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Ordinal Acquisition in Italian-speaking Children

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1. INTRODUCTION

On a day to day basis, number words are used in a variety of different ways and contexts. Adults assign them a variety of different meanings that change according to the situation and the use they make of them. In fact, it would be possible to identify both numerical and non-numerical uses of number words.

Examples of the first kind of use could be cardinal numbers, ordinals or measure numbers, whereas labels represent an example of non-numerical use (Fuson, 1988). Cardinal number words (*one, two, three)* refer the number of entities in a set, both material and immaterial (e.g. the three wishes) and answer the question "how many?". Ordinals, instead, describe the relative position of one item or entity with respect to the others that make up a linearly ordered set. When used as measure, number words are able to measure a quantity, such as time, length, weight, and are often accompanied by the unit of measurement for said continuous quantity (e.g. second, centimetres, kilograms). Several mathematical operations can be carried out on cardinals, ordinals and measures, addition and subtraction being just the simplest example (despite this kind of operations sounds odd when performed on ordinals). Whatever use people make of them, they all have in common the referentiality, which is what differentiate numerical and non-numerical uses.

When used in a non-numerical way, number words serve as symbols. This is the case of bus numbers, telephone number, addresses and so on. Interestingly, when used as symbols, we do not tend to read them as we would do with proper numbers: when we spell our telephone numbers, we don't read 3579854209 as 3'579'854'209 (*three billion...*).

The focus of this work is ordinal acquisition. Before moving on to why it is an interesting research field, it is important to introduce some useful pieces of terminology. One must distinguish between an *ordinal situation*, which is one where ordinal number words (*first, second, third)* apply, and an *order relation*. Order relations do not imply by default the use of ordinals as they may involve cardinals as well as, such as measure or sequence situation (Fuson, 1988). Saying that five apples are more than three or that three kilos are less than five does not corresponds to an ordinal situation, rather to an order relation. Consequently, an established order relation is what forms *an ordering* (e.g. the letters of the alphabet).

Ordinal acquisition is an interesting topic for several reasons. On the one hand, it mixes language specific abilities with general and mathematical domain ones. From the linguistic point of view, ordinals are the result of several different processes, such as morphological derivation, that affect their cardinal correspondents. A child who is acquiring ordinals needs to be able to first understand and then apply specific rules and suffixes to a cardinal root in order to form the required ordinal. Moreover, they have to understand the morphological class to which ordinals belong to and how they behave from a syntactic point of view. From the broader cognitive side, ordinals show an intrinsic link with mathematical abilities. Counting (which has other interesting pre-requisites by itself) is obviously involved in the process of using ordinals, but it is not enough. Understanding numerosity is another ability that a child has to show in order to use ordinals (and cardinals as well). Continuing on this topic, Starkey and Cooper (1980) show how children as young as 4-6 months are sensitive to numerosity. What they also show is that this sensibility stops when objects are more than three or four. Hence, will they be able to use the ordinals corresponding to the cardinals they already know even if their ability to understand numerosity hasn't fully developed yet? Do they have to wait until this ability is fully mastered?

On the other hand, very little is known from the literature on the acquisition of ordinals. In fact, studies investigating ordinal acquisition are very few (see Meyer, Barbiers, & Weerman, 2018; Trabandt, Thiel, Sanfelici, & Schulz, 2015; Lei, 2019; Miller, Major, Shu, & Zhang, 2000). In addition to that, the majority of these studies focus on similar languages, such as Dutch, German and English (all Germanic languages). In particular, Meyer et al. (2018) take advantage on those similarities to minimize linguistic differences. We will discuss later that our study will, on the contrary, maximize the differences in order to see if the ordinal acquisition path is the same among languages belonging to different linguistic families. Surely this handful of studies provide interesting insights on the topic, however they lack systematic empirical work: they focus on different age groups, different languages, they only test a limited array of numerals using different methods (Meyer, Barbiers, & Weerman, 2018)

This chapter will give an overview of the literature on the topic of ordinal acquisition and of its prerequisites which have just been briefly introduced. It will start with cognitive and mathematical abilities which underlie ordinals and will then move to a linguistic discussion on the topic.

1.1. Understanding numerosity

When a child first starts to get in touch with numerical expression (most of which are culture-specific, e.g. number words – one, two, three, etc. – Arabic digits. Roman numerals and so on) the biggest challenge they face is to understand that those expressions do not have an intrinsic, univocal meaning. *Five* (or 5) could refer to the number of friends I have invited at my birthday party, the number of pages John needs to study for the test or the number of the chapter he has to study, it could be the first digit of my mobile phone number and so on (see the previous paragraph).

However, the distinctive feature of numerical expression is that of describing the number of items in a set, which is its numerosity (also *cardinality*) (Butterworth, 2011; Butterworth, 1999). Numerosity can be defined as an abstract concept. We can say that a strawberry is red or sweet but not that it is four and at the same time "being four" does not imply being, or possibly being, a strawberry. Equally, we cannot define what *four* is the same we could describe who a cook or a kind person is. Even if we try our hardest to define *five*, the challenge seems too hard. In fact, we can only provide examples of "five-ness". We can only apparently say that, as an example, a set of five bananas represents the concept "five". What follows is that numerosity is not a feature of objects, such us colour, shape, taste, or an object itself but rather it is a feature of sets of objects.

Through a habituation/dishabituation paradigm, Starkey and Cooper showed how 4-to-6-month-old infants are sensitive to numerosity (Starkey & Cooper, 1980). They believed that representing numerical values is a necessary ability for a later development of number meaning and higher numerical abilities. 72 infants (mean age of 22 weeks) were habituated to arrays displaying a particular number of dots and were then presented a different array in the post-habituation phase. They tested both smaller arrays (from 2 to 3 and from 3 to 2) and larger sets (from 4 to 6 and from 6 to 4). Significant dishabituation was found in both small number condition and infants showed the ability to discriminate between arrays identical in length but not in number or identical in density but not in number. This has led the authors to conclude that children can *subitize* sets of around 3 items. Owning the concept of numerosity does not simply imply being able to tell whether two different sets have the same number of elements or not, but also being able to notice any change in the numerosity when items are added or subtracted to the set, which translates into an ability to understand the consequences of addition and subtraction (Butterworth, 2011).

Today, it is broadly accepted that children, adults and some animals, such as monkeys, crows, chicks, share a common ability to perceive and compare quantities, generally referred to as *numerosity* (Hubbard, et al., 2008; Rugani, 2018). By building a symbolic numerical representation on this perceptive ability, children and adults are then able to use precise number words.

1.2. Counting and cardinal acquisition

Counting is possibly one of the first tasks that children learn when they start dealing with numbers. It seems pointless to say that some children seem to know how to count while other do not, but when counting is taken into a little more consideration, we start to see how things quickly change.

If one considers counting as simply reciting the numeral list (e.g. *one, two, three*), then it would be possible to say that most children know how to count. This type of counting is perfect for playing hide and seek or marking time (e.g. count to five and run). This has no significant difference with reciting any other ordered list of elements, such as the alphabet. What really differentiates counting from reciting the alphabet is the fact that only the former tells the number of items in a set (Sarnecka & Carey, 2008). Clearly, this is only possible if it is done correctly. Fuson (1987) draws a strong distinction between *sequence situations* which are those where number words are just pronounced (e.g. reciting the count list) and *counting situation* which, instead, are those where numbers are put into a one-to-one correspondence with an existing object (this kind of correspondence will be discussed into more depth later on). The task at hand here does not involve simple number word learning, but the mapping between number words and the concepts of numbers (Wynn, 1992).

Literature in the language acquisition field has witnessed several bootstrapping theories which also apply to number word acquisition. Wynn (1992) proposed that syntax and morphology may help children acquiring the meaning of number words. Number marking, in fact, seems to play an important role: children may be sensitive to the contingency between number morphemes and number word and infer the meaning of the latter. As a matter of fact, when *one* modifies a noun, this is in singular form whereas when other number words are used, the noun must be plural. Moreover, verbal morphology also shows instances of number marking. If one supposes that, at least at some stages, children understand that singular forms denote a single item while plurals denote a variety, thus assumes that children are sensitive to nominal and verbal number

morphology, it would be possible to state that they come to understand that *one* refers to a single entity and its cardinality while other number words refer to a multitude.

Le Corre and colleagues (2016) provide bootstrapping theories with supporting data. They investigated weather number morphology supports number words acquisition for *one.* Their hypothesis is that the word is learnt earlier by children whose language has obligatory singular/plural marking. Consequently, they tested 63 English speaking children and 64 Chinese speaking children. Chinese, in fact not only almost never marks singular and plural distinction but has other distinctive feature that may justify the delay (e.g. "numeral floating": the possibility for number words to occur in both pre- and post-nominal position). Data revealed a delay in Chinese the acquisition of *one* up to six months later than English speaking children. Interestingly, this delay is ascribed just to the word for *one*. Once children come to master it, their developmental behaviour follows that of English-speaking children. Taken together, all these findings support the morphological bootstrapping hypothesis.

In order for somebody to count correctly, the three principles identified by Gelman and Gallistel (1978) must be respected. The *one-to-one principle* states that when counting and enumerating a set, one and only one numeral must be assigned to each item in the set; the *stable order principle* says that numerals "used in counting must be used in the same order in any one count as in any other count" (p. 94). Number words appear in a standard sequence in every language and children seem to appreciate it from very young age (Fuson, 1988). Lastly, the *cardinal principle* states that the last numeral "applied to the final item in the set represents the number of items in the set". The authors also underline the fact that when a child applies these principles, the count list they produce represents the cardinal numbers as generated by the successor function (namely, that given a cardinal *n*, its successor is the result of the function *n+1*). In other words, if the principles are respected, what is produced by a child ("one", "two", "three", etc) really represents the cardinals (1, 2, 3, etc.), meaning that "one" actually represents one and only one element and adding +1 to "one" generates the successor "two", which is two and only two elements. According to the authors, these principles serve as guidelines for counting.

The work of the two authors opened up a debate on whether these principles are intuitively understood and naturally acquired or if, on the contrary, they need to be learned gradually and at different times. The fist view has come to be known as *principle-first* or *continuity theory,* which stated that thanks to innate, number-specific abilities even two-year-olds do take into consideration the counting principles when counting, and the

second as *principle-after* or *discontinuity theory* (Le Corre, Van de Walle, Brannon, & Carey , 2006)

To some extent, children may apply some of the principles without any explicit number knowledge: they can give one cookie to each person in a room, they can point and name each person in a photograph, can put a sock on each foot and so on. Instances where children apply the one-to-one correspondence principle are so varied that it seems plausible to admit that they have an innate ability to build a one-to-one relation among elements of different sets. The same is true also for the stable-order principle which applies, for example, every time they recite the alphabet, the days of the week or the names of the months (Wynn, 1990). Several studies, however, proved the principle-first theory wrong reporting that children may violate the one-to-one principle by skipping or counting items twice (Fuson, 1988) or the stable-order principle by producing different sequences. It has been argued, however, that some children may show a wrong, tough consisted count list (e.g. "one, two, five, six").

