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Caitlin Meyer, Sjef Barbiers, and Fred Weerman

1. Introduction

One poorly understood domain in linguistic and cognitive development is ordinality: when do children acquire ordinal numerals and concepts? The past few decades have only produced a handful of findings, an outcome that is surprisingly low given the attention scholars have paid to the development of cardinals and cardinality. This paper extends that work to the ordinal domain, investigating ordinal development in 77 monolingual Dutch children. We argue that ordinal acquisition does not follow the same (universal) pattern found in cardinal development. Moreover, we show that both cognitive and linguistic factors play an important role in the developmental patterns our data reveal.

Section 1 shows why ordinals deserve more scholarly attention. Section 2 contains a brief overview on the development of cardinals, the desired extension of this work to ordinals, and the limited findings on ordinals in the literature. This leads us to section 3, where we name the questions that need to be investigated, i.e. what the timing and pattern of ordinal acquisition looks like, what types of (non-) linguistic knowledge are relevant to this development, and how Dutch fits into this picture. Our study investigates these issues using a modified version of a Give-a-number task (e.g. Wynn 1992), which we describe in section 4. Results and discussion thereof are the focus of sections 5 and 6. We conclude in section 7 that ordinal acquisition follows a different pattern than cardinals, and is influenced by several linguistic factors, such as the singular-plural distinction, (ir)regular ordinal morphology and superlative morphology.

2. Cardinal and ordinal development

Ask any linguistics major why the study of language is important, and chances are the answer will be something to the extent of *because it says something about*

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what makes us human. The truth and relevance of that argument aside, we could obviously query any cognitive capacity as something uniquely human, be it innate or acquired. Numerical cognition is a prime example of this. A vast body of literature has provided evidence that suggests that while there is some kind of numerical knowledge that is shared between humans (adults and infants alike) and a variety of non-human animals, the concept of large exact number is reserved for humans only (see e.g. Carey 2009, Dehaene 1997, Dehaene 2009, Spelke & Kinzler 2007). That is, animals and pre-linguistic infants have been argued to have access to two systems that can be used for numerical concepts. On the one hand, we have a system that allows for imprecise representations of quantities, i.e. the Approximate Number System (ANS). On the other hand, the Object Tracking System (OTS) allows for precise representations of up to three or four individual objects (see overviews in e.g. Feigenson, Dehaene & Spelke 2004; Spelke & Kinzler 2007). What these systems do not provide us with, however, is representations of exact number above this threshold, and yet humans have no difficulty conceiving of and reasoning about large, exact quantities. So what do infants develop (that animals lack) that would allow them to combine these two core knowledge systems (or overcome their limitations) and become adult-like? This brings us back to language.

Different scholars have argued that language plays a critical role in the development of exact number (cf. Carey 2009; Spelke 2011). Which aspects of language (for example, the count list, quantifiers, or grammatical number) are responsible here, and how language bridges the gap between the two systems, have been a topic of debate for some years (see e.g. Carey 2009, Le Corre & Carey 2007 for overview and discussion), but are not the focus of this paper. Instead, let us simply assume that language plays some role here. Given this, we might expect cross-linguistic differences in how cardinals are acquired. In addition, we could expect there to be effects of the interplay between the core knowledge systems of knowledge and (the interplay with) language outside the domain of cardinals, for example in the ordinal domain.

The development of exact numerical concepts is very well-documented. Studies have repeatedly shown that cardinals are first acquired in a slow and sequential fashion, in which children go through so-called 'knower stages' (e.g. Condry & Spelke 2008; Huang et al. 2010; Le Corre & Carey 2007; Sarnecka et al. 2007; Wynn 1992). In the first stage, children are able to recite a count list and (arguably) understand the list has something to do with quantities, even though they do not know the exact numerosities these number words represent, and even though they may not recite the count list flawlessly. These children are referred to as 'pre-knowers'. In the following stage, as 'one-knowers', children know that *one* means exactly one, and that the other numerals are more than one. They progress to the 'two-knower' level when they discover that *two* means exactly two, which means they have exact representations of both *one* and *two*, but not for the other numbers. In other words, when asked for *one banana* they will give you one, and when asked for *two bananas* they will give you two, but if you ask for *three bananas* they may give you three, four, even ten or more, but not one or two. The

