
# Comprehension of verb number morphemes in Czech children: singular and plural show different relations to age and vocabulary



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Abstract

Two experiments examined Czech children's comprehension of grammatical number marking in verbs. Children were presented with picture pairs involving one or multiple participants in the same action, and were asked to point the picture described by a recorded sentence. Experiment 1 (N=72, age 3;0 to 4;7) tested four types of sentences, some of which marked the number of participants on the verb only. There was a marked increase in comprehension scores with age and receptive vocabulary scores in singular, but not in plural sentences. This pattern was present regardless of how number was marked. Experiment 2 (N=45, age 3;4 to 4;9) replicated the key findings of Experiment 1. The results suggest that comprehension of morphological number markers remains difficult even when children routinely produce such markers. However, when compared with results from other languages and experimental paradigms, it appears that the effect is due mainly to children's comprehension of the task and not limitations in their grammatical knowledge.

The category of number is present in most, if not all languages of the world. It 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. This means that the choice of morphemes that mark one element in a phrase or a sentence depend on grammatical categories of a different element; e. g. in English, the marking of a verb depends on the number of the subject (*he walks* vs. *they walk*). The ability to use grammatical agreement demonstrates the knowledge of the relations between various elements within sentences, often non-adjacent, thus showing mastery of complex linguistic rules. The acquisition of agreement and number marking on verbs provides opportunities to study the development of abstract linguistic representations in children. The verb inflection system in general is challenging for children in a number of languages (e. g. Rice, Wexler, & Hershberger, 1998), and examining different aspects of this system in development helps to understand the nature of this challenge.

One peculiar fact about number agreement in development is that for a long time during development, children have limited ability to use agreement morphemes in comprehension. Several reports found that children show surprisingly late comprehension of verb number, having problems to distinguish referents of sentences such as *The birds sing* and *The bird sings*. This is so even when children use the corresponding morphemes in their own productions. 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. There are some addtional studies that made similar findings in English (Johnson, 2005; Leonard, Miller, & Owen, 2000). 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 children acquiring Spanish aged 3 to 6 years in Dominican Republic, 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. The findings were similar to those by Johnson et al. (2005) in that there were asymmetries in singular and plural comprehension. In both languages, children comprehended the morphologically marked forms better than forms with zero marking; comprehension was better for singular forms in English and for plural forms in Spanish. These findings were elaborated in a series of experiments on child Spanish recently reported by Miller and Schmitt (2014). These confirmed that children acquiring Spanish have problems comprehending number encoded in verb affixes.



Preferential looking vs. picture-pointing studies

Even though limited comprehension of verb number has been found in a number of studies, opposite findings have been reported as well. Childers, Echols, and Tomasello (2001) used a picture pointing task with children acquiring Spanish, and their 3-year-old participants showed above-chance comprehension of third-person singular, but not plural. However, as Miller and Schmitt (2014) pointed out, the children showed a baseline preference for the singular pictures, which was different from the two other picture-pointing studies. There are two other studies that used the preferential looking paradigm in addition to picture pointing,

and found evidence of comprehending verb number in young children. In the preferential looking method, children are presented with two visual stimuli and auditory input and the experiments test whether they look towards the stimulus described in the auditory input. Legendre, Barrière, 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. These findings do not confirm 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 indicate that French children comprehend number marking much earlier than children acquiring 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.

Another preferential looking study was reported by Brandt-Kobele and Höhle (2010), who examined the comprehension of number marking in 3-year-olds acquiring German. 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, but are in line with the English and Spanish data, as children showed no comprehension of number in the pointing task. This is at odds with the data from French where children below 3 years performed above chance even in the pointing task.

The existing research thus presents conflicting findings on when and how children understand the verb inflection for number. It is likely that variations in the task format and visual stimuli contribute to the variability of findings, as suggested by Legendre et al. (2010) and Miller and Schmitt (2014). An important source of variability could be the cross-linguistic variation, but the available data do not show any clear pattern. 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. In each group of languages, early comprehension of verb number was found in one but not the other language. The distinction between rich and limited morphology thus does not coincide with children's difficulty in comprehending number agreement. At the same time, it should be noted that the range of languages that have been examined is still quite limited.

