**117 (76%)[16]**	21 (13.6%)	154
6-year-olds	**80 (41%)[17]**	**75 (38.5%)**	40 (20.5%)	195
7-year-olds	**72 (48%)[18]**	**50 (33.3%)**	28 (18.7%)	150
8-year-olds	**145 (92.9%)[19]**	2 (1.3%)	9 (5.8%)	156

Table 3. Overall results of the production task

The responses of the four- and five-year-old groups were characterized by the fact that the majority of them omitted certain components of the structure. In the case of the six- and seven-year-old groups, there was no discernible difference between the production rates of the entire structure and those of its constituent parts. However, the proportion of responses classified as 'other' was significantly lower than that of the other two response types at this age. The majority of eight-year-olds demonstrated an ability to solve the task correctly, with the production of recursive possessives being significantly more prevalent than incomplete or other responses.

Chart 5 illustrates the proportion of correct answers in D1 and D2.

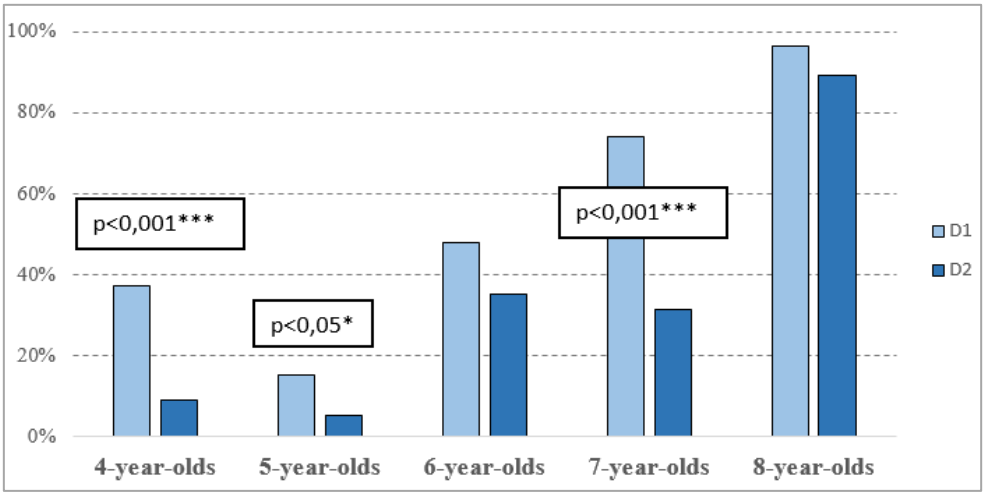

Chart 5. D1 and D2 order in the production task

[12] χ^2 (1) = 5.3607, p < 0.05*
[13] χ^2 (1) = 16.457, p < 0.001***
[14] χ^2 (1) = 16.457, p < 0.001***
[15] χ^2 (2) = 64.075, p < 0.001***
[16] χ^2 (2) = 82.074, p < 0.001***
[17] χ^2 (2) = 7.505, p < 0.05* (The significance value represents the difference between correct and incorrect responses, as well as responses that could be considered "other." It is important to note that there is no difference between correct and incorrect responses.).
[18] χ^2 (2) = 12.877, p < 0.01** (The significance value represents the difference between correct and incorrect responses, as well as responses that could be considered "other." It is important to note that there is no difference between correct and incorrect responses.).
[19] χ^2 (2) = 159.97, p < 0.001***

A comparison of the performance of all age groups for D1 and D2 indicates that D1 is more easily comprehensible and producible at ages four[20], five[21] and seven[22]. Consequently, the aforementioned age groups demonstrated significantly enhanced performance in the production task when they had previously encountered the target sentence in the comprehension test.

5.4. Discussion

The 4 to 8 age group demonstrated a ceiling-level pattern of solving the comprehension task, with even 4-year-olds selecting the correct ingredient for the corresponding character with greater frequency as well as their older counterparts. As previously stated in Section 4, the recursive possessive task also precludes the possibility of conjunctive interpretation, as there is no default conjunctive reading option available to participants. The errors in comprehension were typically due to lexical errors.