literature also describes stages for 'three-knowers' and 'four-knowers', but then the pattern changes dramatically. After four, children lose their 'subset-knower' status and become CP-knowers, short for cardinal or counting principle knowers. These children answer the question *how many* by counting and repeating the last-named cardinal, demonstrating knowledge of at least three counting principles (see also Gelman & Gallistel 1978): the one-to-one correspondence principle (every cardinal belongs to one counted item), the stable order principle (the count list has a strict order), and the cardinality principle (the numerosity of the set is equal to the last number counted). Note that this acquisition pattern is robust, but the timing of each stage varies widely.

The first question that arises here is to what extent this pattern is found in different languages. After all, if language is crucial in developing numerical concepts, we would expect linguistic differences to affect this pattern. Though most of the knower-level evidence comes from children acquiring English, a handful of studies show that other languages, i.e. Japanese, Mandarin, Russian, Saudi Arabic, Slovenian, and Tsimane', also follow this pattern (cf. Almoammer et al. 2013, Barner et al. 2009, Le Corre et al. under revision, Piantadosi et al. 2014, Sarnecka et al. 2007). Despite their geographical, typological and cultural diversity, they all show the same acquisition pattern, suggesting this is universal. Differences in timing have been attributed to the language-specific (i.e. morphosyntactic) properties that prompted studying these languages in the first place. Examples are the use of classifiers, (not) distinguishing between singular, dual and plural, and inflecting numerals for case. However, the role of language is also difficult to disentangle from cultural effects, e.g. effects of exposure in an educational setting, precisely because these languages are both linguistically and culturally diverse. Therefore, focusing on a language more similar to English (minimizing the linguistic distance) might shed light on what differences are non-linguistic. We use Dutch, for which cardinal acquisition has yet to be studied, for this purpose. We return to this in section 3.

The second question that arises, given the development described above, is to what extent we see a similar pattern in the development of ordinality and ordinal numerals. After all, to determine which object in a set is the *fourth*, children must apply the one-to-one correspondence principle as well as the stable order principle. However, unlike in the cardinal situation, not the cardinality principle but the ordinality principle is necessary here: the numeral does not refer to the set of counted objects as a whole, but only to the last individual counted. Though it is not a priori necessary for children to learn to apply the cardinality principle before the ordinality principle (why would it be conceptually easier to refer to the cardinality of a group rather than a particular item in a group?) most ordinals in English (as in Dutch and many other languages) appear to be derived from the cardinal (English adds a suffix *–th* to a cardinal base), suggesting that perhaps ordinals are acquired after cardinals.

Given this conceptual and linguistic relationship, it seems studying ordinal acquisition would be a natural extension of work on cardinals. However, ordinals have received very little attention in developmental literature. The past 25 years

yield (to our knowledge) just four studies that touch on the topic, namely Fischer & Beckey (1990) for English; Miller et al. (2000) for English and Chinese; Colomé & Noël (2012) for French; Koch et al. (2015) for German. It is hard to conclude much of anything from these individual studies, due to the varying languages, age groups, methodologies and the relatively small scale and scope of these studies. Moreover, none of these studies precisely link the acquisition of ordinals to cardinals. Taken together, though, they seem to suggest a number of tendencies: (i) ordinal acquisition begins after cardinal acquisition, (ii) lower ordinals are acquired before higher ones, (iii) the timing and pattern of ordinal acquisition is language-dependent. This last tendency requires some additional explanation. Our interpretation of the data in the literature leads us to believe that the transparency of the relationship between the cardinal and ordinal numeral influences the speed of ordinal acquisition, both with respect to systems in general (more transparent systems are acquired faster than less transparent ones) and ordinals in particular (regular ordinals are acquired before irregular neighboring ordinals). Of the languages above, Chinese ordinals are very regular, formed by adding prefix *di–* to a cardinal base. French ordinals (cardinal plus *–ième*) are all regular, except suppletive *première* 'first'. German *erste* 'first' is also suppletive, and root allomorphy occurs in *dritte* 'third' (not **dreite*; regular ordinals: cardinal plus *–te*). English low ordinals are the least transparent, with *fourth* the only regular low ordinal. And indeed, Chinese children master ordinals quickly, whereas children acquiring English lag behind those speaking French or German.