One limitation of the existing studies is the fact that they only considered the factor of age in a very rough way, if at all. Johnson et al. (2005) reported their results for English-learning children in yearly age bands from 3 to 6 years, with evidence of comprehension only in children 5 and above. Similarly, Pérez-Leroux (2005) compared two groups of children, below 5, and 5 and older. Miller and Schmitt (2014) used one group of 4-year-olds in the experiment targeting comprehension of verb morphemes in Spanish null-subject sentences. The existing studies on German and French found comprehension of verb agreement in much earlier ages but also in these studies, the age factor was treated only on group level (Legendre et al., 2010) or not at all (Brandt-Kobele & Höhle, 2010). It is thus not clear when and how abruptly the changes in comprehending singular and plural verb forms happen. Related to this

is the question of whether the ability to comprehend number changes with age, or rather with increasing linguistic skills. The existing studies provided no estimate of individual level of language development.

The present study: design, questions, hypotheses

The present paper presents two experimental studies that attempted to extend the available data on children's comprehension of number agreement morphemes. The studies are novel in two directions. They test a new language, Czech, and they track language development using continuous data on age and overall language development. The experiments are also based on larger participant numbers that the existing studies in Spanish and English, and have thus greater power to detect differences from the chance level. In addition, Experiment 1 compared comprehension of sentences with subject number marked on the verb only, and sentences where number information was also presented on nouns.

Examining a new language may be viewed as a critical contribution. The previous research examined four languages. Only two of them, Spanish and German, have complex verb inflection paradigms, and the results from these proved somewhat contradictory. Adding another language may thus show which of the previous results is more likely to generalize across languages.

The key questions motivating the studies are:

1) Do Czech children around 4 years of age comprehend number marking on verbs in the absence of other cues?
2) Is there an asymmetry between comprehending singular and plural?
3) How does comprehension of verb number increase with age and vocabulary skills? Is there a steady increase? Is the increase similar for singular and plural stimuli?

In order to keep the results comparable with as much of the existing research as possible, the experiments used the pointing task rather than the preferential looking method. While preferential looking has only been used in German and French, all existing studies included picture pointing. In addition, the pointing task may reflect the typical use of language comprehension better than the preferential looking task. While the process of language comprehension is highly automatic, its results, i. e. the messages we comprehend and upon which we perform deliberate actions, are open to conscious control. The pointing task is sensitive to this level of comprehension. The alternative, implicit tasks such as preferential looking may reveal some aspects of children's language knowledge but do not show that children are able to act on this knowledge. Moreover, preferential looking results may be affected by children's preferences for individual pictures, and it is not always possible to created a fully counterbalanced design to control for this preference.

The basic properties of Czech

Czech is West Slavic language, together with Polish, Slovak and Upper and Lower Sorbian. It is highly inflected with extensive case marking and verb inflection. Nouns, adjectives and many pronouns and numerals are marked for seven cases, as well as number. Verb marking reflects person, number, tense and aspect on verbs. Both nouns and verbs have different inflectional classes, so that the same categories can be marked by different morphemes, depending on the class membership of the noun or verb. There are 14 main inflectional classes of nouns and 13 for verbs, with numerous minor subclasses. From the viewpoint of the present study, the relevant forms are the third person present indicative form of verbs in singular and plural. There are five main classes of verbs with regard to these forms.

Hypotheses and expectations

The working hypothesis for the study was that children will show problems with using agreement in comprehension. Furthermore, we hypothesized that the performance will be positively related to age and general language tasks, e. g. a vocabulary test. Given the existing findings from other languages, we expected that children would show reliable comprehension of number morphemes only after their 5th birthday or later. This is the predominant pattern in the literature for the picture-pointing task. Only in French, children responded better than chance at 3 years of age even in the pointing task (Legendre et al., 2010); however, the marking of number in the studies of French differs from the other languages in that the plural marker was not a suffix on the verb but a clitic merging with the initial segment of the verb. As such, it may be more salient than number markers in other languages. It could be argued that Czech, as a language with rich agreement morphology, provides children with ample opportunities for learning the significance of number marking on verbs, and they would thus perform better than children acquiring a language with limited morphology, such as English. However, the same argument could be made for Spanish, and there is enough evidence to show that number marking is difficult for children acquiring Spanish. Even German children show limited performance in pointing tasks, even though the language inflects all main verbs for number. For this reason, the expectation was that Czech children would also show weak performance with number interpretation. At the same time, given the age range of children involved in the study, it was expected that children's performance would show a positive relation with age and vocabulary skills.

