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Early Comprehension of Verb Number Morphemes in Czech: Evidence for a Pragmatic Account

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The category of number is present in many languages of the world. The category encodes whether a linguistic expression refers to one or more referents and it is used primarily with nouns, e. g. *car* vs. *cars*. In addition to that, many languages possess various agreement morphemes that mark number information on elements other than nouns, such as adjectives or verbs. One question in language acquisition research is when children master these agreement relationships. This ability demonstrates the knowledge of dependencies between non-adjacent elements within sentences, thus showing mastery of complex linguistic rules. Number marking in verbs is also interesting because it constitutes a part of the verb inflection system, which is challenging for children in a number of languages.

The data on the acquisition of number morphology in verbs is relatively limited. Some information is available from studies that examined when children acquire different grammatical morphemes. In English, de Villiers and de Villiers (1973) showed that children achieve 90% accuracy on using the third-person singular morpheme on verbs between the ages of 26 and 46 months. The case of English, however, is somewhat special because the only number-marking verb morpheme is the 3sg. ending *-s*. Children may acquire agreement marking earlier in languages with richer verb morphology, such as German or Italian. In German, Clahsen (1986) showed that children master the use of the third person singular morpheme by 35 months of age, and its plural counterpart some two months later. Therefore, if there is any difference against English, it is not large. On the other hand, data on Italian show 90% accuracy of third-person singular and plural verb inflections even in children around 28 months of age (Caprin & Guasti, 2009).

The mastery of a morpheme in production does not necessarily correspond to the age when children understand the meaning of the morphemes. It has been shown that comprehension precedes production in various areas of language development, such as lexicon (Fenson, Dale, Reznick & Bates, 1994) or syntax (Golinkoff, Hirsh-Pasek, Cauley & Gordon, 1987). It is thus possible that children

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can use number morphology in verbs even before they reliably produce the corresponding verb morphemes. However, the available studies suggest the opposite. Kenney and Wolfe (1972) examined the production and comprehension of third-person singular forms in children acquiring English. While 4-year-olds used the inflected form correctly in most cases, they were not able to interpret the singular meaning of the form.

Problems with the comprehension of verb number were also reported in more recent studies in different languages. Johnson, de Villiers and Seymour (2005) presented three- to six-year-old American children with sentences such as *The duck(s) swim(s)*, and asked them to point to a picture with one or two referents. The nominal plural ending was masked by blending with the verb-initial *s-*, and children thus had to rely on the verb ending to interpret the number of participants. Only five- and six-year olds performed above chance. The poor performance of children acquiring English might be due to the subject-verb agreement system of English that gives children only limited opportunity to learn the agreement phenomena. However, Pérez-Leroux (2005) performed a similar study in Spanish and found very similar results. Only children above five showed reliable use of verb number inflection in comprehension, even though Spanish has a richer system of verb agreement than English.

Interestingly, the comprehension of number marking on verbs may be asymmetrical. English-speaking children studied by Jonson et al. (2005) understood sentences with the singular form of the verb better than those in plural. Pérez-Leroux (2005) found similar but opposite asymmetry in Spanish, where third-person plural verb forms were comprehended better than sentences with third-person singular verbs. Because in English, third-person plural is marked with zero inflection, and the zero ending is used for third person singular in Spanish, Pérez-Leroux interpreted the results so that children can use number inflections on verbs only when they are explicitly marked, such as in English 3sg. *-s* or Spanish 3pl. *-n*. The zero-marked verb forms are comprehended later.

The results suggesting slow development of verb number comprehension have been challenged by two more recent studies that used the preferential looking paradigm in addition to picture pointing. In the preferential looking method, children are presented with two visual stimuli and auditory input and the experimenters test whether they look towards the stimulus described in the auditory input. Legendre, Barriere, Goyet and Nazzi (2010) used the method, along with the picture pointing task, in French children. Spoken French has no phonological differences between the singular and plural forms of most verbs and pronouns, but there is one context in which the pronoun-verb phrase is different in singular and plural. In this context, the normally silent [z] ending on the third-person plural pronoun is pronounced when the pronoun is followed by a verb beginning with a vocal. Legendre et al. showed that French 30-month-olds, but not 24-month-olds, could use this single-phoneme cue to make the distinction between singular and plural referent pictures. Children at 30 months showed sensitivity to number marking in the preferential looking task, as well as in the pointing task, and there was no significant difference between comprehending the

singular and plural forms. The findings disconfirm the suggestion that children are only sensitive to overt number marking; if this were the case, French children should show better performance in plural. The results also show that French children comprehend number marking much earlier than children in English or Spanish. This may be related to the differences in how number was marked in the French stimuli, where the number-marking morpheme preceded the verb, while the English and Spanish stimuli used suffixes.