This calls for a more detailed investigation of the acquisition of ordinals in general, as well as in comparison to cardinals. An informative language for studying the role of linguistic factors would have an ordinal system that is in between regular and irregular, having one or two irregular ordinals in an otherwise transparent ordinal list. Dutch is a fine candidate here.

3. The present study: cardinals and ordinals in Dutch

As described above, Dutch meets the criteria for studying cardinal and ordinal acquisition. Table 1 lists the first twenty cardinals and ordinals in Dutch.

Table 1: Cardinal and ordinal formation in Standard Dutch

#	Cardinal	Ordinal		#	Cardinal	Ordinal
1	één	eer–ste		**11**	elf	elf–de
2	twee	twee–de		**12**	twaalf	twaalf–de
3	drie	der–de		**13**	der–tien	der–tien–de
4	vier	vier–de		**14**	veer–tien	veer–tien–de
5	vijf	vijf–de		**15**	vijf–tien	vijf–tien–de
6	zes	zes–de		**16**	zes–tien	zes–tien–de
7	zeven	zeven–de		**17**	zeven–tien	zeven–tien–de
8	acht	acht–ste		**18**	acht–tien	acht–tien–de
9	negen	negen–de		**19**	negen–tien	negen–tien–de
10	tien	tien–de		**20**	twin–tig	twin–tig–ste

Ordinals in Standard Dutch are derived by adding a suffix *–de* or *–ste* to the rightmost part of a cardinal. The first twelve add *–de* to the cardinal (as do those through *negentien* 'nineteen', which are formed on base ten), except those for *één* 'one', *drie* 'three', and *acht* 'eight'. All other ordinals take *–ste*.

Note that the irregularities found in *eerste* 'first', *derde* 'third', and *achtste* 'eighth' are crucially different. While *achtste* is regular except that it takes the suffix generally used for higher ordinals, and while root allomorphy plus a regular suffix *–de* gives us *derde*, it seems implausible for *eerste* to be a product of both of these explanations (i.e. root allomorphy plus *–ste*). Perhaps *–ste* is not an ordinal suffix here at all:*–ste* is also used to create superlative adjectives, such as *lang–ste* 'tall–est'. Barbiers (2007) observes that *eerste* 'first' behaves as a superlative in the following respects: *eerste* can modify plural nouns, its final schwa may be reduced in predicative position, it may be intensified by *aller–* 'very' and (diachronically) it has a positive and comparative form (*eer, eerder* 'fore, former'). None of these properties apply to Dutch ordinals.

This leads us to the following expectations. For cardinals, we see no reason to expect anything different from the pattern found in English, though we may see differences in timing due to cultural effects. For ordinals, we expect that linguistic factors influence acquisition. One expectation is that children in the earliest stages of ordinal acquisition should distinguish between cardinals and ordinals, even if they lack exact representations thereof. Children should take just one object when asked for the *fourth duck* even if they do not know exactly what *fourth* is. The reasoning is that ordinals modify singular nouns, whereas cardinals except *one* combine with plurals, hence children may use this distinction to induce that ordinals refer to individuals.

In addition, given that ordinals are derived from cardinals, children should acquire ordinals after their corresponding cardinal. We also expect lower ordinals to be easier than higher ones, since lower cardinals are acquired before higher ones. This is to be expected for purely performance reasons as well: the higher we have to count, the more demanding the task becomes.