## Experiment 1

In the first experiment, comprehension of sentences with singular or plural arguments was compared in four types of structures. There were two types of sentences in which number

information was only carried on the verb and the subject was omitted. The two types differed by containing either transitive or intransitive verbs. Two additional types were included as controls; one with explicit lexical subjects, including a redundant number marker on the subject as well as the verb. The other type of controls had singular subjects and singular verb forms but differed in whether the object noun was singular or plural. This compared the comprehension of number marking in verbs and in nouns. Examples of the four sentence types are in Table 1.

## Method

*Participants.* The final sample consisted of 65 monolingual Czech-speaking children aged 3;0 to 4;7 years (M = 3; 6), who were were not receiving special educational services and their teachers had no suspicion of developmental delays. They were all recruited from standard public preschools in Prague, Czech Republic. There were seven cases when children were dropped because of incorrect information on the consent forms, or because they did not cooperate during the procedure. However, most children who started the procedure were able to finish.

*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. 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 stimulus sentences representing one condition (signular and plural) and 3 sentences representing the other condition. This was counterbalanced using two versions of the protocol, so that the total of singular and plural items per person was the same,

and that the total number of singular and plural items across persons in each condition was the same..

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Table 1 about here

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The stimuli were designed so that we first created the stimulus sentences, and then asked an artist to create the pair of pictures for the singular and plural version so that there were as few changes as possible. The artist used computer graphics so that the pictures for plurals included the original picture for singular, and added one participant.

*Procedure*. Children were tested individually in a quiet room in their preschool. Only the examiner (the second author, VB) was present during the session, and the whole session was videorecorded. Children were instructed that they would 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 confounding effects of intonation, we controlled these by using the same pre-recorded stimuli for all participants (native speaker, male voice). 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).

*Vocabulary test.* Because there is no standardized assessment instrument available for Czech, an experimental task developed by the authors was used. This was a 30-item receptive vocabulary task that used similar format as the Peabody Picture Vocabulary Test (Dunn & Dunn, 2007). In each item, children were shown a page with four pictures and asked to point to the picture that corresponded to the word given by the experimenter. The task was used in previous studies from the same lab (e. g. Smolík, 2015).

*Analyses.* The data were analyzed using binomial mixed models fitted using the lme4 library for R (Bates, Maechler, & Bolker, 2011). 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 trials, and the same trials are presented to a number of participants. To account for this, the models reported here include crossed random effects for persons and trials. 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.

## Results

The overall mean 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 relations between comprehension and age, captured in Figure 1.

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 primary 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 significant decrease in the model fit ($\Delta\chi^2(12)=7.57$, $p=0.82$). 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 odds ratio of 1.036 shows 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.

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Figure 1 about here

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Table 2 about here

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Since it is known that young children of the same age show substantial individual differences in their linguistic skills, an alternative analysis was performed with vocabulary score used instead of age. This was warranted also by the results of a regression analysis examining the overall performance in the comprehension task as a function of age or the vocabulary score. Vocabulary score accounted for 8.5 % of variance in the task, while age only for 1.7 %. The model with vocabulary scores as a predictor provided similar results to the model with age (cf. Table 2 and Fig. 1). There was a clear interaction between condition and lexical score, i. e. the relation between sentence comprehension and vocabulary was different for singular and plural sentences. Comprehension of singular sentences improved with larger vocabulary, but this was not the case in plural sentences.

## Discussion

Experiment 1 suggested that children at the age of 3 years have limited ability to comprehend verb number and the number system in general. Three-year-olds had below-chance performance in singular, and significantly better performance in plural. But while the performance in singular got considerably better in older children, the performance in plural was not related to age. Using vocabulary knowledge instead of age resulted in a similar pattern; the children with higher vocabulary scores showed better comprehension of singular sentences, but the relation between vocabulary and number comprehension was much weaker in plural sentences.

An important finding is that that there was no evidence of differences between sentence types. The pattern of performance was the same whether number was marked on verb only, noun only, or both. The results thus suggest that the difficulty in comprehending

number morphemes is not specific to verb morphology but affects number morphology in general, or perhaps the notion of reference to number using grammatical means.