In German, Brandt-Kobele and Höhle (2010) examined the comprehension of number marking in 3-year-olds using the preferential looking method. Children in their study showed preference for pictures that corresponded to the linguistic input, and this was comparable for singular and plural sentences. However, children did not show reliable comprehension in the pointing task. The data from German thus contradict previous studies from English and Spanish in that the number inflection was comprehended by children below 4 years of age. In line with the English and Spanish data, children showed no comprehension of number in the pointing task. This is at odds with the data from French where children below 3 performed above chance even in the pointing task.

To summarize, the existing research presents conflicting findings on when and how children understand the verb inflection for number. It is possible that the different findings reflect cross-linguistic differences in the acquisition process, but variations in the format of the task and visual stimuli may contribute to the variability of findings, as suggested by Legendre et al. (2010). With regard to the cross-linguistic differences, of the four languages studied, French and English have very limited number morphology of verbs, while German and Spanish have distinct inflectional forms for most person/number combinations of the inflected verb. However, the Spanish study was performed on a fairly small sample (N=11 in the age band below 4;6 years), which means that the power to detect above-chance performance was relatively low. Most data on languages with richer verb morphology thus originates from the German study (Brandt-Kobele & Höhle, 2010), in which children demonstrated some comprehension in the preferential looking task but not in the pointing task. Children before the age of four thus showed at least some understanding of number morphology. At the same time, the pointing task in this experiment was secondary to the preferential looking task, which might affect performance on both tasks. The aim of the present study was to use a dedicated pointing task to test children's comprehension of verb number in a language with rich verb morphology. This should provide a cross-linguistic extension of the existing studies on languages with rich morphology.

The basic hypothesis for the present study was that children in a language with rich verb morphology should show sensitivity to number inflection in verbs before the age of four. One reason to expect such sensitivity is the existing research on the early comprehension of grammatical gender. Various studies have shown can process grammatical gender as early as 2.5 years of age, and use it to guide comprehension (e. g. Van Heugten, Shi, 2009). The other reason is that children in languages with rich verb morphology do not appear to make errors in

number agreement or omit its markers, even though they generally produce singular and plural verb forms by the age of four (e. g. Smoczyńska, 1985). The lack of sensitivity towards number in Spanish, and in part in German, may thus be due to the limitations of the existing studies.

The present study also addressed the hypothesis that children initially understand unmarked forms of verbs only (Pérez-Leroux, 2005). Czech verbs are interesting from this point of view because both singular and plural third person verb forms are morphologically marked. The suffixes that mark person and number tend to be shorter in singular, but it is not generally the case, and even singular suffixes are clearly distinct from the suffixes in a number of other verb forms. If children have problems with suffixed or marked forms in general, Czech should be rather challenging for them.

The study reported here tested number comprehension in a larger sample of children than the existing studies. Children's responses were examined using age as a continuous predictor, not just as a grouping variable defining the younger and older group. The effects of age on comprehension could thus be studied in more detail. The design compared four types of sentences. In two types, the number inflection on the verb was the only cue to choose between the two possible interpretations. Two additional types were included as controls; one contained a redundant number marker on the subject as well as the verb, the other tested the comprehension of number marker on a noun rather than a verb, contrasting the number of entities referred to by the sentence object rather than object.

The experiment addressed three questions. The first was whether Czech children show comprehension of verb number before four years of age. The second question was whether sentences with singular or plural verbs were comprehended better, or whether there was no difference. The third question asked about the age effects and their possible interaction with the singular or plural distinction. The analyses examined whether comprehension improves during the fourth and fifth year, and whether this improvement is comparable in singular and plural.

1. Method

1.1 Participants, Stimuli and Procedure

Participants. The sample included 72 monolingual Czech-speaking children aged 3;0 to 4;7 ($M = 3;6$), who were considered typically developing by teacher report and were not receiving special educational services. They were all recruited from standard public preschools in Prague, Czech Republic.

Experiment stimuli. In a picture-pointing task, twenty items were presented on a laptop computer screen. Items consisted of a sentence and a pair of pictures that differed in the number of participants/objects involved in the action (see Figure 1). In ten items, the subject was omitted and the only cue for the interpretation was the number inflection on the verb. Five of these items contained a transitive verb, five an intransitive one. Of the remaining items, five items included a lexical subject, and five items contrasted the singular or plural

object instead of subject. For each stimulus type, there were 2 or 3 stimulus sentences representing singular and plural form of the verb, respectively. Two versions of protocol were created that counterbalanced these items.

Table 1: Sample sentence for each stimulus type.