However, we do not necessarily expect the tiered pattern found in cardinals to be visible in ordinals: if irregular morphology hinders acquisition of *derde* 'third', we expect regular low ordinals *tweede* 'second' and *vierde* 'fourth' to be acquired before *derde* 'third'. Something similar may hold for *eerste* 'first', though it is also possible that frequency[1] and superlative morphology (more than) make up for this potential difficulty. In other words: the eyes of the learner may see *eerste* 'first' as a transparent superlative or an non-transparent ordinal.

4. Method

We used a modified version of the popular 'Give N' task, also known as e.g. Give-a-number (a.o. Wynn 1992, Condry & Spelke 2008, Huang et al. 2010). Our

[1]In SUBTLEX (Keuleers et al. 2000) and the Spoken Dutch Corpus (Oostdijk 2000), *eerste* is (53.18% and 43.29%) more frequent than all other ordinals in Table 1 combined.

version started with a short introductory story, in which a monkey named Jaap is going on a trip. All of his things are so excited about joining him that they are getting in line to jump into his suitcase. Sadly, not all of them will fit, so the child is asked to help pack the correct items from the line in the suitcases.

We showed children the monkey's suitcases and some of his things (laminated cards with everyday objects on them). Children then picked the suitcase they wanted to pack first, after which two practice items followed. For each item, cards were placed one by one in a straight line in front of the child, starting near the suitcase and working from left to right. This way, a child could access an ordinal interpretation both temporally or as an event (the n^{th} to be placed on the table), and spatially (the n^{th} from the beginning of the line). The experimenter pointed out the beginning of the line for both practice items, in which children had to find the object *at the front* and *at the back*. Most children could. The experimenter asked those who failed where the line began and/or in which direction the things went to familiarize them with the concept of the line.

For all further items, children were asked to find a certain item (e.g. *one toothbrush, the second rubber ducky*) and pack it in the suitcase. Note that we selected objects or animals that had clear fronts and backs for ordinal items to emphasize the line. We tested all children on cardinals *one* through *four*, *eight*, and their corresponding ordinals (*first* through *fourth*, *eighth*). Each numeral appeared three times, meaning the initial task consisted of 30 critical trials. Items for *nine* and *ninth* were later also incorporated to check for performance consistency on higher numerals and to exclude the possibility that *achtste* 'eighth' was misheard as *achterste* 'backmost'. This version of the task contained 36 critical items. The 41 fillers contained the degrees of comparison of *groot* 'big', *klein* 'small', *lang* 'long', *dik* 'fat', and *veel* 'many', and the superlatives *middelste* 'middle–est' and *laatste* 'last'. The task was divided in a cardinal and an ordinal session, which lasted around 15–20 minutes each and were administered within a week of each other. We presented items in one of eight pseudo-random orders within each session, and these orders and starting sessions were counterbalanced between participants. Children were asked to count to twenty after each session. Examples of items are given in (1) and (2).

(1) De tweede eend mag mee. Kun je de tweede eend vinden en
The second duck may.sg with. Can you the second duck find.inf and
in de koffer doen?
in the suitcase do.inf
'The second duck can come. Can you find the second duck and pack it in the suitcase?'

(2) Er mogen acht stiften mee. Kun je acht stiften tellen en
There may.pl eight markers with. Can you eight markers count and
inpakken voor Jaap?
pack for Jaap?
'Eight markers can come. Can you (count and) pack eight markers for Jaap?'

Formulaic variations occurred to keep the setting natural, but typical stimuli offered children the numeral as part of a full subject DP; ordinals were often repeated with a definite article (e.g. *de tweede*, 'the second'), cardinals with a noun (e.g. *acht stiften*, 'eight markers'). Follow-up questions (e.g. 'Can you count and make sure?') allowed children to check and correct their responses.

A total of 77 typically-developing monolingual Dutch children (37 girls) participated, of which 29 partook in the longer version of the task. We tested children in three age groups: 31 three-year-olds (*M*=3;6, *SD*=3.5 mo.), 26 four-year-olds (*M*=4;6, *SD*=3.1 mo.) and 21 kindergartners (*M*=5;6, *SD*=5.13 mo.). We excluded an additional 8 children from analysis for not completing both sessions. No children were excluded for failure to understand or perform the task.