What really determines the principle-first theory wrong is the violation of the cardinal principle. In fact, while the first two principles are more domain-generic abilities, the cardinal principle is only related to counting. Gelman and Gallistel (1978) considered a child to possess the cardinality principle if (i) emphasizes the last tag used in a count, (ii) repeats the last tag used in a count, (iii) states the correct numerosity of a set without counting after that set has been counted earlier, or (iiii) responds with the correct number word without counting when asked how many items there are. Despite it has been reported that two-year-old may display some of these behaviours, children do not always seem aware of the fact that the last numeral they used represents the number of items in the set, hence they violate the cardinal principle. This evidence comes from the How-Many task which found many children responding incorrectly despite proper counting, and recounting, sets when asked "how many?" rather than using the last tag. Moreover, some authors criticized the How-Many task underlining the fact that some children respond to the How-Many question with the last numeral used without understanding that it represents the numerosity of the set. Wynn (1990) also reports that English-speaking children do not understand the cardinality principle or the relationship between counting and numerosity until about 3-and-a-half years of age.

The principle-after theory states that children first learn counting as a routine activity (such as repeating the alphabet or a nursery rhyme). At this point they do not distinguish the different number words and may also consider either the whole sequence

to be one word ("onetwothreefourfive") or all the elements to be equally essential (Wynn, 1992). Later, children may learn how to count thanks to *subitization,* which is the ability to recognize numerosity without having to count. It has been suggested that by repeating those meaningless counting routines, children learn to associate those words ("one", "two", "three") with the numerosity they can innately recognize and, later on, come to understand that counting defines numerosity (Wynn, 1990).

Data from Give-N studies reported a detailed picture of the learning pattern for cardinal meaning (Wynn, 1990, Le Corre et al, 2006, Sarnecka, Carey, 2008). Children seem to show a universal pattern in cardinal acquisition (*three* dogs) valid across languages as well (Japanese in Barber, Chow, & Yang, 2009; Russian in Sarnecka, Kamenskaya, Yamana, & Ogura, 2007; Slovenian in Almoammer, et al., 2013; Saudi-Arabic in Almoammer et al. 2013):

- *Pre-knowers* or *no-numeral-knowers:* especially at the earlier stages, children show no cardinal comprehension at all and make absolutely no distinction from of meaning for the different cardinals;
- *One-knowers:* they distinguish what is *one* and what is not *one.* Sarnecka and Carey (2008) report that English-speaking children reach this stage by age 2 to 3 years*;*
- *Two-knowers*: they show an exact representation of what is *one* and *two* but would probably select a random quantity if asked to pick three or more objects;
- *Three-knowers:* they show an exact representation of what is *one, two* and *three,* but would probably select a random quantity if asked to pick four or more objects;
- *Four-knowers* which is the stage that seem to be the shortest, in fact four-knower children are often rare to find;

Le Corre and colleagues (2006) collectively classify these learners as *subset-knowers* since they can produce sets that correspond to those numerals despite being able to count up to ten or higher. Once the child overcomes the step of being a subset-knower they are classified as *high-numeral-knowers* or *cardinality-principle knowers*. Now they are able to generate sets for the cardinal five and above. What is interesting is that, even if they progressed through the subset stages, they seem to grasp the meaning of higher numerals all at the same time. When asked "how many?" they would answer with the last

numeral used after counting, they would also count to create sets and if counting underlines a mistake, they are able to correct it accordingly. What really separates them from the subset-knowers is the implementation of the successor function (Sarnecka & Carey, 2008), which allows them to understand that given a cardinal *n,* the next integer on the count list is represented by *n+1.* The study by Sarnecka and Carey (2008) adds other abilities that mark the difference from subset- and cardinality- principle knowers. As a consequence of what has been outlined previously, the authors conclude that if the successor function represents the difference between the two groups of knowers, then the high-numeral-knowers should also understand that the numeral denoting *n+1* will be somewhere after the numeral denoting *n* in the numeral list (the direction of numerical change) and that "the numeral for cardinality *n+1* must be the very next numeral in the list after the numeral cardinality *n",* the unit of numerical change (p.10). Their results prove their theory right: only high-numeral-knowers understand that moving *one* forward on the list means adding *one* item to a set.

The *principle-after theory* is also supported by other types of evidence not strictly related to language acquisition (Le Corre, Van de Walle, Brannon, & Carey , 2006). Anthropology provides *principle-after* supporters with cultures, such as that of the Pirahã in the Amazon, that do not have a count-base representation of numbers. They do not have number words except those for "one" and "two" and no developed counting system. Theirs is a "one-two-many" system where the word for one does not denote exactly one item but rather "roughly one" or is used to denote small quantities. They do understand Portuguese Brazilian number words, but cannot grasp the meaning (Gordon , 2004). When Gordon asked Pirahã adults to produce sets up to ten objects, they never used any counting strategy, nor ant that provide evidence for the one-to-one correspondence principle which translated into a poor performance on the task. Not only this proves the *principle-first theory* wrong but also sheds light on the fact that representation of larger quantities is not universal (Le Corre, Van de Walle, Brannon, & Carey , 2006)

1.3. Ordinal acquisition

Moving from cardinals to ordinals, two other counting principles outlined in the work of Gelman and Gallistel (1978) have to be mentioned. The first is the *abstraction principle* which states that everything can be counted and the second is the *order irrelevance principle* that says that any element of a given set can be the starting point for counting. The latter principle is a direct consequence of the lack of a precise or pre-made

order of the elements that make up a set, whereas the former is legitimated by the fact that there are no *a priori* norms that rule what can be part of a set. It is true that if we think of the letters of the alphabet, we cannot find any specific reason that justifies the order in which they appear in the very first place. However, we are all aware of the fact that we cannot say that letter *f* follows letter *s.* This is because we, as humans, came to accept that precise sequence of letters as an ordered set of items and when we think of the first letter of the alphabet, the only possible answer is *a.* It is obvious to conclude that the *order irrelevance principle* does not always apply. When we reason in terms of cardinality, in terms of number of items in a set, then the principle does apply: it does not matter which element we count first, as long as we count them all we will end up with the exact number of items that make up the set. It does not matter if we start counting the letter of the alphabet from letter *I* or *p*, the number will always be the same. Contrarily, when we reason in terms of ordinality the way we count becomes fundamental. As Lei (2019) states, *the acquisition of ordinal numbers has to rely on an understanding of the relevant concepts of cardinality, but also requires knowledge that goes beyond and is independent of the cardinal numbers.* Consequently, it would be possible to identify another principle, which would be called *order relevance principle* stating that the order in which the elements are counted influences the ranking of the element itself. As it will be further stressed in the following chapters, the *abstraction* and the *order relevance* principle are at the basis for a correct use of ordinals. When a child needs to pick the *third* element of a set, the initial task they face is to understand which elements belong and which does not belong to said set. In addition, asking to pick the *third* means that a specific order has been given to the group of items and a starting point for counting has already been set. Hence, the child needs to be aware of that as well in order to pick the right one. What follows is another principle called the *ordinality principle*: an ordinal refers to a specific element in an ordered set, which we could also think of as a scale.

If many studies on the acquisition of cardinals can be found in the literature, those focusing on ordinals are scarce. Comparing data and results from cardinal and ordinal acquisition, two facts are to be mentioned. It has been noticed that the acquisition of ordinals seems to be delayed with respect to the acquisition of cardinals, thus labelled *cardinal advantage* (Meyer, Barbiers, & Weerman, 2018) and that children perform better on trials involving cardinals (Miller, Major, Shu, & Zhang, 2000).

Fishen and Beckey (1990) tested 97 kindergarten children (median age 64 months) in a variety of different tasks including ordinal numbers. Their purpose was to examine

number knowledge of children entering kindergarten in order to see if what they knew matched what textbooks and the school system required from them. The first task involving ordinals consisted of a pointing task where children needed to point to the third car in a row, the second was a naming task using the ordinal number word and in the third task children needed to order cards according to the number of dots depicted on them. Out of the 97 children tested, only 30 responded correctly to the pointing task, 24 could produce the ordinal *fifth* (second task) and 22 could put the card in the correct order. Despite the limits of the study (e.g. variety of ordinal tested), it provides a first insight into ordinal acquisition underling that ordinals are generally acquired later than cardinals.

Cross-linguistic and cross-cultural evidence comes from Miller, Major, Shu, Zhang (2000). The group focused on cardinal and ordinal acquisition in Chinese and English-speaking children attending kindergarten, grade 2 and 4. Their rationale for comparing English and Chinese comes from the way in which numeral system is organized in these two languages, which is outlined below.

a) From one to ten

Numeral		1	2	3	4	5	6	7	8	9	10
Cardinal	Chinese (written)	一	二	三	四	五	六	七	八	九	十
	Chinese (spoken)	yi	er	san	si	wu	liu	qi	ba	jiu	shi
	English	one	two	three	four	five	six	seven	eight	nine	ten
Ordinal	Chinese	Chinese ordinals are all formed by adding a prefix 第 (di) to the cardinal number name									
	English	first	second	third	fourth	fifth	sixth	seventh	eighth	ninth	tenth

b) Ten to twenty

Numeral		11	12	13	14	15	16	17	18	19	20
Cardinal	Chinese (written)	十一	十二	十三	十四	十五	十六	十七	十八	十九	二十
	Chinese (spoken)	shi yi	shi er	shi san	shi si	shi wu	shi liu	shi qi	shi ba	shi jiu	er shi
Ordinal	English	eleven	twelve	thirteen	fourteen	fifteen	sixteen	seventeen	eighteen	nineteen	twenty
	English	eleventh	twelfth	thirteenth	fourteenth	fifteenth	sixteenth	seventeenth	eighteenth	nineteenth	twentieth

c) Twenty to ninety-nine

Language		Rule	Example
Cardinal	Chinese	Decade unit (two,three,four,five,six,seven,eight,nine)+ten+unit	三十七 san shi qi
	English	Decade name (twen,thir,for,fif,six,seven,eight,nine) + "-ty" + unit	thirty seven
Ordinal	Chinese	Chinese ordinals are all formed by adding a prefix 第 (di) to the cardinal number name	第三十七 di san shi qi
	English	Cardinal decade name + ordinal unit name (if any) or "-th" (if no unit value)	thirty second

d) Above one hundred

Language		Rule	Example
Cardinal	Chinese (written)	Hundreds unit + hundred + [ling if remainder < 10] +[name for portion < 100]	三百零八 san bai ling ba
	English	Hundreds unit + hundred + [Name for portion < 100]	Three hundred eight
Ordinal	Chinese	Chinese ordinals are all formed by adding a prefix 第 (di) to the cardinal number name	第三百零八 di san bai ling ba
	English	Cardinal hundreds and decade name + ordinal unit name (if any) or "-th" (if no unit value)	Three hundred eighth

Image 1: English cardinal and ordinal system (from Miller et al. 2000)

The main differences are to be found in the ordinal formation process[1]: while English uses a variety of strategies to form ordinals (e.g. completely suppletive formations– *one, first* – suffixation – *four, fourth* – phonological changes and suffixation – *five, fifth* – and so on), Chinese uses one single suffix before the corresponding cardinal. According to the authors, since the meaning and conceptual system does not change from one language to the other (e.g. *one* and the corresponding Chinese word denote one single element) different cognitive developmental paths are to be justified by linguistic differences in the systems. Participants underwent several comprehension and production tasks: counting with cardinals and ordinals, bare ordinal understanding, one-to-one ordinal

[1] For a more detailed description of the differences, refer to Miller, K., Major, S. M., Shu, H., Zhang, H., 2000, *Ordinal Knowledge: Number Names and Number Concepts in Chinese and English,* Canadian Journal of Experimental Psychology, 54:2, 129-139

correspondence which involved the identification of various items from a set of similar objects or from set of different objects. It is of particular interest for the purpose of this work to describe into more depth this task. In the first task (called intersection task) objects were all of the same kinds, all were cars, and children needed to identify the N^{th} within the subset of cars. Moving on to the second task (interspersed task), children were presented with a series of black and white stones and needed to identify the N^{th} black or white stone. Results for these two tasks showed that in the intersection task all children performed at ceiling despite U.S. kindergarteners. Children found the interspersed task more difficult than the preceding, especially for U.S. kindergarteners. These results are in line with those of (Matthei , 1982). He compared the performance of children on sentences like *give me the second green ball* (two Mod – N type) and *give me the second hippo* (one Mod – N type) and found a significant interaction effect showing up mostly on two Mod – N type sentences where it appeared that children found the most difficult. In general, results showed that Chinese speaking children are facilitated in acquiring ordinal by the easy and immediate formation rules characterizing their language, which translates into the fact that "*cross-language differences in the organization of ordinal number names are associated with predictable differences in children's acquisition of ordinal numbers"* (Miller, Major, Shu, & Zhang, 2000).