Although Experiment 1 provided clear results, it was limited in some ways. One limitation is the low number of stimulus sentences per condition. Because the tasks given to young children must be limited in length, and there were four conditions in total, there were only 5 items per condition. Another limitation is the use of verbs with different complexity of number marking. Different classes of verbs in Czech have different way of forming the plural, and the distinction between plural and singular has different salience for different words. In Experiment 1, the verbs used in the test sentences were mixed with respect to the inflectional class. In some verbs, singular differed from plural only by changing the final vowel or replacing it with a diphtong (nes*e*-nes*ou*; carry). In others, the plural form contained an extra syllable (děl*á*-děl*ají*; do). It is thus possible that the differences between the saliency of singular and plural marking in some of the verbs were the primary reason for the differential effects of age or skill on singular and plural comprehension.

Experiment 2 was thus designed to compare comprehension of transitive and intransitive sentences with omitted subjects, for which the verbs used one type of plural marking with comparable level of saliency for singular and plural. Another purpose was to replicate the findings of Experiment 1 in an independent sample of participants, though in only a subset of the stimulus sentence types.

## Experiment 2

Experiment 2 replicated Experiment 1 in most respects. However, the key focus was on establishing whether the asymmetries between singular and plural comprehension will persist if the singular and plural marking of verbs will be similarly complex. For this reason, only two sentence types from Experiment 1 were included, transitive and intransitive sentences with omitted subjects number marking on verbs only. The verbs were selected from one class only, with the ending –e (pronounced [ɛ]) in the third person singular form, e. g. *nese* (he/she carrries). The third person plural form for these verbs is marked by the diphthong –ou [oʊ], such as *nesou* (they carry).

### Method

*Participants.* A total of 45 children aged 3;4 to 4;9 years, (M=4;1, SD=4.49 mo.), participated in the follow-up study. All of them spoke Czech as the first language and were drawn from standard public preschools in Prague, Czech Republic. Children were not receiving special educational services, and their teachers considered them typically developing. Like in Experiment 1, there were less than 5 cases of children being dropped because of incorrect information on the consent forms, or because they did not cooperate during the procedure. However, most children who started the procedure were able to finish.

*Stimuli.* The stimuli were constructed in the same way as in Experiment 1, but because there were only two experimental conditions, the total number of stimuli 16, which was lower than in Experiment 1, even though there were more stimuli (8 as opposed to 5) per condition. Children were presented with pairs of pictures on a laptop computer screen, and a stimulus sentence describing one of the pictures was played while watching the picture. Children's task was to point to the correct picture. There were two training items presented before the 16 experimental items. Half of the stimulus sentences contained a transitive verb, the other half

an intransitive verb. All sentences had null subjects, and the number was only marked on the verbs. Table 3 shows a sample transitive and intransitive sentence.

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Table 3 about here

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*Procedure and analyses.* The procedure was identical to that in Experiment 1. The same vocabulary task was used to obtain vocabulary scores from the children. Statistical analysis was performed in the same way as in Experiment 1.

Results

Statistical analysis with age and experimental condition as dependent variables revealed an interaction between the predictors. There was no relation between age and comprehension levels for plural items, but a clear increase in comprehension performance with increasing age for singular items. The model estimates are reported in Table 4, and Fig. 2 shows the graph capturing the relation between age and comprehension. The results with age as the predictor closely resemble the results of Experiment 1. The results using vocabulary scores as the measure of language development differed from Experiment 1, finding no effects or interactions of experimental condition. The only significant effect in this analysis was an increase in accuracy with increased vocabulary scores.

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Table 4 about here

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Figure 2 about here

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General discussion

The two experiments reported here bring new evidence to the discussion about children's early comprehension of number agreement morphemes. Czech children were shown to have considerable limitations in comprehending number. These limitations differed for singular and plural sentences in that the comprehension of singular sentences improved with age, but this was not the case for sentences with plural forms. The younger children in both studies, who were about 3;0 or 3;6 years, showed poor performance in both singular and

plural comprehension, perhaps with somewhat higher comprehension scores for plural. Older children, before 5, comprehended singular sentences substantially better than sentences in plural. In both experiments, the age at which the comprehension of singular forms became better than comprehension of plural was around 48 to 50 months, i. e. around the 4th birthday. Given that this is a finding from independent samples of children with a partially different set of stimuli, the similarity provides strong evidence for the interaction between experimental conditions and age.