5. Results

Before going into the cardinal and ordinal results, it is worth taking a brief look at the fillers. Figure 1 depicts the mean percentage of correct responses on the comparatives and superlatives for *big*, *small*, *long*, *fat* and *many* per age group. Most children were near ceiling and all answered correctly on at least 11 out of 15 forms, showing they understood the task and were engaged throughout.

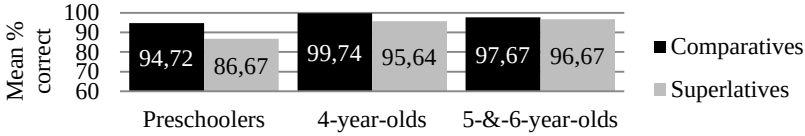

Figure 1: Mean % correct responses to comparatives and superlatives.

5.1. Cardinals

We determined each child's knower-level using the criteria reported by e.g. Le Corre & Carey (2007) and the tool provided by Negen et al. (2012). We considered children a certain *n-knower* when they gave *n* cards at least two out of three times when asked for that *n*, and gave *n* cards at most once when asked for a different number. The tool approximates a Bayesian inference of a child's knower-level (see Lee & Sarnecka 2010ab). The outcomes of both methods were typically the same and children were easily categorized. In the 7 cases where outcomes differed or the model was inconclusive, we carefully reviewed each child's responses (and any notes on the score sheet) before categorization.

Table 2 displays the ages and counting data for each knower-level. Figure 2 is an area plot of knower-levels by age groups in months. These data are in line with findings in previous studies: (i) children can typically count further than they can comprehend, and (ii) acquisition of cardinals appears to be tiered. Table 1 shows that children in our sample show a wide range of individual differences. Despite this variation, a Spearman's correlation test reveals that count lists increase with

age (r_s=0.610, p<0.001) and knower-level (r_s=0.648, p<0.001); older children also tend to be further along in cardinal comprehension (r_s=0.745, p<0.001). There was no significant difference in knower-levels between genders (Mann-Whitney U=594.0, Z=-1.584 p=0.113, two-tailed) or in how far boys (*M*=14.20, *SD*=6.726) and girls (*M*=16.49, *SD*= 4.897) could count (Mann-Whitney U=640.0, Z=-1.103, p=0.270, two-tailed).

Table 2: Knower-level, age and count list length of all participants.

Levels	***n***	**Age (months)**			**Count List**			
		Range	*Mean*	*SD*	*Mean*	*Range*	*SD*	*% at least 10*
Pre-knowers	3	35–40	37.3	2.5	8.33	5–10	2.89	66.7
1-knowers	9	36–51	41	4.9	9.89	1–20	6.15	55.5
2-knowers	12	36–53	44.5	5.3	9.33	0–20	6.02	66.7
3-knowers	1	44	44	–	14	14	–	100
4-knowers	16	42–63	52.1	6.9	17	9–20	4.46	93.7
CP-knowers	36	43–76	59.6	8.9	18.5	6–20	3.62	97.2

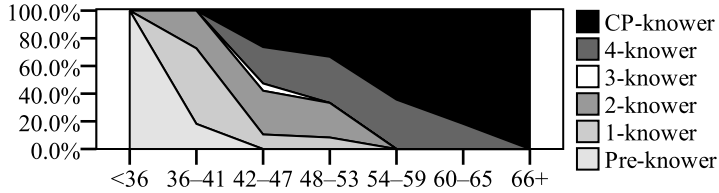

Figure 2: Area plot of knower-level distribution by age in months.