The work of Trabandt and colleagues (2015) shifts from English to German speaking children acquiring ordinals. They focused on the interpretation of second and third in 4- to 6-years-old children through a give-me task. They found that children reach adult like performance around ages 4 and 5. Their acquisition, however, did not follow a stepwise fashion for the majority of learners. They did not report any statistical difference between the performance for second and third, however an individual analysis stated that eight children out of the 81 tested mastered second but not third. The authors, considering this piece of evidence taken together with the fact that at age 4 children performed better on second that on third, concluded that ordinal acquisition could proceed stepwise at least for some learners.

In line with the topics previously discussed, what has been previously said for cardinals does not seem to be valid for ordinal numerals as well, even though the two are semantically similar. Meyer, Barbiers and Weerman (2018) studied ordinal acquisition in Dutch-speaking children. By focusing on Dutch, their goal was to minimize the differences with English in order to use data from cardinal acquisition as a baseline for the study of ordinals. Their results showed, unsurprisingly, an improvement in

performance with growth and confirmed the cardinal advantage. Of particular interest is the fact that CP-knowers performed at ceiling while subset knowers correct response was around 20%. However, they stressed the fact that cardinality principle knowledge is not the only element playing a role in cardinal acquisition but the parameters of age, the place of the ordinals in the count list and the degree of morphological transparency of the lexeme also influence the process. Interestingly, both CP- and subset-knowers never gave more than one object during the Give-X trials which were formed by DPs made of the ordinal itself and a singular noun. Also, the fact that all the DPs were in subject position triggered singular agreement on the verb. Taken together, all these cues could provide children with the knowledge that only one element was required. Their data ultimately suggest that ordinals acquisition is rule-base rather than lexical. This is to say that children do not simple "store" the ordinals as they are, rather they decompose them into the corresponding cardinals and suffix to, later, compute their meaning. This makes morphological regularity and transparency crucial for the acquisition.

The most recent published work on ordinal acquisition is that of Lei (2019) focusing on Cantonese-speaking pre-schoolers. Grounding her work on Miller and colleagues (2000), her study is of particular interest not only for the results, but for the language choice. Not only her data support the *cardinal advantage* effect, but also show that children's overall correct response rate was generally higher than that of children acquiring ordinals formed by less transparent operations. This has led the author to conclude that morphological transparency and regularity are important for the acquisition of a language ordinal system. Moreover, thanks to an error analysis, a specific behaviour that children who speak other languages didn't show emerged. One of the most frequent type of errors was that of giving multiple items that either matched or did not match with the cardinal value of the number word. According to Lei, this may be due to the fact that Cantonese does not require any number marking on the nominal. This lack of number marking, obligatory in other languages such as Dutch, may mislead children to understand that singularity of the item required.

2. OUR STUDY

Chapter 1 ends with a summary of the results of the previous studies and highlights some of the weak points that make the acquisition of ordinals a topic that needs to be investigate further.

Our study aims at filling the gap in the literature. As it has already been mentioned, systematic studies on the acquisition of ordinal modifiers are barely existent and those that have been carried out investigate languages that are typologically different from Italian (Chinese, English, German, Dutch, etc) and languages with morphologic processes that make ordinals more transparent (again, Chinese). Moreover, theoretical motivations come into play. In fact, when comparing Italian and the languages that have already been tested, two characteristics have to be taken into consideration. The first one is the degree of transparency of the form of the ordinal compared to its cardinal root. The second characteristic is the high degree of allomorphy we find in Italian ordinals which is not seen in the other languages tested with the same design. Some of the previous cross-linguistic studies have tried to minimize linguistic differences, while here the parameter of structural complexity and the ways in which children deal with it becomes crucial to motivate possible different developing paths. The table below reports how two already tested languages English and Dutch, and Italian form ordinals from cardinals.

	English		**Dutch**		**Italian**	
	cardinal	**ordinal**	**cardinal**	**ordinal**	**cardinal**	**ordinal**
1	One	First	Één	Eerste	Uno	Primo
2	Two	Second	Twee	Tweede	Due	Secondo
3	Three	Third	Drie	Derde	Tre	Terzo
4	Four	Fourth	Vier	Vierde	Quattro	Quarto
5	Five	Fifth	Vijf	Vijfde	Cinque	Quinto
6	Six	Sixth	Zes	Zesde	Sei	Sesto
7	Seven	Seventh	Zeven	Zevende	Sette	Settimo
8	Eight	Eighth	Acht	Achtste	Otto	Ottavo
9	Nine	Ninth	Negen	Negende	Nove	Nono
10	Ten	Tenth	Tien	Tiende	Dieci	Decimo
11	Eleven	Eleventh	Elf	Elfde	Undici	Undicesimo
12	Twelve	Twelfth	Twaalf	Twaalfde	Dodici	Dodicesimo

13	Thirteen	Thirteenth	Dertien	Dertiende	Tredici	tredicesimo

Table 1: comparison of the English, Dutch and Italian ordinal paradigm

Before moving on to a more detailed analysis of the subject matter, it is necessary to go into depth about the terminology used to refer to the structure of ordinals. So far, we have been talking about *productivity* and *transparency* as if their definition was trivial. Facts, however, prove the opposite: defining what *productivity*, in fact, is still a matter of dispute in the literature. Scholars often refer to productivity in terms of *creativity*, the ability to create new words but what is productive, or creative, is still unclear. Some take particular affixes to be productive, other morphological processes, rules are often referred to as productive and words as well. It has also been noted how some of these points of view are, indeed, different statements for a single phenomenon (Bauer, 2004). In this study we will use *productive* as a synonym of *regular,* used to form the majority of attested forms, since ordinal modifiers are a closed class.

Moreover, the literature over the topic splits into those who believe that productivity is a "yes or no" question, so that a process/affix/rule/etc can either be productive or non-productive, and those who believe that it exists a gradient of productivity. Within the latter group, it is possible to find those who believe that productivity is gradable along steps (e.g. fully productive, intermediate and unproductive) and those who see it as a variable along a scale. We stand with the latter group.

For the purpose of the study it is also interesting to outline what makes a process/affix/rule/etc productive and Bauer quotes three factors which are often equated to *productivity* itself: frequency, semantic coherence and the ability to make new forms (Bauer, 2004).

Frequency if probably the most referred element when trying to define productivity. In particular, type frequency is what we will be referring to when talking about frequency and productivity. Type frequency can be defined as the number of items in the language that contain the process/affix/rule under consideration. For example, the suffix *–th* in English in the most frequent to derive ordinals from cardinals.

Semantic transparency (or semantic coherence) together with phonological transparency - a word is transparent if the phonology of the base word is preserved, according to Cutler (1980)- give rise to the broader concept of *transparency.* Dressler (1985) draws a hierarchy of transparency which is reported in the table below and it will be further used to classify Italian ordinals.

('$' = syllable boundary)

I	Only allophonic rules interfere between form and meaning	excite$·ment
II	Phonological rules such as resyllabification interfere between form and meaning	exis$t·ence
III	Neutralising phonological rules such as intervocalic flapping interfere between form and meaning	[raɪɾ·ɚ] for both *writer* and *rider* (American English)
IV	Morphophonemic rules which cause no fusion between morphemes (for example, velar softening) interfere between form and meaning	electri[s]·ity
V	Morphophonemic rules involving fusion interfere between form and meaning	conclu[ʒə]n
VI	Morphological rules such as those reflecting the English Great Vowel Shift interfere between form and meaning	dec[ɪ]sion
VII	Weak suppletion creates opacity (no generalisations available)	child·ren
VIII	Strong suppletion creates opacity (stems with forms unpredictable by general rule alternate)	be → am

Image 2: from Bauer, 2004, 52

The purpose of this paragraph is not to find a solution for the problems above, rather it aims at defining some basic concepts to build our theory and study upon. In the following paragraphs and chapters, we will take suffixes, since suffixation is process used to derive ordinals, to be productive and their productivity will be measured in terms of regularity and type frequency (e.g. a suffix is productive if used to create the majority of attested forms). Transparency of the base, on the other hand, will be measured using Dressler's classification.

Going back to the previously mentioned ordinal comparison, it is evident how in English and Dutch the regularities – or majority suffixes - (underlined) in the suffixation that leads to the ordinal from the corresponding cardinal start at the lower levels of the count list. In Italian we see that a productive (e.g. regular) suffix is used only from *undicesimo* (eleventh) on. The productivity of the suffix *–th* would, in fact, make it easier to produce and comprehend *fifth* than the less-productive Italian *–to* for *quinto*, which also shows root morpho-phonological alternations. Along this line, it is interesting to analyse what happens in the Italian paradigm of ordinals from a linguistic point of view as we are witnessing something that it is not valid for the languages that have been studied so far.

We could analyse Italian ordinals as follows:

CARDINAL	ORDINAL	MORPHO-PHONOLOGICAL PROCESSES ON THE BASE	SUFFIX
Uno	Primo	Totally opaque forms / strong suppletion[2]	
Due	Secondo		
Tre	Terzo[3]	Weak suppletion	
Quattro	Quarto[4]	Weak suppletion	-to
Cinque	Quinto[5]	Labialization tʃ > kw	-to
Sei	Sesto[6]	Weak suppletion	–to
Sette	Settimo[7]	Transparent base	-imo
Otto	Ottavo[8]	Weak suppletion	
Nove	Nono[9]	Weak suppletion	
Dieci	Decimo[10]	Diphthong reduction ie > e	–imo
Undici	Undicesimo	Transparent base	-esimo
Dodici	Dodicesimo		
Tredici	Tredicesimo[11]		

Table 2: Italian ordinals morpho-phonological analysis

What follows is that Italian ordinals could be organized in groups according to the suffix they take and the operation involving the root. Table 3 below specifies the organization going from the most transparent to the opaquest formations.