The analyses using vocabulary scores as the measure of linguistic advance resulted in similar findings as the analyses with age in Experiment 1; comprehension performance for singular was related to vocabulary scores more strongly than comprehension of plurals. In Experiment 2, the interaction between vocabulary score and the condition was not significant, even though the tendency was similar as in Exp. 1 (see Fig. 2). Children in Experiment 2 were somewhat older, so it is possible that the lack of a significant interaction reflects the absence of younger children with particularly low performance on singular items.

An important result of Experiment 1 is the lack of differences between sentence types in which number was marked on verbs, on nouns, or on both. This suggests that the problems with number comprehension are not due specifically to number marking on verbs. Children appear to have problems with morphological marking of number in general. Finally, the use of age and vocabulary scores as continuous independent variables demonstrated a steady increase of comprehension performance during the observed age ranges, at least for singular items. The change in comprehending singular sentences appears to be smooth rather than sudden, spread out over the period between 3 and 5 years of age.

The present study is in line with previous findings reported for English by Johnson et al (2005), and for Spanish by Pérez-Leroux (2005), and Miller and Schmitt (2014). Even

though morphological marking of verb agreement is substantially richer in Spanish compared to English, children before 4 or 5 show limitations in number comprehension in both languages, suggesting that the poor performance is not due to children's limited experience with morphological marking. The present data from Czech strengthen this conclusion, as Czech has a rich system of morphological marking as well, and the children still showed problems with comprehending number morphology.

The present findings correspond to those reported by Johnson et al. (2005) and Pérez-Leroux (2005) also with respect to age differences. Three-year olds in Johnson's et al. study showed no comprehension of either number, but the differences were observed among six-year olds. In the study by Pérez-Leroux, 5-year-olds showed no comprehension, but 6-year-olds comprehended plural sentences above chance. The present study suggests that the ability to comprehend number develops during the fifth year. This is somewhat earlier than suggested by Pérez-Leroux, but the present study was substantially more powerful due to larger participant numbers and continuous design; it is thus possible that Pérez-Leroux was only able to discover comprehension in the older children while the present study was able to find smaller differences.

Explictly-marked vs. zero-marked categories

Based on the findings from English and Spanish, Pérez-Leroux (2005) suggested that children initially have problems comprehending verb forms with zero morphological marking, and understand explicitly marked forms earlier that zero-marked forms. Our results show that this is generally not the case. In Czech, the third person present forms have some morphological marking in singular as well as plural, but there was a clear difference in comprehension in the older children, with singular being easier. It could be argued that the marking of singular and plural is in fact different; the morphemes marking plural are longer

and sometimes add another syllable to the form, while the marking of singular forms is usually shorter. However, if this asymmetry were the cause of the difference between singular and plural comprehension in Czech, it would be the direct opposite of what the hypothesis of explicit marking predicts. If children comprehend the more salient morphological markers better, older Czech children should be better at plural, not singular comprehension. This was not the case.

The comprehension-production asymmetry

The problems with plural comprehension are surprising because four-year-olds routinely use verb number marking in their own productions. It is true that children acquiring English tend to omit the 3rd person singular –s for a fairly protracted period, but they do not ignore it completely and appear to have at least partial mastery of it (e. g. Rice et al., 1998). In languages with richer morphology, to our knowledge, systematic omission of plural markers has not been reported. In the absence of experimental studies, it is difficult to exclude the possibility that children sometimes fail to use plural morphology in their productions, and this goes undetected because adults do not know the child's communicative intention. However, the comprehension performance in pointing tasks before 4 years of age is essentially random. This is not the case in production. Overall, the present experiment and the previous research suggest that comprehension of number morphology is in some way behind its production. This is atypical in comparison to most other areas of language acquisition; usually, children show comprehension of structures that they do not yet produce.