Though Dutch children follow the typical pattern in cardinal development, it seems they are somewhat slower at doing so. For example, knowledge of the exact meaning of at least *three* is available to most American English speakers by age 3;6 (e.g. Le Corre & Carey 2007, Le Corre et al. under revision, Sarnecka & Carey 2008). Our sample included no children under 3;6 who were three-knowers or better and by age 3;11 only 57.89% were. Huang et al. (2010) report that most English-speaking children are CP-knowers around their fourth birthday, whereas most Dutch children are CP-knower from 4;6 (54 months) on.

5.2. Ordinals

The criteria for ordinal comprehension were similar to those for cardinals. Children were considered to comprehend (or be a 'knower' of) an ordinal if they provided two out of three correct responses for that ordinal, and gave that ordinal no more than once in response to a different ordinal. We made an exception for *derde* 'third': errors made when asked for the *derde* 'third' were not included

when determining the knower-status for a different ordinal.[2] Figure 3 shows the percentage of 'knowers' of each ordinal by cardinal-knower group.

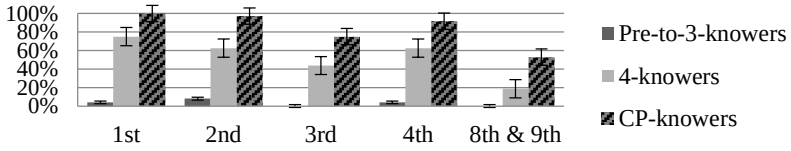

Figure 3: Percentage of 'ordinal knowers' by cardinal knowledge.

Figure 3 illustrates that ordinal comprehension starts as or right before children master the cardinal principle, i.e. as four-knowers or CP-knowers. Three children were able to provide correct responses to *achtste* 'eighth' even though they were not CP-knowers. Moreover, not all ordinals are acquired simultaneously: we can see that *derde* 'third' seems to lag behind the other low ordinals, and that higher ordinals follow even later.[3] This difference between ordinals is made more explicit in Figure 4, which shows the percentage of children who can be considered knowers of different ordinals. More precisely, this figure answers the question: what percentage of children who know a given ordinal, also know other ordinals?

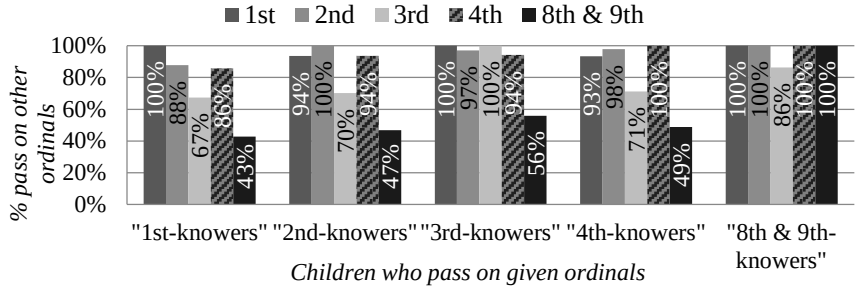

Figure 4: % of 'ordinal knowers' who also know other ordinals.

What is immediately obvious, is that the tiered pattern found in cardinals is not visible in Dutch ordinals: knowing *vierde* 'fourth' does not guarantee knowledge of *derde* 'third' (as 29% of children who know *vierde* do not know *derde*) whereas all four-knowers by definition must comprehend *three*. Thus, it seems that irregular *derde* is harder than its regular neighbors. We do not see difficulty with

[2]The reasoning behind this adaptation is as follows. Say a child knows every ordinal but *derde* 'third', which he thinks is *driede* 'lit: threeth'. A systematic error leads to being a non-knower of both *derde* 'third', and that other ordinal. A random response may negatively impact his score on multiple ordinals. The only 'safe' options are those ordinals not tested, which would obviously be task-specific. Theoretically, this issue could also arise with cardinals, but we saw no reason to deviate from the literature there.

[3]Those tested on *ninth* performed the same on *eighth*.

eerste ‘first’. In fact, *first* is the only ordinal some children know. Then children go on to acquire other low ordinals, and later higher ordinals (see the lower scores on *eighth* and *ninth*). The pattern suggested in these group results are visible in the individual patterns in Table 3.