BASE	SUFFIX	ORDINALS

[2] *Primo* comes from the Latin form *primus* (made of the root **pri-* "in front of", "which comes before")**.** It seems to come from **pris-mo-s*, where **pris-* is a form of comparative and the suffix *-mo* stands for the superlative form. *Secondo* instead comes from the participial form *secundus* (from lat. *sĕquo, sĕquĕris, secutus sum, sĕqui)* which later came to mean the respective ordinal of the cardinal *duo* (Oliveri, 1961).

[3] Coming from the Latin cardinal *tres.* From **tri-tiyo-* (gr. Tritos, eng. Third, ger. Dritte) (Oliveri, 1961).

[4] From the Latin form *quartus,* from **kwtwrto-s,* and cardinal *quattuor,* (Oliveri, 1961)..

[5] From the Latin form *quintus* (**quinc-tos)* (Oliveri, 1961). Pit. **kwenkwe* yielded **Ifinkwe* by regular sound change. Subsequently, the **k* in the ordinal **kwinkto-* was spirantized and the preceding vowel phonetically lengthened: *tkTinxto-*. Finally, the spirant was lost, yielding *quintus.* (De Vaan, 2008)

[6] From the Latin cardinal *sex* (*sextus*) (Oliveri, 1961).

[7] From gr. *Hebdamos* and then the Latin form *septimus* (Oliveri, 1961).

[8] From the Latin *octavus* (**octow-o)* (Oliveri, 1961). For further information we quote De Vaan (2008: 425): *The ordinal seems to show a change of *-ouos > ^-auos, which is reinterpreted by Schrijver 1991: 300 as a delabialization of PIE *-eh3-uo- (with labialized laryngeal) to *-eh2-uo- due to the following *-w-.*

[9] Oliveri (1961) underlines the fact that the original cardinal should have ended with an -n, hence the Italian *nono* from lt. *nonus*.

[10] From lt. *dĕcĭmum,* from the cardinal *decem* (Oliveri, 1961; De Mauro, 2000)

[11] The last three ordinals are respectively derived from *undici, dodici, tredici* + *-esimo* (De Mauro, 2004)

Completely transparent	Productive and regular *(-esimo)*	Undicesimo, dodicesimo, tredicesimo
	Shared by one and only one ordinal *(-imo)*	Settimo
Modified by a single morpho-phonological process (apophony, metathesis)	Shared by more than one ordinal	Quinto
	Shared by one and only one ordinal	Decimo
Weak suppletion	Shared by more than one ordinal	Sesto, quarto
Weak suppletion		Terzo, ottavo, nono
Totally opaque formation / strong suppletion		Primo, secondo

Table 3: Italian ordinals grouped by transparency of the base and productivity of the suffix

To make the point clearer, then, it would be possible to group Italian ordinals into:

1. A completely transparent base + a productive and regular suffix: undicesimo, dodicesimo, tredicesimo;
2. A completely transparent base + a suffix which is shared by one and only one ordinal: settimo;
3. A base which is modified by a single morpho-phonological process + a suffix which is shared by more than one ordinal: quinto;
4. A base which is modified by a single morpho-phonological process + a suffix which is shared by one and only one ordinal: decimo;
5. A weak suppletive base + a suffix which is shared by more than one ordinal: sesto, quarto;
6. Weakly suppletive forms: terzo, ottavo, nono;
7. Totally opaque forms: primo, secondo;

Summing up the analysis in table 2 and the grouping in table 3, it follows that Italian ordinals position themselves on a gradient in both transparency (of the base and of the suffix used) and productivity of the suffix. In other words, it is possible to find four different types of bases and four different types of suffixes with different distributions, plus two completely opaque formations (*primo* and *secondo*) where it is not even possible to distinguish the base and a suffix. For a clearer explanation of the ordinal structural composition, we have outlined the possible base/suffix combination in table 4.

BASE	SUFFIX	Productive and regular	Shared by more than one ordinal	Shared by one and only one ordinal	Weak suppletion	Strong suppletion
Completely transparent		Undicesimo, dodicesimo, tredicesimo		Settimo		
Modified by a single morpho-phonological process			Quinto	Decimo		

(apophony, metathesis and insertion)					
Weak suppletion		Quarto, sesto		Ottavo, nono, terzo	
Strong suppletion					Primo; secondo

Table 4: base and suffixes possible combinations

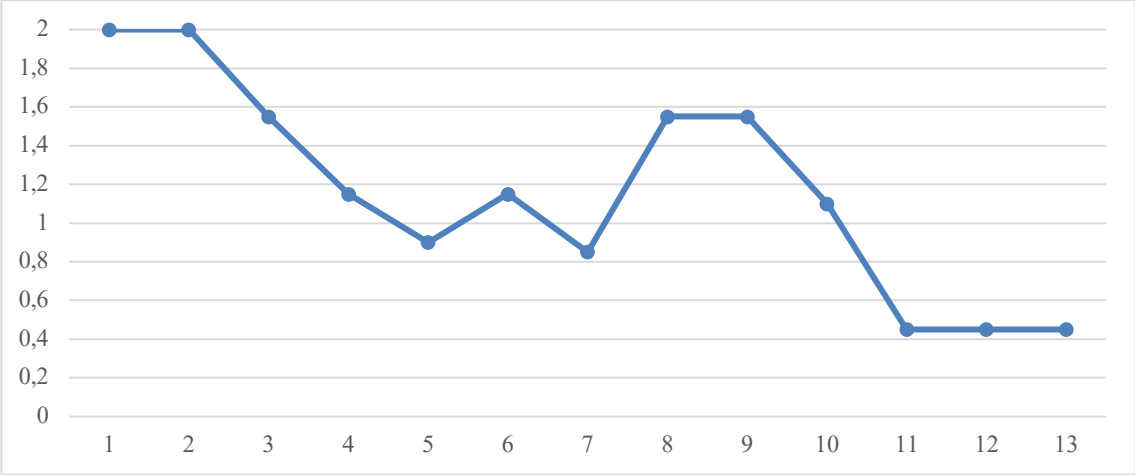
This classification raises the question of whether every formation (given the array of possible combination) has the same weight on a cognitive level. Namely, we wanted to investigate if children were somehow sensitive to productivity and transparency. Hence, we attributed a hypothetical weight to the array of bases (from 0,25 to 1) and suffixes (from 0,2 to 1) and combined them to check which ordinals may be more difficult to learn from a structural point of view. Our proposal is summarized in the following tables and graph.

	weights	productive and regular	shared by more than one ordinal	shared by one and only one ordinal	weak suppletion	total suppletion
		0,2	0,4	0,6	0,8	1
complitely transparent	0,25	0,45		0,85		
modified by one morpho-phonological process	0,5		0,9	1,1		
weak suppletion	0,75		1,15		1,55	
total suppletion	1					2

Table 5: weight distribution

Ordinals	Weight
primo	2
secondo	2
terzo	1,55
quarto	1,15
quinto	0,9
sesto	1,15
settimo	0,85
ottavo	1,55
nono	1,55
decimo	1,1
undicesimo	0,45
dodicesimo	0,45
tredicesimo	0,45

Table 6: ordinals and their relative weights



Graph 1: ordinal weight plot

Graph 1 displays the inner structural weight of each ordinal. As it can be seen, *primo* and *second* are the "heaviest" ordinals compared to *undicesimo, dodicesimo* and *tredicesimo* which, being regular, are the least heavy. This opens up extremely interesting questions which will be outlined in the paragraph 2.1.

In conclusion, Italian shows a fairly high degree of suffix allomorphy and root morpho-phonological alternations which we do not find in other languages. However, the panorama that initially seemed to be dominated by pure irregularities shows an inner structure which becomes the basis of our study. Other languages, in fact, make use of some completely irregular forms (e.g. English *first* and *second*) and of an array of allomorphs which are very limited compared to the Italian ordinals panorama. Thus, to master ordinals Italian children need to compute many more allomorphs which are often restricted in their use to just one or a couple of forms; not to mention that they also need to recognize the processes in which roots are involved. Taken all together, these pieces of information may influence the acquisition of ordinals and the next paragraph will go into more depth about how we think they may have an effect on children's language development.

Lastly, acquisitional motivations drive our study as it would shed light on the ways in which children learn ordinals. In other words, it would be possible to understand if the acquisition of ordinals is lexically- or rule-based and would underline how children deal with the interface of the morphological, syntactic and semantic parameters needed to use ordinals in an adult-like way.

2.1. Research questions

From the premises above rise our research questions:

Q1: what are the patterns and timing of the acquisition of ordinal adjectives for Italian speaking children?

Q2: can a *subset-knower* (a child who has not reached the *CP-knower* level yet) derive rules for the ordinals from the cardinals they already know?

To answer Q1, it would be possible to speculate on two patterns of acquisition: a lexical-based pattern and a rule-based one. The former requires that a child learns each ordinal as a premade lexical item devoid of any morphologic formation processes. Regarding the latter, a child who is acquiring ordinals needs to be aware of and be sensitive to the operations that each type of ordinal undergoes and the distribution of the allomorphs to derive the corresponding ordinal from cardinals. Hence, if we avoid considering how the position on the count list may interact with the acquisition of ordinals, we may assume that ordinals such as those of the *undicesimo* type may be acquired earlier than the completely opaque forms such as *primo* or *second.* Along this line, if the acquisition of Italian ordinals proceeds in a rule-based manner, one could speculate on the weight attributed to ordinals in Table 6 and argue that those with a lower weight are acquired earlier due to the simplicity of their structure. Presumably, the "one-fits-all" derivational suffix of Chinese may help children go for the rule-based approach as the way Chinese ordinals are form is very straight-forward. On the contrary, one could think that an Italian-speaking child would lean on learning every lexical item *per se* and later would come to understand what lies behind them. This may either be due to transparency issues discussed above, which may hide the cardinal base, or simply due to the fact that they are still in the lexical phase The interesting consequence of said pattern is that it would not rely on the natural order of the ordinals (e.g. they would not learn *primo* first just because it is the first one on the list) but would rather rely on the input frequency of each item. This means that a child would learn first the ordinals that they hear the most (presumably, as the frequency of the items lowers as the list goes up, we might except lower ordinals to be acquired earlier than higher ones)..

Touching on the second part of Q1, we believe that the timing is delayed with respect to the findings of previous studies on the topic. This is because we are convinced that age is the factor that allows children to learn ordinals. What we mean by this is that, children even as old as 5 have not yet acquired the inner morpho-phonological structure of ordinals and the operations required to form them. This implies that even if 5-year-old

Chinese children performed at ceiling on lower ordinals, their Italian peers may not do the same since Italian lower ordinals are the heaviest (recall graph 1). At the same time, just as their foreigner counterparts, they are not able to understand higher ordinals due to their position on the count list.

To answer Q2, it is fundamental to discuss what is relevant in ordinal acquisition: if it is the frequency of ordinal itself, the transparency of the base, the productivity and regularity of the suffix or rather the whole parsing operation? Would it be the frequency of the ordinal, then it would be possible for a subset knower to understand ordinals lexically acquired. In fact, the frequency of each ordinal gets higher as their position on the count list lowers (see also Zip's law). Hence, it would be possible for, say, a 4-knower to understand what *first* mean even though they may not know the processes behind it or the cardinals higher than 4 just because they have heard it often. Would it be either the a) transparency of the base, b) the productivity of the suffix or c) the parsing operation then the answer would be no. This is because a) a completely transparent base is used for ordinals as high as *thirteenth, twelfth* and *eleventh, seventh, eighth* and *ninth* b) and the same is valid for the productivity of the suffix as well. This leads us to c) say that parsing would still be a hard process for lower ordinals.