Possible limitations in pragmatics

Even though there is now good evidence that children across languages have problems with interpreting number morphology in pointing and act-out tasks, the available research gives reasons to suggest that the failure is not due to limitations in morphological knowledge,

or to any limitations in comprehending the notion of number. The chief reason to assume that children have the knowledge of linguistic number is research using preferential looking. This has shown comprehension of number in French (Legendre et al., 2010), German (Brandt-Kobele & Höhle, 2010), as well as English (Kouider et al., 2006). The studies in each of these languages tested somewhat different structures, and the languages differ in the exact way number is marked, but this confirms that preferential looking studies show sensitivity to various form of number marking. The existing pattern of results indicates that the problems with number comprehension are limited to the pointing tasks. The failure to select appropriate referents may thus result from a difficulty in understanding the task or making a conscious decision in the task. There are at least two reasons why the pragmatics of the task situation may be challenging for children. First of all, the singular sentences may be viewed as appropriate descriptions of both pictures presented to the children in each trial. When a child is confronted with two pictures, one with one sleeping cat, the other with two sleeping cats, a sentence such as *The cat sleeps* describes the one-participant picture as well as a part of the two-participant picture. Perhaps children have problems with evaluating the two pictures in a task as distinct units, "framing" them as the objects of reference. Similarly, the plural sentence *The cats sleep* may be viewed to refer to the whole array of the singular and plural picture together, rather than individual pictures. The comprehension problems may thus result from a failure to interpret the two pictures in a trial as units of which only one is described, and the description must fit the whole picture.

The interpretation of children's deficits as limitations in pragmatics might explain why there are differences between the pointing and preferential looking tasks. The pointing task requires children to make a controlled, intentional decision about where they should point, while preferential looking tasks rely on automatic processes manipulating children's attention. The effects of linguistic comprehension on the latter may be more direct than its effects in

conscious decision making. If this proposal is correct, some alternative behavioral tasks should result in improved performance of the children. One possibility is to replace the pointing task with some version of the truth value judgment task (Crain & Thornton, 2000), in which the children have to decide whether a description is true about a particular picture. This may be embedded in a play context in which children are asked to help a character who is just beginning to learn the language, and say whether the character is labeling pictures appropriately. Children thus see only one picture with each stimulus sentence, and they have a reason for "plausible dissent" if the character describes the picture incorrectly. In this type of task, the pragmatic difficulties connected to selecting the appropriate picture should be eliminated or reduced. Another way of testing the proposal of pragmatic limitations is to include measures of pragmatic development, and examine whether comprehension of number is better in children with higher pragmatic scores.

The suggestion of pragmatic limitations is plausible given the existing research, but the present study does not provide direct evidence that this is the actual cause. Rather, it suggests that this possibility should be investigated further. One problem with the suggestion is that it does not explain the asymmetries between singular and plural in development, and the fact that these asymmetries may be different across different languages. While the current Czech data and the data from English (Johnson et al., 2005) suggest that young children improve in comprehending singular but their comprehension of plural remains weak, the data from Spanish suggest better comprehension of plural (Pérez-Leroux, 2005; Miller & Schmitt, 2014). This is not easily explained by pragmatic factors because such factors should be similar in children across languages. At the same time, the current results show that the difference between Czech and English on one hand and Spanish on the other is not due to the way number is marked on verbs: in this respect, Czech is more similar to Spanish than to English.

Even though children's limitations in comprehending the grammatical marking of number have been described some time ago (Kenney & Wolfe, 1972), the amount of available research on this topic is limited but growing (e. g. Aljenaie, Abdalla, & Farghal, 2011; Arias-Trejo, Abreu-Mendoza, & Aguado-Servín, 2014; Arias-Trejo, Cantrell, Smith, & Canto, 2014, Lanter, & Basche, 2014). The present paper reports on studies that used a new language and larger samples than previous research, and provides converging evidence that children's comprehension is indeed limited. Taking into account the existing findings, it appears that the poor comprehension is limited to language tasks that require active participation and decision on the side of children, such as pointing and act-out tasks. Further research should focus on the possibility that these effects are caused by limitations in children's ability to understand the task requirements, i. e. to the development of pragmatics, rather than morphology.