Table 3: Ordinal knower-patterns by cardinal knower-levels.

	1st only	*1st, 2nd, 4th*	*1st–4th*	*All but 3rd*	*All*	*Other*
Pre-to-3	4.00%	0.00%	0.00%	0.00%	0.00%	8.00%
4-knowers	12.50%	18.75%	25.00%	6.25%	12.50%	6.25%
CP-knowers	2.78%	13.89%	25.00%	5.56%	47.22%	5.56%

Again, we see that pre-to-three-knowers do not know much about ordinals, and that CP-knowers know the most. Qualitatively, however, four-knowers and CP-knowers show similar response patterns on ordinals. It seems that children first learn the meaning of *eerste* ‘first’, but quickly also discover the regular ordinals *tweede* ‘second’ and *vierde* ‘fourth’. Irregular *derde* ‘third’ follows later. Both four-knowers and CP-knowers are found in all of these stages, and only 17 CP-knowers (47.22%) performed at ceiling. Note that one observation has thusfar remained unillustrated: only two children took more than one card when asked for an ordinal, and they only did so twice each. Hence it seems that even pre-to-three knowers have minimal knowledge of ordinals, namely that they refer to an individual rather than a set. We interpret these findings in the following section.

6. Discussion

The cardinal data above are largely in line with what we expected: children follow the tiered pattern as they acquire cardinals. Moreover, like many children, they can count further than they comprehend. However, two findings are less straightforward. The first is the lack of three-knowers, which we believe is accidental. If we look at the mean ages of each knower-level, the difference between two- and four-knowers is the same difference found between subset stages that are only one level apart (i.e. four months). This suggests children move through the three-knower stage relatively quickly (not uncommon, see e.g. Almoammer et al. 2013), making them difficult to capture. Second, the children in our sample seemed slower to acquire cardinals than e.g. American children. Since the languages are so similar, the reason is unlikely to be linguistic in nature. Rather, we claim the discrepancy is cultural in nature (cf. Almoammer et al. 2013). Dutch children typically go to school at age four; preschool is optional for most typically developing children aged 2;0–3;11. Our three-year-olds attended day care centers without specific goals or programs for training linguistic or numerical skills, whereas children attending preschool in the US are attending educational institutions that have to meet certain academic standards. Thus, we take our data to

mean that these children received less structured exposure or explicit training in number routines, though direct comparisons to other populations should be sought out.[4] The observation nonetheless stands: the knower-level pattern seems universal, the timing and speed of its stages do not.

The timing and pattern of ordinal acquisition also differs somewhat from what we see in cardinals. First, we see that children are unable to give correct responses on ordinals in the early stages of cardinal acquisition, showing that cardinal acquisition starts before ordinal acquisition. However, this does not mean that pre-to-three knowers have no knowledge of ordinals. These children all have in common that they only selected one card when asked for any given ordinal. We take this to mean that children are able to use morphosyntactic cues, i.e. that ordinals combine with singular nouns, to conclude that one and only one item is requested. Children do know the relevant nominal and verbal morphology and are sensitive to number agreement by this age (e.g. Polišenská 2010). However, we can make no claims about the status of this knowledge with respect to its application to ordinals: it might be that children respond to the absence of plural marking on the noun (and/or agreeing verb) in the stimulus, and we do not know how general this knowledge is. For example, we offered children a full DP in the stimulus (see (1)). If children have genuine knowledge that ordinals are singular, then children should also provide one card when explicit cues for number are missing, i.e. if the stimulus were *Kun je de tweede inpakken?* 'Can you pack the second?' Note that *one* is obligatorily absent here and the definite article appears with both plural and common singular nouns.