3. METHODS

3.1. Participants

30 participants, 11 girls and 19 boys were tested and divided into 3 age groups, from 3 to 6 years old, mean age 4;4.

	Age group 3	Age group 4	Age group 5
N° male	8	6	5
N° female	2	4	5

Table 7: Gender, age group and participant number

Before testing, we gave parents a detailed questionnaire which investigated not only children's possible language impairment or language delay but hearing problems as well. Only those children whose parents agreed on the methods of testing took part in the experiment. All participants were typically developing monolingual Italian speakers and completed both sessions of the test.

3.2. Procedure and materials

The test is made of two parts: a pretest and the test itself. The test part will be discussed first since it has some important consequence on the structure of the pretest.

In order to investigate the comprehension of ordinal adjectives, children were tested using a "give-me" task containing ordinals with sentences such as "give me the fifth toy". Despite the literature shows a great variety of this kind of test, ours is an adaptation of the experiment designed by Trabandt et al. (2015). As in the work of Trabandt and colleagues (2015), a background story was told to every child. They were told a story of a superhero who has to pack and go on a mission and every child had to help him find what he needed to put in his luggage. The objects, represented on laminated cards, were laid down in a vertical column and an arrow from top to bottom displayed the direction of counting. This way, children were invited to count from top to bottom and results showed no problem with the direction of counting. Differently from the original experiment which tested second and third, we tested ordinals from *primo* to *tredicesimo* (first to thirteenth). Every participant took the test individually at their day-care facilities. They would sit comfortably on a chair in front of a table in a quiet room with just the examiner. They would start with the pretest and, during this phase, to avoid any distraction only the pretest board in image 5 was visible.

Once the pretest was over, children were presented with the board depicting the test items which were arranged in a pseudo-random order. To answer, they would have to pick a card out of the column and pass to the other test item. No formulaic variations of the test item were given but the noun of the DP could change accordingly to the noun the child used in the pretest phase (e.g. *give me the second TV/television*). The examiner would present the items with an unmarked prosody to avoid any focalization. Moreover, as in the work of Meyer and colleagues (2018) the examiner would use the superhero to mediate situations in which the child argued the presence of the asked object ("So you think there isn't the third car? Are you sure? If Superman is asking for that, we probably have to double check"). Two warm up items preceded the testing phase. Every session lasted from 15 to 20 minutes.

3.2.1. Test items

Every test item consists of a DP with the following material: a definite article followed by an ordinal adjective, which is in turn followed by a lexical noun, e.g., *il secondo libro* 'the second book'. A preliminary selection of the lexical nouns was made using the Primo Vocabolario del Bambino (PVB) corpus (Caselli & Casadio, 1995). We excluded items referring to animate entities and used only inanimate referring items in order to eliminate animacy as a disturbing variable from our experiment. We then selected only countable nouns in order to properly depict the object and apply the ordinal adjective. We then chose only nominal lexemes which have been reported to be acquired by children before age 3 (first age in our test). Our selection resulted in 11 lexical items and all of them were used for the test.

Table 2 - Parameters and values of the chosen words (Rinaldi, Barca, & Burani, 2003)

Word	Gram. Cat.	% PVB	IIMM (med)	IIMM (ds)	LE-t	LE-l	LE-s	AD-s	LIP
BORSA (accessory)	N	56,99	5,94	1,53	59	27	32	192	31
LETTO	N	68,65	6,34	1,22	622	140	482	613	67
LIBRO	N	61,14	6,34	1,21	296	135	161	636	185
PALLA	N	84,72	6,34	1,44	240	73	167	126	44
TAVOLO	N	51,04	6,20	1,48	129	54	75	271	59
TELEVISIONE	N	52,33	6,46	1,18	432	41	391	292	79
TRENO	N	62,44	6,18	1,37	150	74	76	187	30
BICICLETTA	N	64,51	6,44	1,05	361	46	315	65	6
MATITA	N	50,78	6,24	1,35	43	27	16	37	4
TELEFONO	N	58,55	6,20	1,51	102	48	54	294	161
AUTOMOBILE	N	51,81	6,38	1,10	123	46	77	132	15

Table 1 outlines the different parameters used to classify the words in the PVB. Gram. Cat. identifies the grammatical category of every lexical item, as it is reported every lexical item we chose is a noun. %PVB is the percentage of 30-month-old children able to produce the noun. The values are based on a sample of 386 Italian children aged from 18 to 30 months. The reported percentage indicates the number of children, out of the 386 tested, that are able to produce each word. Imm, imaginability[12], defines how quickly a word creates or reminds of a visual representation, a sound or other sensory experience. LIP, frequency in speaking, refers to the work of De Mauro "Lessico di Frequenza dell'Italiano Parlato" (De Mauro, 1993). LE values, frequency in baby writing and AD-s, frequency in adult writing were not given the same weight as the parameters we have just introduced upon choosing lexical item. Lexical items were considered suitable for the test if they presented over 50% PVB score. Among that, only those with the highest rates of IMM and LIP were chosen.

Every noun was then randomly linked to an ordinal to form a DP. Our study focuses on ordinals from *primo* (first) up to *tredicesimo* (thirteenth). This choice was made to investigate the relations between the high degree of allomorphy that the Italian paradigm of ordinal shows and how children deal with it. The reasoning behind the investigation of both the lower and the higher side of the count list is that the lowest one displays the highest degree of morpho-phonological micro-variation while the higher side (merely from *eleventh* on) is where we start to see a productive pattern for deriving ordinals from cardinals, e.g. the suffix *–esimo.* The dichotomy regular vs. irregular that has been witnessed in other language is much more varied in Italian. As we have already discussed in chapter 2, the debate is between completely irregular formations and highly specific suffix that can only applied to certain cardinals. Below, it is reported a summary of the typology of ordinal formation we found in Italian[13].

BASE	SUFFIX	Productive and regular	Shared by more than one ordinal	Shared by one and only one ordinal	Unproductive and opaque	Totally opaque
Completely transparent		Undicesimo, dodicesimo,		Settimo	Ottavo, nono	

[12] For further details on how imaginability data have been collected, see Primo Vocabolario del Bambino (PVB) (Caselli & Casadio, 1995).

[13] For additional information, see chapter 2.

	tredicesimo				
Modified by a single morpho-phonological process (apophony, metathesis and insertion)		Quinto	Decimo	Terzo	
Modified by a multiple morpho-phonological process			Quarto,		
Weak suppletion		Sesto			
Totally opaque					Primo; secondo

Table 3: Italian ordinals grouped according to the required suffix

This makes our study different from the one of Meyer and colleagues as well as they focused on the ordinals from first to fourth, eighth and ninth (Meyer et al, 2015). The design is made of 39 test items arranged in two blocks administered to the same participants in two sessions with a delay of seven days.

Image 3 – examples of test item boards

3.2.1 Conditions

The experiment comprises three different conditions which manipulate two variables, i.e. the types depicted objects and the position of the target object (henceforth, TO). This manipulation allowed us to test the comprehension of the ordinal and its scope within the DP. The depicted scenario varied as to whether we depicted all objects of the same kind (Condition 1) or whether we included more than one kind of object, i.e.

distractors (henceforth, D) (Condition 2, 3). The position of the TO varied depending on whether the reading of the ordinals applied to the absolute position of the TO (Condition1), i.e. the third book is the one in the third cell, or not (Condition 2, 3), and if not, whether in the absolute position there was depicted a possible TO (Condition 2) or not (Condition 3).

As illustrated by Matthei (1982), conditions like 2 and 3 force a child to perform two different conceptual operations. Firstly, they need to form a subset of elements (e.g. if they are asked for the third book and books and pens are displayed, they need to isolate only the books). Secondly, they need to focus only on the required subset of elements and identify the one in the target position. Not only they have to perform these operations, but they must be able to put them into a relation. Table 4 illustrates the conditions and the variables.

	Type of depicted objects	Position of the TO	Depicted reading of the ordinal
Condition 1	1 type *all books*	TO = Absolute *the third book = the book in position three*	Ambiguous between scoping on the N and no scope
Condition 2	2 types *books, pens* (Ds)	TO ≠ Absolute; Absolute = same type of TO *The third book ≠the book in position three* *In position three = a book*	Both no scope on N and scope on N
Condition 3	2 types *books*, *pens* (Ds)	TO ≠ Absolute; Absolute = D *The third book ≠ the book in position three* *In position three = a pen*	Scope on N only

Table 4: test conditions

CONDITION 1: TO among objects of the same kind (e.g. *give me the third book).* Under this condition, target and absolute position in the column overlap. This condition only clarifies a child's comprehension of the ordinal meaning rather than giving insights on the nature of scope relations between the constituents of the DP. Moreover, since the objects are all of the same kind (e.g. all books, all pens, etc), children do not need to form

any subset in the array of objects displayed.

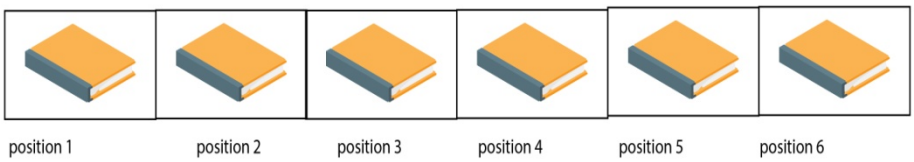


Image 4: example of condition 1 – *give me the third book*

TO TO TO TO TO TO TO TO TO TO

CONDITION 2 – intersective reading depicted: TO in the x position among objects of the same kind and D (e.g. *give me the third book* where books are among, for example, pens - D.) This time there will be a TO in the third absolute position among distractors. This condition aims to verify whether children allow for a restrictive reading where "the third book" means being a book and being the third among the books in the column or whether they allow for an intersective reading which is the result of a different semantic operation and syntactic structure, namely being a book and being the third thing on the scale. According to the data in Matthei (1982), when children are presented with a biased condition like the one depicted in condition 2, they are more likely to go for an intersective interpretation of the sentence.