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Table 1: Sample sentence for each stimulus type.

| Type | |
|---|---|
| No subject intransitive | Tady běží/ běhají |
| | here $runs_{sg}$/ $run_{pl}$ |
| No subject transitive | Tady čte/ čtou knihu |
| | here $reads_{sg}$/ $read_{pl}$ a book |
| Lexical subject | Maminka/ maminky tlačí kočárek. |
| | $mom_{sg}$/$moms_{pl}$ push a stroller |
| Lexical object | Pán nese tašku/ tašky. |
| | man carries $bag_{sg}$/ $bags_{pl}$ |

Table 2:

Parameter estimates and significance tests for the fixed-effect terms in Experiment 1.

| Effect | Log-odds | OR | z | p |
|---|---|---|---|---|
| Model with age | | | | |
| Intercept | -0.578 | 0.56 | 2.89 | 0.004 |
| Age (yr, centered at 3) | 1.036 | 2.82 | 4.09 | <0.001 |
| Condition (plural) | 1.451 | 4.27 | 6.65 | <0.001 |
| Age × cond. (plural) | -1.390 | 0.25 | 4.86 | <0.001 |
| Model with lexicon | | | | |
| Intercept | -0.793 | 0.45 | 3.15 | 0.002 |
| Lexicon (raw, median centered) | 0.137 | 1.15 | 3.90 | <0.001 |
| Condition (plural) | 1.316 | 3.73 | 4.64 | <0.001 |
| Lexicon × cond. (plural) | -0.119 | 0.89 | 2.92 | 0.003 |

Table 3

Sample sentences from Experiment 2

| Type | |
|---|---|
| Transitive | Tady líže/ lížou zmrzlinu |
| | here $lick_{sg}$/$lick_{pl}$ ice cream |
| Intransitive | Tady plave/plavou |
| | Here $swim_{sg}$/$swim_{pl}$ |

Table 4

| Effect | Log-odds | OR | z | p |
|---|---|---|---|---|
| Model with age | | | | |
| Intercept | -1.04 | 0.35 | -2.09 | 0.04 |
| Age (yr) | 1.43 | 4.18 | 3.34 | <0.001 |
| Condition (plural) | 1.70 | 5.47 | 2.90 | 0.003 |
| Age × cond. (plural) | -1.51 | 0.22 | -3.20 | 0.001 |
| Model with lexicon | | | | |
| Intercept | 0.588 | 1.80 | 3.57 | <0.001 |
| Lexicon (raw, median centered) | 0.110 | 1.12 | 2.50 | 0.01 |
| Condition (plural) | -0.114 | 0.89 | -0.71 | 0.48 |
| Lexicon × cond. (plural) | -0.070 | 0.93 | -1.45 | 0.15 |

Figure 1: Proportion correct in each condition, along with the regression lines for each condition.

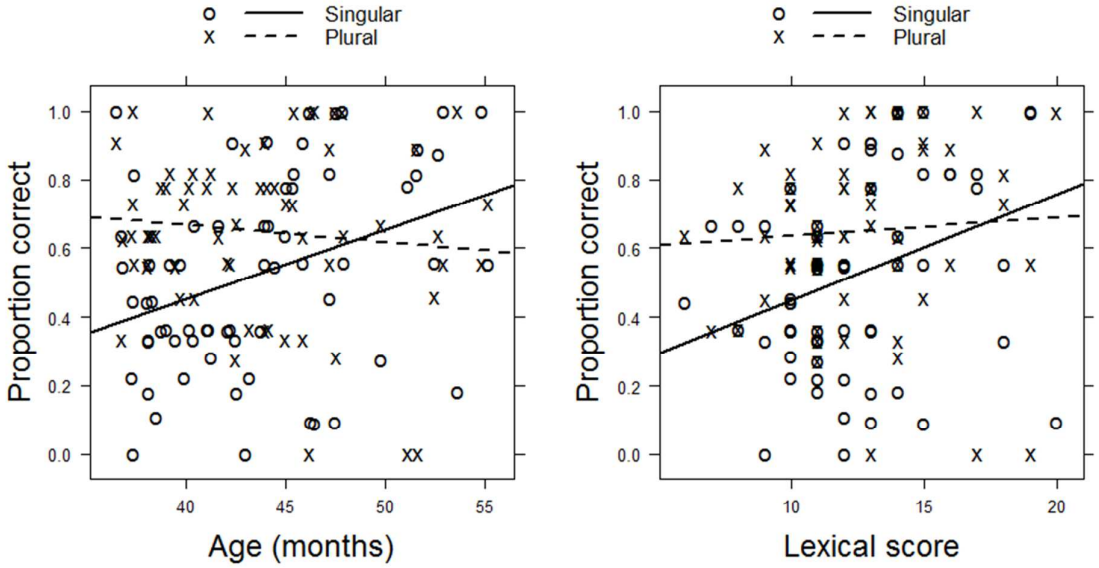

Figure 2