Type	Example
No subject transitive	Tady běží/ běhají. here runs _{sg} / run _{pl}
No subject intransitive	Čte/ čtou knihu. reads _{sg} / read _{pl} a book
Lexical subject	Maminka/ maminky tlačí kočárek. mom _{sg} /moms _{pl} push a stroller
Lexical object	Pán nese tašku/ tašky. man carries bag _{sg} / bags _{pl}

Procedure. Children were instructed that they will see two pictures involving one or more things/persons/animals. They were asked to point to the picture that corresponded to the sentence heard. In order to avoid effects of intonation, pre-recorded stimuli (native speaker, male voice) were used. For each item, the picture was shown first, and the recording was played while the child looked at the screen. The answer was considered correct if the child pointed to the picture that corresponded to the sentence within a 10s limit. Otherwise, the answer was regarded as incorrect (wrong picture, out of limit) or missing (no answer). If children did not obey the instruction for the first time, the pre-recorded sentence was presented once more. The relative position of the target picture was also counterbalanced in both of the protocols (10 on the right, 10 on the left).

Lexical test. Because there is no standardized assessment instrument available for Czech, an experimental task developed by the second author was used. This was picture-selection receptive vocabulary task that used similar format as the Peabody Picture Vocabulary Test (Dunn & Dunn, 2007). The whole set consisted of 30 items.

1.2 Analyses

The data were analyzed using binomial mixed models. This method is similar to logistic regression in that it can estimate the effects of continuous predictors, such as age, on the chance of a categorical event, such as a correct response in an individual trial. Categorical predictors, e. g. experimental condition, may be included as well. Unlike logistic regression, mixed logistic models can account for the repeated-measures nature of experiments in which a participant responds to multiple items, and the same items are presented to a number of participants. The method estimates the value of the logarithm of the odds of the correct response, and the change in this value associated with different values of the

predictors. By taking the exponential of the estimated value for a categorical predictor, we obtain the odds ratio, i. e. the ratio between the baseline odds and the odds when the predictor has a non-baseline value. For a continuous predictor, the odds ratio is the expected change in odds when the predictor increases by one unit.

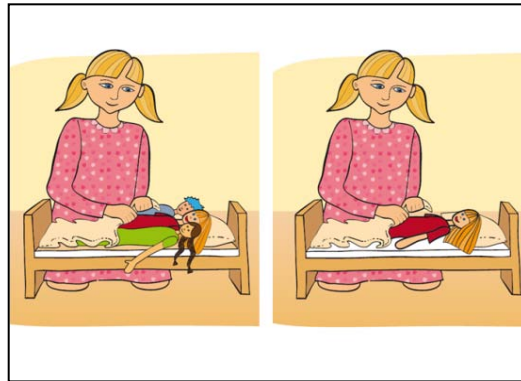


Figure 1: Pictures for stimulus sentence *The girl is covering the doll(s)*.

2. Results

The overall proportion of correct responses was 0.58 (SD=0.16), with 0.52 (0.28) in singular and 0.65 (0.24) in plural trials. However, these mean values are of little interest since the goal was to examine the relationships between comprehension and age. This relationship is demonstrated in Figure 2.

The figure suggests that younger children show similar performance in singular and plural, perhaps with an initial advantage for plural sentences. However, the comprehension of singular sentences increases sharply in older children, while the comprehension of plural remains at the same level. The initial statistical analysis included three predictor variables, age, grammatical number (singular vs. plural), and the sentence type (4 types), as well as the interaction between age and number. There was no significant effect of sentence type, and removing this predictor from the model did not result in a significant decrease in the model fit. For this reason, the model without sentence type was retained and is reported here.

The results of the statistical analysis (see Table 2) confirmed the tendencies observed in the graph. The intercept, which reflects the estimated performance in singular at 3 years of age, is significant and negative, suggesting that the initial performance in singular is below the chance level. The significant positive effect of condition means that the performance in plural at 3 years is significantly better than in singular. The effect of age is an estimate of age-related change in the singular condition. Since the effect is highly significant, it shows that performance in singular increases with age; the estimated log-odds of 1.036 show

that the chance of observing a correct response is 2.81 times higher at 4 than at 3 years. The significant negative interaction term for condition and age shows that the effect of age is lower in plural than in singular; in fact, there is a slight decrease in successful comprehension with age.