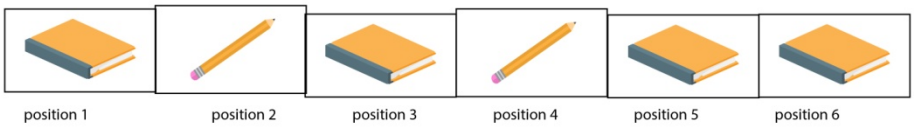
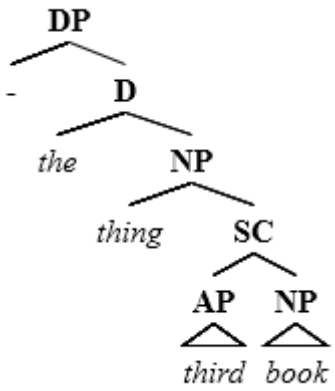


Image 5: example of condition 2 - *give me the third book*

TO D (TO) D TO D TO TO TO D

Consequently, with condition 2 we want to test whether a child allows for an adult-like reading of the test items (namely, *the third of books*) or not. Should they avoid an adult-like interpretation, then we would expect a child to understand the command *give me the third book* as *give me the thing which is a book and is the third on the scale.* The consequent syntactic structure of this reading would be the one in (1), where the nominal element is a silent THING and both the ordinal and the noun, e.g. *book*, are treated as symmetric predicates such that one predicate symmetrically c-commands the other, and both of them modify the nominal THING:

(1)



The fact that in (1) *terzo (third)* has not scope over *libro (book)* sparks an intersective reading of the two features. In fact, in this case *terzo* and *book* are to be considered two coordinated properties rather than hierarchical organized. The reasons why children should prefer this type of interpretation are several: they may prefer a simpler syntactic structure, they do not control the semantic operation required for a correct reading of the sentence or, simply, they just not possess the required cognitive and perceptual operation (1982).

CONDITION 3 – non-intersective reading depicted: TO in the x position among objects of the same kind and D (e.g. *give me the third book* where books are among pens – D). The difference with condition 2 is that condition 3 does not depict a biased scenario which allows for an intersective reading: this time the TO will not be in the absolute third position, thus the child has to pick the thing which is the third among books. This is to see if children allow for a restrictive reading where being a book and being the third thing in the column are to be considered as two hierarchical properties, e.g.]*e*[third(target object) ∧ book(target object; *e*)].

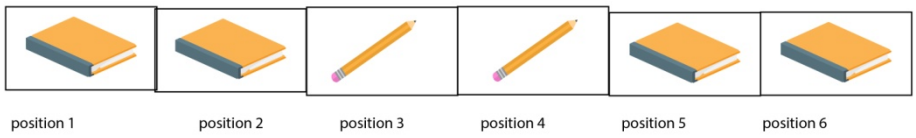


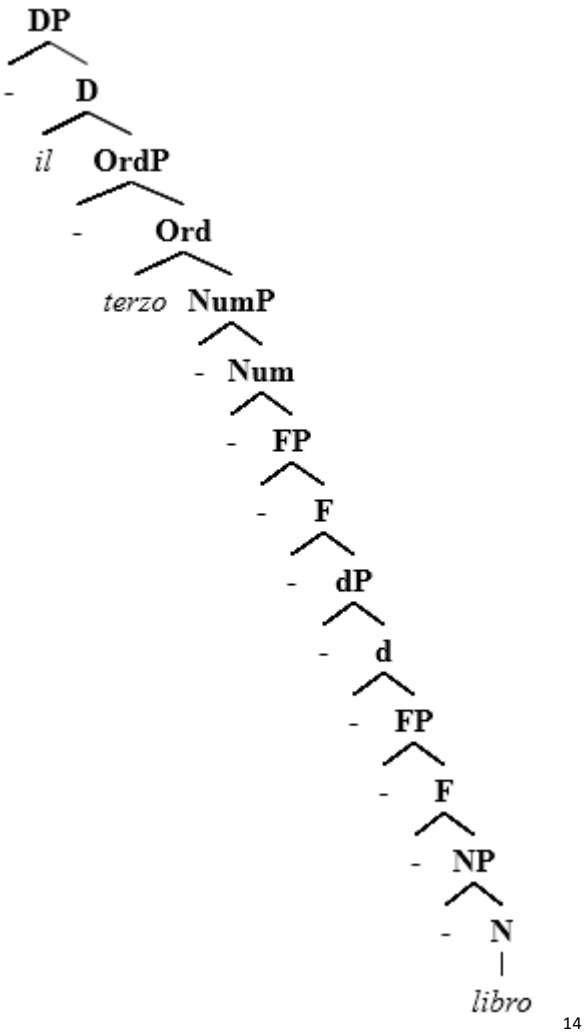
Image 6: example of condition 3 - *give me the third book*

TO TO D D TO D TO TO TO D

This time the child needs to divide the set into two different subsets (that of the TO and that of D) and pick the thing which is the n^{th} within the right subset. Syntactically, we are dealing with a totally different structure (2) that has consequences on the Semantics as

well. Being *terzo* merged higher on the structure justifies the fact that the two are hierarchical properties: *terzo* has scope over *libro.*

(2)



[14]

The inclusion of distractors is what really makes a difference with every other study on ordinals: the works of Meyer and coll. (2018), Trabandt and coll. (2015) and Lei (2019) displayed only objects of the same kind. Every ordinal was tested under each of the following three conditions.

[14] For the position of the ordinal modifier on the structure, see (Cinque, 2010)

3.3. Pretest

The pretest was built upon the test and evaluates two aspects that are fundamental for the result analysis. The first is the lexical knowledge of the nouns used in the test, which is evaluated through a naming task. The examiner showed every child a board where all the objects we used in the test were represented and asked them to name each item. This is to make sure that every child knows all lexical items used in the test session and to avoid any mistake due to the lexical knowledge of the nouns. The second part of the pretest evaluates cardinal knowledge through a "how many" task focusing on cardinals from 1 to 5. Children were asked to count the number of a given object, which was depicted multiple times. This allows us to understand which knower level every child was at the time of testing. We are aware of the critics moved to the how-many-type task and of its possible drawbacks (Wynn, 1990; Sarnecka, Carey, 2008). Our decision was made in order to keep testing conditions coherent with that of the previous studies on ordinals. Children who failed one or both parts of the pretest were excluded from taking the test.

Image 7: sample of the pretest board

3.4. Coding

At the end of each testing session, data were collected on an excel spreadsheet as the one in image 6.

ID	Birth_Da	Test_Dat	Age_in_mont	Age_grou	Type_Ite	Description_Item	Ordinal_teste	Conditi	Choice_Participant	Ordinal_pers	Correct/Wron	Comment	Scope	cp-knowl	knower grou	Ordinal_Group	Root_Wi	uffix_Wi	Total_Weigh
ANNA_COPPOLA	27/05/13	23/01/19	67	5	F	pretest on cardinal	NA	NA	NA	NA	0	4	0	non cp-k	4	NA	NA	NA	NA
ANNA_COPPOLA	27/05/13	23/01/19	67	5	F	warm up	NA	NA	NA	NA	NA	NA	0	non cp-k	4	NA	NA	NA	NA
ANNA_COPPOLA	27/05/13	23/01/19	67	5	F	warm up	NA	NA	NA	NA	NA	NA	0	non cp-k	4	NA	NA	NA	NA
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la seconda borsa	2	1	1	0	0	NA	0	non cp-k	4	7	1	1	2
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi il terzo tavolo	3	2	1	0	0	1	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la prima matita	1	3	1	1	1	NA	1	non cp-k	4	7	1	1	2
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la settima bicicletta	7	2	1	0	0	3	0	non cp-k	4	2	0,25	0,6	0,85
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi l'ottava matita	8	1	6	0	0	NA	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la 11esima palla	11	1	8	0	0	NA	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la nona bici	9	3	6	0	0	10	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la 13esima borsa	13	2	13	1	0	NA	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la sesta televisione	6	3	3	0	0	4	0	non cp-k	4	3	0,75	0,4	1,15
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi l'ottavo telefono	8	2	4	0	0	7	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi il secondo libro	2	2	3	0	0	4	0	non cp-k	4	7	1	1	2
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la quarta borsa	4	3	4	1	1	NA	1	non cp-k	4	3	0,75	0,4	1,15
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi il sesto tavolo	6	1	6	1	1	NA	1	non cp-k	4	3	0,75	0,4	1,15
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la 11esima palla	11	3	5	0	0	9	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la quarta matita	4	2	4	1	1	8	1	non cp-k	4	3	0,75	0,4	1,15
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la terza bicicletta	3	1	7	0	0	NA	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi la seconda televisione	2	3	5	0	0	7	0	non cp-k	4	7	1	1	2
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi il 13esimo letto	13	3	6	0	0	9	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	23/01/19	67	5	T	dammi il settimo libro	7	1	9	0	0	NA	0	non cp-k	4	2	0,25	0,6	0,85
ANNA_COPPOLA	27/05/13	05/02/19	68	5	F	warm up	NA	NA	NA	NA	NA	NA	0	non cp-k	4	NA	NA	NA	NA
ANNA_COPPOLA	27/05/13	05/02/19	68	5	F	warm up	NA	NA	NA	NA	NA	NA	0	non cp-k	4	NA	NA	NA	NA
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi l'undicesimo tavolo	11	2	5	0	0	7	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi l'ottava televisione	8	3	6	0	0	9	0	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi la quinta palla	5	1	11	0	0	NA	0	non cp-k	4	5	0,5	0,4	0,9
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi la nona borsa	9	1	9	1	1	NA	1	non cp-k	4	6	0,75	0,8	1,55
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi il 12esimo libro	12	2	NA	1	0	12	INTERSECTIVE	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi il 12esimo letto	12	3	10	0	0	16	0	non cp-k	4	1	0,25	0,2	0,45
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi la prima borsa	1	2	NA	1	0	1	INTERSECTIVE	non cp-k	4	7	1	1	2
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi la decima matita	10	3	8	0	0	12	0	non cp-k	4	4	0,5	0,6	1,1
ANNA_COPPOLA	27/05/13	05/02/19	68	5	T	dammi il sesto telefono	6	2	8	0	0	13	0	non cp-k	4	3	0,75	0,4	1,15

Image 8 - spreadsheet example

The spreadsheet presents 15 different variables, one for each column:

ID: name_surname of the participant;

BIRTH_DATE: date of birth (dd/mm/yyyy);

TEST_DATE: date of the test (dd/mm/yyyy). This is useful to keep records of the delay time for each child;

AGE_IN_MONTHS;

AGE_GROUP: either 3, 4 or 5;

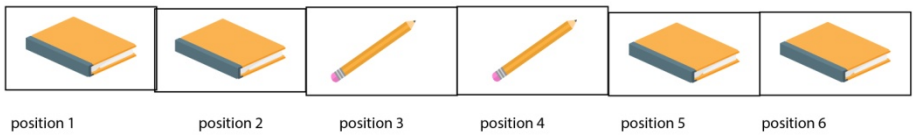
TYPE_ITEM: Filler (F) used for the pretest on cardinals and warmups and test item (T);

DESCRIPTION_ITEM: the content of each item (e.g. *dammi la secondaborsa* or *warm up/pretest*);

ORDINAL: the ordinal tested. The values range from 1 to 13 and NA is used when no ordinal is tested (i.e. for fillers or warmups);

CONDITION: either 1, 2 o 3. NA is used when no ordinal is tested (i.e. for fillers);

CHOICE_PARTICIPANT: reports the cell position of the card picked by the child within the subset of target object. Consider the image below as the cardboard the child is given. The examiner asks for the third book and the child picks the book in position 5. CHOICE_PARTICIPANT would be 3, as they picked the third of books.