Based on the four- and CP-knowers' response patterns, we suggest that children acquire *eerste* 'first', *tweede* 'second' and *vierde* 'fourth' almost simultaneously. Four children could be classified as knowers of *eerste* but not any of the other ordinals, which suggests this may be a (short) initial stage in acquisition, after which the regular ordinals follow. It takes more time for children to acquire irregular *derde* 'third' and regular higher ordinals. We suggest the poor performance on *derde* 'third' (relative to *tweede* 'second' and *vierde* 'fourth') is evidence that children derive ordinals via a morphological rule (informally: cardinal + *–de* = ordinal) rather than store them lexically. If failure on *derde* 'third' is indeed linguistic in nature, rather than conceptual, we expect children who fail on such forms to perform better when the irregularity or opacity is resolved. We also expect acquisition shape and speed to differ across languages, depending on the transparency of the ordinal system.

Why such problems do not appear in the case of *eerste* 'first' can be explained if we follow Barbiers (2007): *eerste* is not actually an ordinal, but a superlative.

[4]Hamilton et al. (2000) describe large and consistent differences in vocabulary development between children aged 1;0–2;1 acquiring UK and US English, with British children being relatively delayed . The reason is unclear, but the authors speculate about culture, cultural expectations and the influence of day care; socio-economic status did not significantly affect vocabulary development in either group.

Children's performance on the superlative fillers show they were able to comprehend superlatives in the contexts we provided. This suggests that children at least have the option of interpreting *eerste* as such and do not need any kind of ordinal rule to know what *eerste* means. Moreover, *eerste* is much more frequent than other ordinals (see section 3). This does raise the question why not all children were able to interpret *eerste*, since cardinal knowledge is irrelevant and superlatives were easy for children. One suggestion is that *eerste* 'first' has less transparent degrees of comparison, making (acquisition of) the relationship between the positive, comparative and superlative more complex.

Note that the pattern and explanation above do not exclude the possibility that ordinals could be acquired in the stepwise fashion cardinals are. After all, there is some evidence that *eerste* 'first' precedes at least *tweede* 'second', evidence that *tweede* precedes *derde* 'third' and that higher ordinals are acquired after lower ones. Moreover, we also see that children begin to acquire ordinals before cardinal acquisition is complete, suggesting that application of the relevant counting principles for ordinals comes in as children are still discovering how those for cardinals work. Hence, it could be that a tiered acquisition pattern is viable in some languages, but is not (or is at least not visible) in languages like Dutch, where morphology intervenes in this process.

One question remains. If children do apply a rule to derive ordinals, why do many CP-knowers, who know higher cardinals and regular low ordinals, fail on high ordinals? There are various possible answers. Perhaps it is due to inconsistency in performance. Perhaps children have not acquired a rule but rely on frequency or some other mechanism, though this would leave problems with *derde* 'third' unexplained. Perhaps children have more difficulty computing a rule on the already more demanding higher numerals. Or perhaps there is a tiered acquisition pattern after all: lower ordinals are individually mapped to their respective meanings (where a transparent relationship between form and meaning helps), but children need time to productively combine the linguistic rule with the ordinality principle. We leave this for future studies to explore.

7. Conclusion

This study examined the timing and pattern of ordinal acquisition, and asked (i) to what extent linguistic factors influence this pattern and (ii) how ordinal acquisition compares to cardinal development. We found that, in line with our expectations, the tiered pattern in cardinal acquisition was visible in Dutch. However, we did see differences in timing: Dutch children seem somewhat slower to acquire cardinals. We argued that this cannot be attributed to linguistic factors but was likely caused by differences in exposure. In other words, we maintain that the pattern of cardinal acquisition is universal, whereas the timing thereof varies between languages and cultures.

For ordinals, we expected (i) even children who did not know the exact meaning of ordinals to know or infer that ordinals refer to individuals, not sets, (ii)

lower ordinals to be easier than higher ordinals, given that ordinals are derived from cardinals and given the increase in task demands on higher numerals, and (iii) linguistic factors to influence the pattern of ordinal acquisition. All these expectations were met: children's performance indicates that (ir)regular ordinal morphology, superlative morphology and the singular-plural distinction may all influence how and when ordinals are acquired. Children seem to benefit from a transparent relationship between the ordinal and its corresponding cardinal.

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