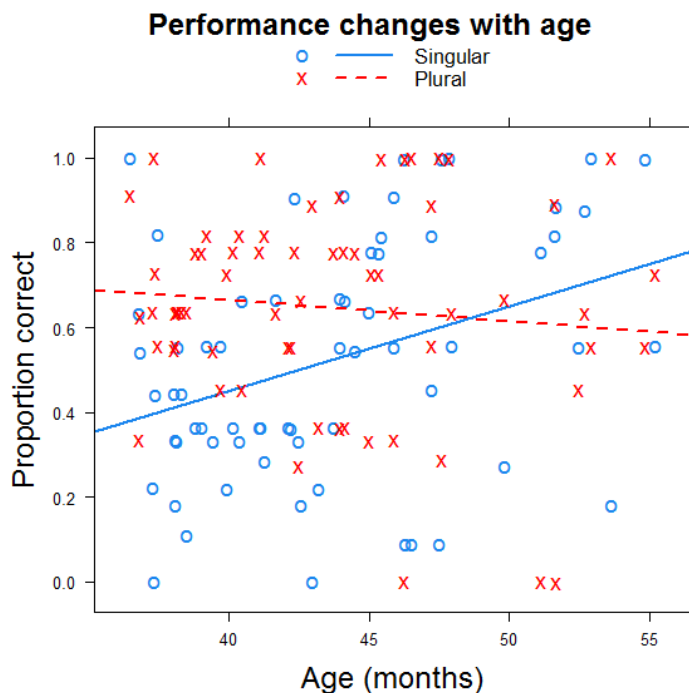


Figure 2: Proportion correct in each condition, along with the regression lines for each condition.

Since it is known that young children of the same show substantial differences in their linguistic skills, an alternative analysis was performed with lexical score used instead of age. This was warranted also by the results of a regression analyses examining the overall performance in the comprehension task as a function of age or the lexical score. Lexical score accounted for 8.5 % of variance in the task, while age only for 1.7 %.

The model with lexicon instead of age (see Table 2) provided similar results to the model with age, except that in the plural condition, there is no decrease in performance with increasing lexical skills. However, there is a clear interaction between condition and lexical score, i. e. difference between the relationship of comprehension and lexicon in singular and plural sentences. Comprehension of singular sentences improves with improving vocabulary, but it is not the case in plural sentences.

Table 2: Proportion correct in each condition, along with the regression lines for each condition.

Effect	Log-odds	z	p
Model with age			
Intercept	-0.578	2.89	0.004
Age (yr)	1.036	4.09	<0.001
Condition (plural)	1.451	6.65	<0.001
Age × cond. (plural)	-1.390	4.86	<0.001
Model with lexicon			
Intercept	-0.793	3.15	0.002
Age (yr)	0.137	3.90	<0.001
Condition (plural)	1.316	4.64	<0.001
Age × cond. (plural)	-0.119	2.92	0.003

3. Discussion

The findings of our study suggest that children at the age of 3 have some knowledge of verb number, but still must acquire important aspects of the system. We found differences between the comprehension of singular and plural in 3-year-olds. Interestingly, we found differences in how the comprehension of singular and plural changes with age. Three-year-olds in our study showed below-chance performance in sentences with singular forms, and significantly better performance in plural. But while the performance in singular increased considerably with the age of children, the same effect did not occur in plural, where the comprehension remained above chance constantly.

These outcomes are not in line with the suggestion that children comprehend marked forms only. This suggestion was based on the findings that English-learning children find singular forms (3sg. ending *-s*) easier to understand (Johnson et al., 2005), while children acquiring Spanish show better performance in plural (3pl. ending *-an*; Pérez-Leroux et al., 2005). However, it is not consistent with the current data. First of all, Czech verbs are morphologically marked both in singular and in plural 3 person form, but an asymmetry in comprehension was still observed. Second, the current data show no consistent pattern of performance in singular and plural, but a different developmental trend in each of these categories.

One important observation is that the comprehension of sentences marked with singular or plural verb inflections did not significantly differ from sentences in which number was encoded on nouns. Even though the current design was probably not powerful enough to confirm a general lack of differences in this respect, it suggests that the comprehension of number may be challenging not just because of verb morphology.

It is difficult to explain the observed developmental asymmetry in terms of grammatical development. However, the observed asymmetry in interpreting singular and plural sentences may result from limits in understanding the task, and these limitations in verb number comprehension might be related to developments in pragmatic, not grammatical understanding. Generally speaking, singular sentences are true even about pictures with multiple actors/objects. In a picture where people *are* cutting the grass, there is always an individual who *is* cutting the grass. This is not true about plural sentences, which may be only used for pictures showing plural situations. Children may initially find it difficult to understand that they should select the more appropriate one-actor picture for singular sentences, even though the sentence is literally true about both pictures. In other words, since singular sentences may refer to one participant in a multi-participant picture, the choice of the single-participant picture is not based solely on grammatical understanding, but more likely on the pragmatic interpretation of the selected task (“*point to the more appropriate picture of two possible ones*”).

Since no significant effect of sentence type was found, the present study also indicates that children’s problems in comprehending number morphemes in Czech are not specific, or strictly limited, to verb number, which is also consistent with the pragmatic interpretation. On the other hand, the pragmatic interpretation cannot explain the conflicting findings from the previous studies. Clearly, the topic of early comprehension of number morphemes in sentences requires further research and the use of varied experimental tasks in order to triangulate the factors that affect children’s performance. The present study shows children may not only find certain structures less or more difficult, but also that the comprehension of different structures may develop on a different schedule. This demonstrates the developmental aspect needs to be taken into account in future studies

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