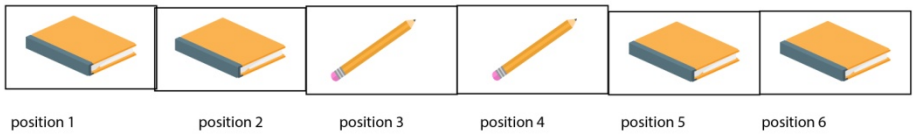


ORDINAL_PERSE: this is to keep track of children's understanding of the target ordinal devoid of any condition. Its values are 1 if a child picks either the right n^{th} element within the subset of target object (non-intersective reading) or picks the

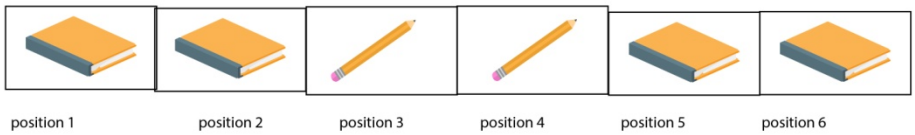
n^{th} in the scale (intersective reading), 0 if they do not pick anything that corresponds to the ordinal requested.

CORRECT/WRONG: 1 for correct answer, 0 for wrong answer. We considered an answer to be correct when the child showed a non-intersective reading of the command (hence, picks the n^{th} within the subset of TO).

COMMENTS: reports the absolute cell position of the card picked by the child. Consider the image below as the cardboard the child is given. The examiner asks for the third book and the child picks the book in position 5. COMMENTS would be 5, as they picked the fifth element of those displayed on the cardboard.



SCOPE: either 1 (correct) when the interpretation is non-intersective, 0 when the answer is wrong, INTERSECTIVE if so is the interpretation or OTHER (which has never been used) if a child picks something that has nothing to do with the command (e.g. when asked for the third book, they pick the pen in position 4) or when asked for the third book, they pick the pen in position 3 (hence, ORDINAL_PERSE: 1, SCOPE: other.



CP-KNOWER: either non cp-k or cp-k;

KNOWER_LEVEL: if CP-KNOWER: non cp-k, then KNOWER_LEVEL: 1, 2, 3 or 4 depending on how far every non-cp knower could count. If CP-KNOWER: cp-k, then KNOWER_LEVEL: cp-k.

ORDINAL_GROUP: with values from 1 to 9 in relation to the classification of Italian ordinals in chapter 2;

WEIGHT_ROOT: from 0,25 to 1, it is the hypothetical weight we have given to the ordinal roots;

WEIGHT_SUFFIX: from 0,2 to 1, it is the hypothetical weight we have given to the ordinal suffixes;

WEIGHT_TOTAL: from 0,4 to 2, it is the hypothetical weight we have given to the ordinals as lexical items;

4. RESULTS

Before moving to a more detailed analysis, it is important to draw some premises on the results. Even at the earliest stages of ordinal acquisition, children are able to distinguish between cardinals and ordinals even if they lack exact representation of the latter. Moreover, there has never been a case where a child would pick more than one card. This is in line with what was found by Meyer and col. (2018) and the bootstrapping theories outlined in the previous chapters. During the *give me* task, ordinals were modifiers of singular nouns only as we have never asked for *i terzi pantaloni* (the third trousers), for example. We justify that considering children sensitive to singular nouns generally referring to a single entity and, therefore, they would never pick out more than one card.

4.1. CP knowers versus NON-CP knowers

The pretest was fundamental to be able to classify children as CP and NON-CP knowers and to subgroup them into *n*-knower levels according to Wynn's classification (Wynn, 1992). Out of the 30 tested children, 13 were found to be CP knowers and 17 subset knowers. This is summarized in table 8 below.

cp-k	subset	total
13	17	30

Table 8: number of CP and subset knowers

We considered children to be a n-knower when failed to give n+1 objects twice. Table 9 outlines the subset knowers' levels and the number of children who belong to that beam.

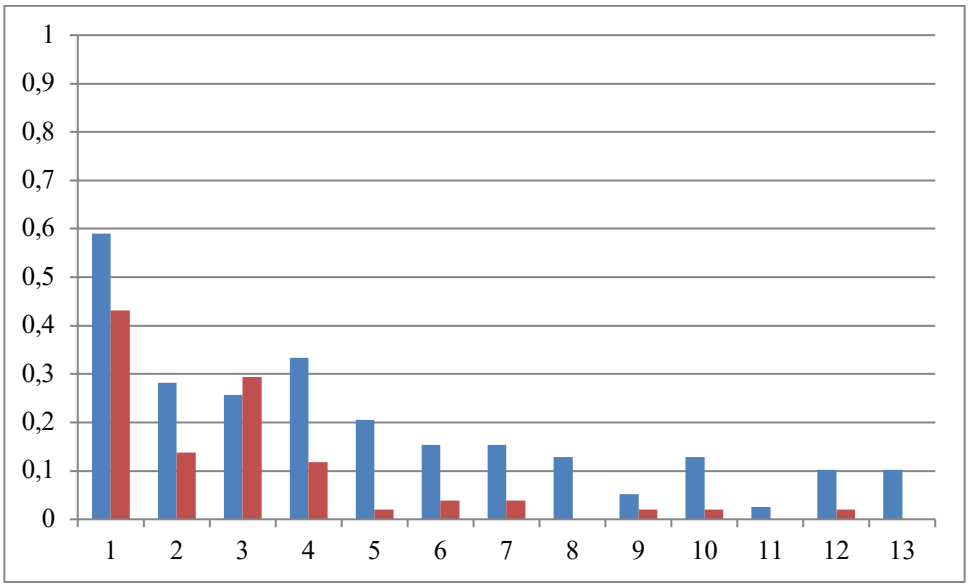
1 knower	2 knower	3 knower	4 knower
1	7	7	2

Table 9: Knower-level subgrouping of NON-CP knowers

Out of the 17 children classified as subset knowers, only 1 was considered to a 1-knower, 7 were 2-knowers, 7 were judged to be 3-knowers and, lastly, only 2 were 4-knowers.

Comparing CP and NON-CP knowers' performances, data show that the overall performance seems to be enhanced by the acquisition of the cardinality principle. Not only children who are already familiar with the notion of cardinality are more capable of

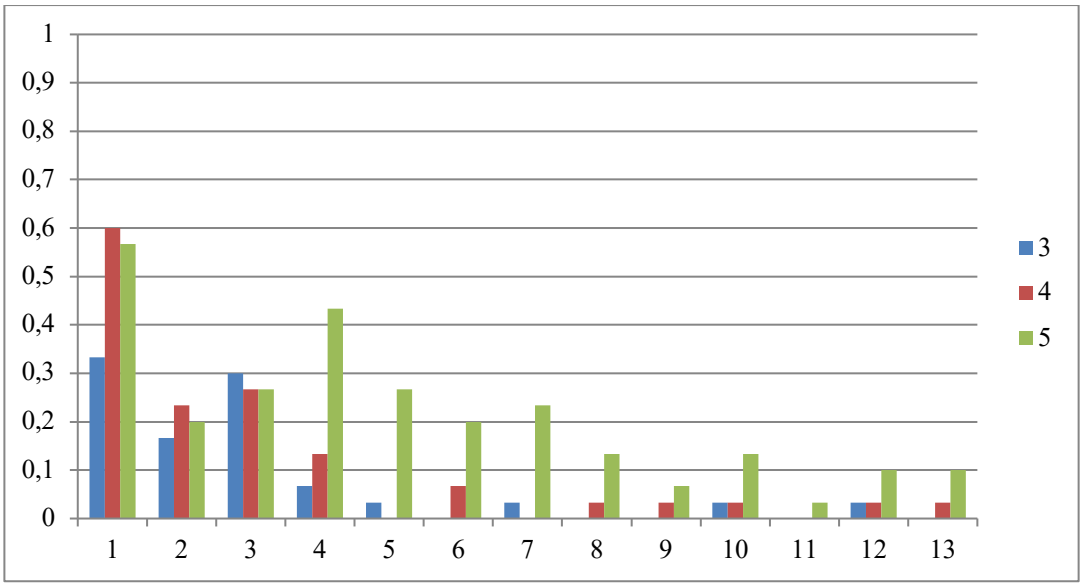
understanding ordinals correctly, hence display higher levels of accuracy, but can go further on the count list and derive ordinals that subset knowers are not able to understand at all.



Graph 2: Overall CP knowers (blue) and subset knowers (red) correct scores for each ordinal tested

4.2. Age

In this paragraph we will take into consideration the results related to the parameter of age. First, we will analyse the overall performance over the ordinals we tested and then will focus on single age groups.



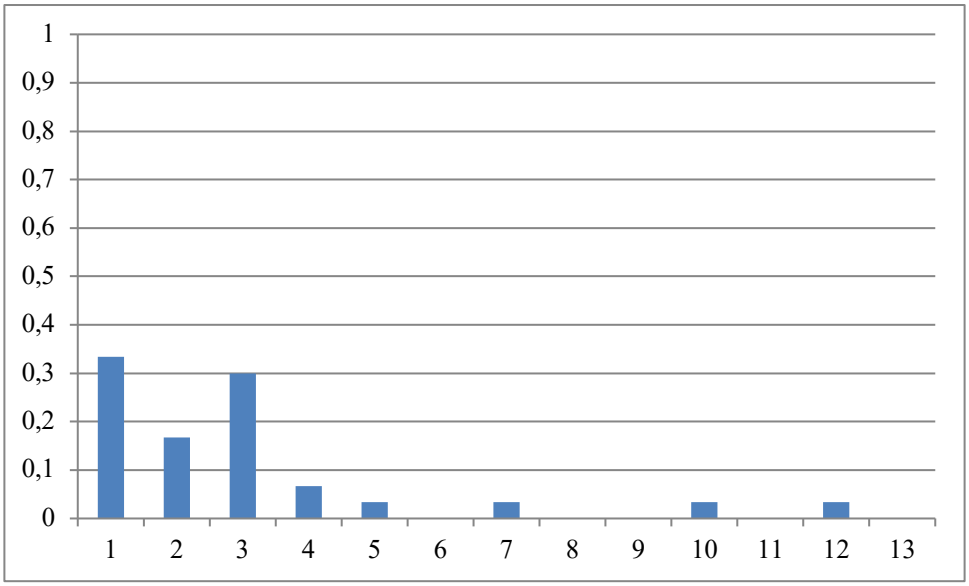
Graph 3: overall correct rates for each age group (both CP and subset knowers)

From the data in graph 2, it is possible to see a clear improvement in the performance as children get older. The effect that age has on the performance is no

surprise since its importance has already been noted both for cardinals and ordinals. As children grow up, they are able to understand higher ordinals and go further on the count list. It is, nonetheless, interesting to point that even younger children are able to understand lower ordinals. The next paragraphs will go into more depth on the performance of each age group.

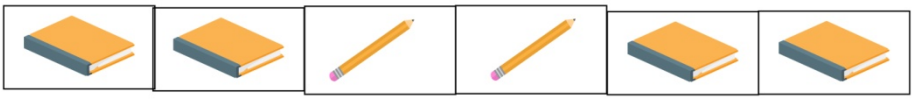
4.2.1. Age 3 group

The following is an analysis of the performance of 3-year-old children only.