It is more probable that children will correct a wrong response rather than persist with it in comprehension task. In the event of an error, the error is typically located in the second possessor, with the 'corrections' more likely to originate from the second possessor's error than the first. This can be explained by the fact that the second possessor is more complex than the first one, both morphologically and semantically. The suffix *-ja*, which indicates that this element is possessed by the first possessor, is combined with the suffix -NAK, which also indicates possession. This means that it is itself a possessor in the structure. The higher rate of errors observed in the second possessor may be attributed to the morphological overloading of this element.

It is noteworthy that there was no discernible difference in performance between the five age groups in the comprehension task, and that the two designs exhibited no significant difference. Furthermore, it is notable that the size of the sample was relatively limited. Subsequent experiments are planned to involve a larger number of participants. The complexity of D2 is reflected in the fact that, in this case, the four-year-old age group made more corrections than in D1. This assertion is limited to the comprehension task, not the production task. However, it is unlikely to have any impact on the comprehension task. In contrast, the production phase does exhibit a priming effect, whereby the comprehension phase can influence the production of the target structure, but not vice versa. In the production phase, any type of structure could be produced that corresponds to the visual stimulus material.

It has been demonstrated that even four-year-olds are capable of producing recursive possessives. However, it is also evident that up to the age of seven years, in addition to the overall structural configuration, children tend to produce the components of the structure in isolation. In comparison to four-year-olds, the performance of five-year-olds demonstrated a decline. Of all the age groups, five-year-olds were the most likely to ignore the possessors presented in the pictorial stimulus, either the first (*the **witch's** duck's apple*) or the second (*the witch's **duck's** apple*) possessor. It was observed that the participants were only able to successfully produce the target structure after repeated attempts. This was evidenced by the fact that they typically said only the possessee first, then one and then the other possessor, and finally succeeded in producing the whole structure. This is also typical for the other age groups, although the proportion of children who exhibited this behaviour was lower than for the five-year-olds. The data indicate that children aged four and five, as well as those aged six and seven, demonstrate comparable performance in the production task. Therefore, there is a notable increase in performance between the ages of five and six, as well as between the ages of seven and eight.

The double -NAK structure is produced significantly more often than the single -NAK variant by all age groups except seven-year-olds. The data indicate that recursive possessives are produced

[20] $\chi^2(1) = 17.223$, $p < 0.001$***
[21] $\chi^2(1) = 4.6621$, $p < 0.05$*
[22] $\chi^2(1) = 17.185$, $p < 0.001$***

from the age of four, although this is not a universal phenomenon and is specific to the performance of some children. The general production of recursive possessives commences at the age of six or seven and reaches a ceiling-level performance by the age of eight.

The distinction between the two designs is discernible during the period spanning from the ages of four to seven years. Four-, five-, and seven-year-olds are the most receptive to this phenomenon. The impact of having previously primed the target structure in the D1 order during the comprehension test, prior to the initial significant shift, is discernible. A design effect was also observed at age seven, as this is when the target structure begins to be produced. Across all age groups, except for eight-year-olds, there is a positive correlation between performance on tests measuring comprehension and performance on tests measuring production.

It is only at the ages of six and seven that an increase in the number of corrections made during the production phase is observed. The production task (with the exception of eight-year-olds) is more challenging than the comprehension task for all age groups.

6. Conclusion

Two fundamental questions were posed at the outset of the research. The first question that arises is the age at which Hungarian children begin to understand and produce full recursive possessives. The answer to this question is that children already understand the recursive concept by the age of four and begin to produce recursive possessives at the age of six.

Our second question was to ascertain whether, in the event that the different age groups are unable to correctly interpret or produce the target structure as a whole, they are nevertheless able to understand it or to comprehend the meaning of the test sentences. The data on comprehension do not provide much information on this matter, since children as young as four years old can understand recursive possessives with excellence. It can be observed that children under the age of six tend to produce sub-structures rather than the complete structures.

The experiment has demonstrated that Hungarian recursive possessives emerge at an earlier age in both comprehension and production than previously assumed. It is therefore possible that recursion is challenging not because of its inherent complexity, but because it places a heavy load on working memory capacity due to the length of the structures involved. This is a question we intend to address in future experiments.

References

Chomsky, Noam 1959. On certain formal properties of grammars. *Information and Control* 2(2): 137–167. https://doi.org/10.1016/S0019-9958(59)90362-6

Chomsky, Noam 1993. A minimalist program for linguistic theory. In: Hale, Kenneth L. – Keyser, Samuel J. (eds.): *The view from building 20. Essays in linguistics in honor of Sylvain Bromberger*. Cambridge, MA: MIT Press.

Dékány, Éva 2021. Possessive DPs. In: Dékány, Éva (ed.): *The Hungarian nominal functional sequence*. Springer International Publishing. 159–211. https://doi.org/10.1007/978-3-030-63441-4_4

Di Sciullo, Anna Maria 2015. On the domain specificity of the human language faculty and the effects of principles of computational efficiency: Contrasting language and mathematics. *Revista Linguística* 11(1): 28–53.

Freidin, Robert 2014. Recursion in generative grammar. In: Lowenthal, François – Lefebvre, Louise (eds.): *Language and recursion*. Springer. 139–147. https://doi.org/10.1007/978-1-4614-9414-0_11

Gervain, Judit 2014. Early rule-learning ability and language acquisition. In: Lowenthal, François – Lefebvre, Louise (eds.): *Language and recursion*. Springer. 89–99. https://doi.org/10.1007/978-1-4614-9414-0_7

Hauser, Marc D. – Chomsky, Noam – Fitch, W. Tecumseh 2002. The Faculty of language: What is it, Who has it, and how did it evolve? *Science* 298(5598): 1569–1579. https://doi.org/10.1126/science.298.5598.1569

Hollebrandse, Bart, – Roeper, Tom 2014. Empirical results and formal approaches to recursion in acquisition. In: Roeper, Tom – Speas, Margaret (eds.): *Recursion: Complexity in cognition*. Springer International Publishing. 179–219. https://doi.org/10.1007/978-3-319-05086-7_9

É. Kiss, Katalin 2003. A birtokos szerkezet [Possessive structures]. In: É. Kiss, Katalin – Siptár, Péter – Kiefer, Ferenc (eds.): *Új magyar nyelvtan*. Budapest: Osiris Kiadó. 49–54.

Langó-Tóth, Ágnes 2018. The acquisition of Hungarian recursive PPs. *Yearbook of the Poznań Linguistic Meeting* 4: 105–123. https://doi.org/10.2478/yplm-2018-0005.

Mota, Sergio 2017. The never-ending recursion. *Journal of Applied Logic* 25: 89–108. https://doi.org/10.1016/j.jal.2017.03.003

Pinto, Manuela – Zuckerman, Shalom 2019. Coloring book: A new method for testing language comprehension. *Behavior Research Methods* 51(6): 2609–2628. https://doi.org/10.3758/s13428-018-1114-8

Perez-Leroux, Ana Teresa – Castilla-Earls, Anny – Béjar, Susana. – Massam, Diane 2012. Elmo's Sister's Ball: The problem of acquiring nominal recursion. *Language Acquisition* 19: 301–311. https://doi.org/10.1080/10489223.2012.685019

Perez-Leroux, Ana Teresa – Castilla-Earls, Anny – Béjar, Susana – Massam, Diane – Peterson, Tyler 2018. Strong continuity and children's development of DP recursion. In: Amaral, Luiz (ed.): *Recursion across domains.* Amsterdam: John Benjamins. 296–313. https://doi.org/10.1017/9781108290708.018

Perez-Leroux, Ana Teresa – Castilla-Earls, Anny – Massam, Diane – Peterson, Tyler – Béjar, Susana – Roberge, Yves 2018. The acquisition of recursive modification in NPs. *Language* 94(2): 332–359. https://doi.org/10.1353/lan.2018.0019

R Core Team 2019. *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing. https://www.R-project.org/

Roeper, Tom 2011. The acquisition of recursion: How formalism articulates the child's path. *Biolinguistics* 5(1–2): Article 1–2. https://doi.org/10.5964/bioling.8831

Roeper, Tom – Oseki, Yohei 2018. Recursion in the acquisition path for hierarchical syntactic structure. In: Amaral, Luiz (ed.): *Recursion across domains*. Cambridge: Cambridge University Press. 267–278. https://doi.org/10.1017/9781108290708.016

Watumull, Jeffrey – Hauser, Marc D. – Roberts, Ian G. – Hornstein, Norbert 2014. On recursion. *Frontiers in Psychology* 4: Article 1017. https://doi.org/10.3389/fpsyg.2013.01017