Graph 4: age 3 group correct rates

Every 3-year-old child we tested was not a cp-knower. Graph 3 shows how their performance declines as ordinals get higher. This is easy to explain if we think that going up on the list is more and more demanding from a cognitive point of view. Even though *Primo* does not seem to be fully acquired yet, the accuracy is high anyway. It drastically lowers when moving to *secondo* and rises again with *terzo*. Regarding the performance on *primo*, it has to be mentioned that when asked for the N^{th} thing, children in this group would most likely pick the first item of the column that represented the target object, no matter which was actually asked. For example, if we refer to the image below and during the testing session we asked for the *second book* (either under condition 1, 2 or 3) a 3-year-old child would probably pick the book in position 1 which is obviously incorrect. On the contrary, if the examiner asked a child for the *first book* (either under condition 1, 2 or 3), they would keep picking the book in position 1 scoring a correct response purely by chance.



This translates to higher chances of picking the first TO correctly, when asked for it. This behaviour is underlined in the table below which shows how out of 347 times that age 3 group was asked for a specific item, they answer consisted of the first TO available.

1	2	3	4	5	6	7	8	9	10	11	12	13	Total
257	36	22	7	5	11	11	10	1	3	1	3	7	374

Table 10: number of times age group children select an object in one specific position

Age-group-3 children were then divided into knower levels (e.g. 1-knowers, 2-knowers up to 4-knowers) depending on the last cardinal they were able to use correctly. Table 11 shows that out of the 10 3-year-old children tested, only 1 was found to be 1-knower, 6 were classified as 2-knowers and the left 3 children were 3-knowers.

Knower levels	1	2	3
Number of children	1	6	3

Table 11: 3-year-old children divided into knower levels

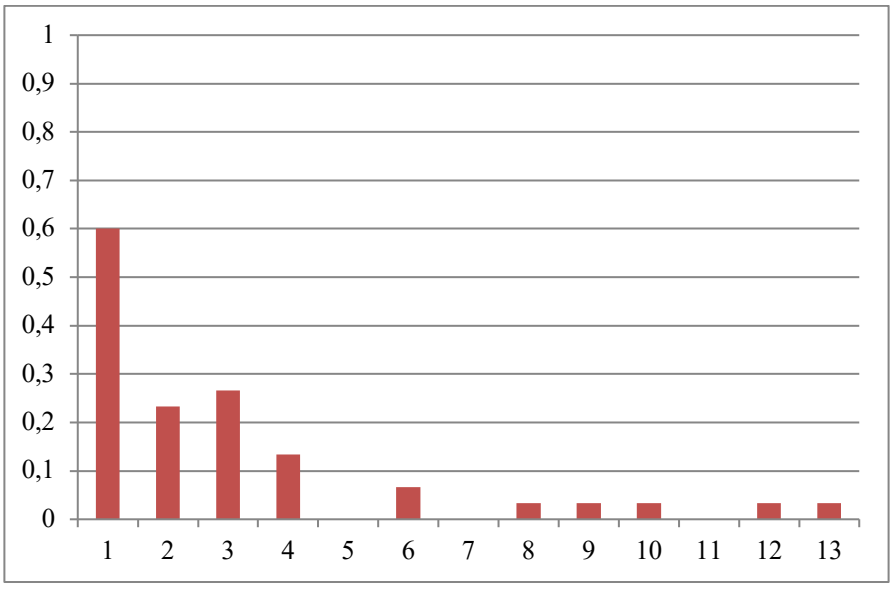
Their performance was then analysed (Table 12) and what was found is that, despite 2-knowers seem to be able to use higher ordinals, 3-knowers show higher accuracy scores. Taken together, these data underline the hypothesis that, proceeding from one knower level to the next one, the ability to understand ordinals improves. It is interesting for the purpose of this study to note that 2 and 1-knowers did not proceed in a stepwise manner in understanding ordinals. For example, 2-knowers understood *fifth* and *seventh* but not *sixth* the same way they didn't understand ordinal *ninth* but did so with *tenth.* What is also interesting is the fact that, despite all of them being all NON-CP knower, they could understand some of the ordinals tested. This may be in favour of a lexical-based acquisition and could start giving insights on a possible answer to Q3.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0,33	0	0,33	0	0	0	0	0	0	0	0	0	0
2	0,38	0,16	0,22	0,05	0,05	0	0,05	0	0	0,05	0	0,05	0
3	0,22	0,22	0,44	0,11	0	0	0	0	0	0	0	0	0

Table 12: knower levels (raws) and their mean of correct responses (columns) on each ordinal tested

4.2.2. Age 4 group

The following data regard the performance of 4-year-old children. At this point, no distinction in terms of condition is made, instead the whole performance was taken into consideration.



Graph 5: age 4 group perfomance (both CP and subset knowers)

Moving from age 3 to age 4, not only do we see the accuracy levels rising but we also witness correct responses for ordinals that were not understood correctly by age 3 children. However, even age 4 children would sometimes pick the first item of the column instead of whichever Numberth asked.

Out of the 10 4-year-old children tested, 5 proved to be CP-knowers while 5 did not demonstrate cardinal principle knowledge (table 13). Within the subset knower group, no child was classified as 1-knower or 4-knower, only 1 was 2-knower and 4 of them were 3-knowers (table 10).

cp-k	subset	total
5	5	10

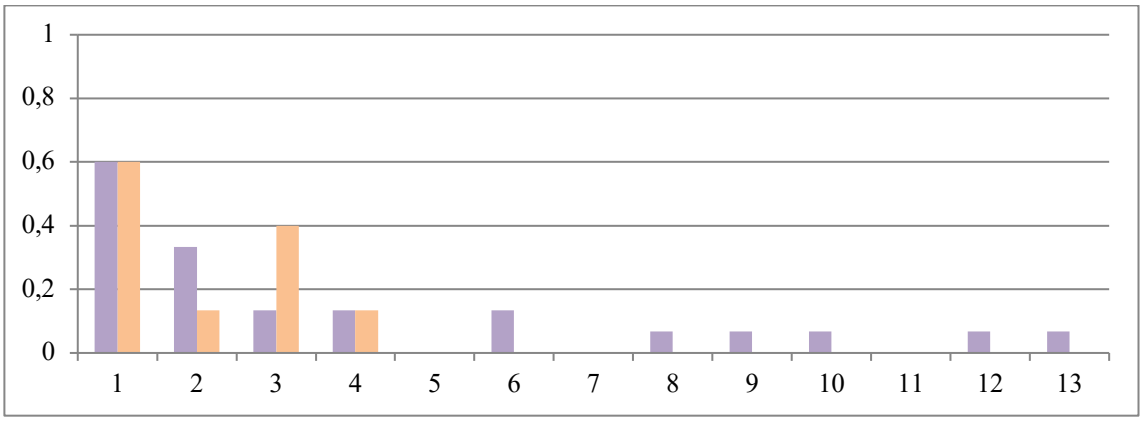
Table 13: number of CP and subset knowers in age group 4

1 knower	2 knower	3 knower	4 knower
0	1	4	0

Table 14: knower-level classification for age group 4 children

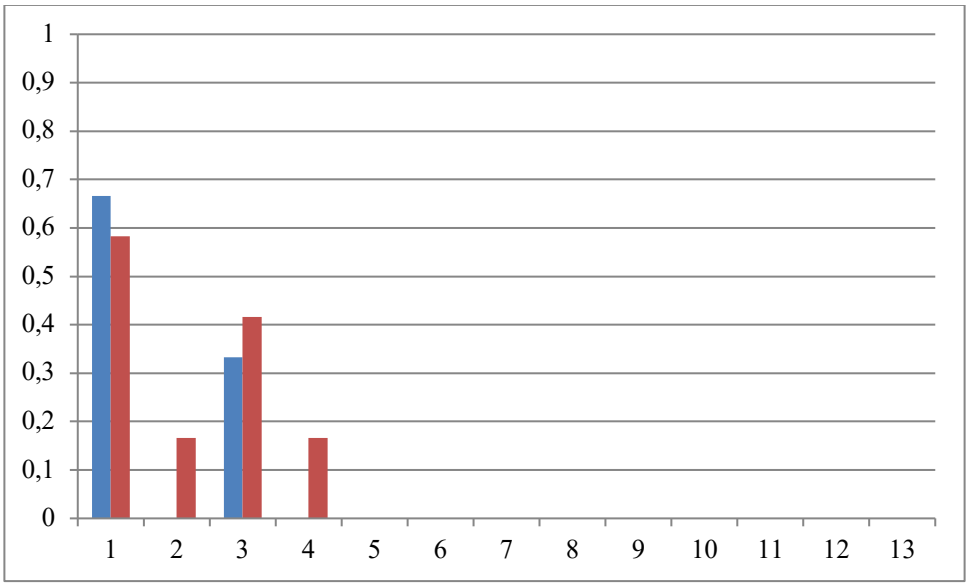
Splitting CP and NON-CP knowers' performance, again we witness a CP-knowers advantage: not only their accuracy is generally higher, but they impressively go higher on the count list. It is interesting, however, to note that regarding *primo* and *quarto* the

level of accuracy is exactly the same and, even more surprising, is the higher number of correct responses for *terzo* given by subset knowers.



Graph 6: CP (purple) and subset (orange) knowers' performance within age 4 group

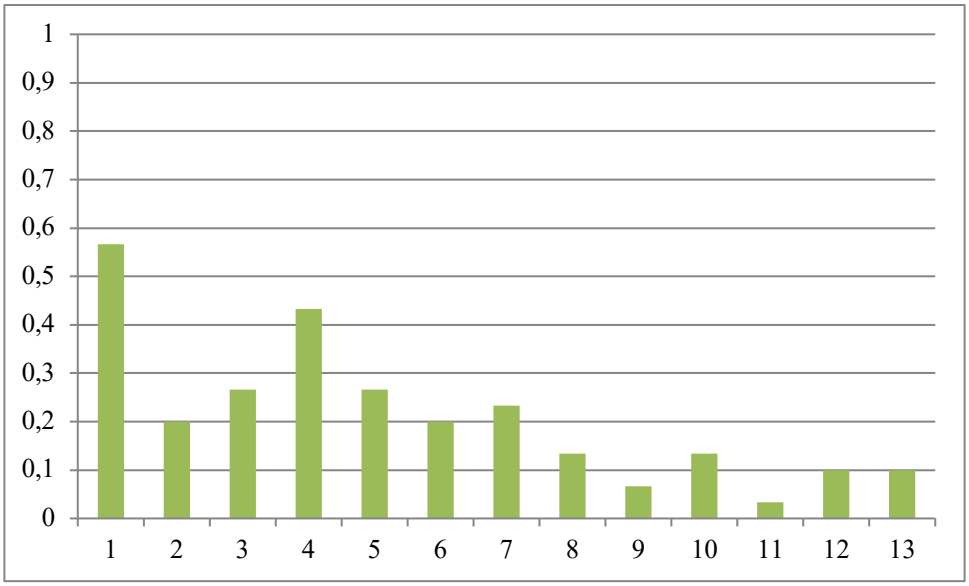
As previously stated, no child was classified as 1- and 4-knowers. Consequently, the following analysis comprises only of the data of 2- and 3-knowers. Analysing every knower level performance it is no surprise that data represented in graph 7 below show an improvement comparing 2 and 3-knowers' performances. Surprisingly, however, 2 knowers were not able to understand *second* but succeeded in understating *third*.



Graph 7: 2 knowers (blue) versus 3 knowers (blue)

4.2.3. Age 5 group

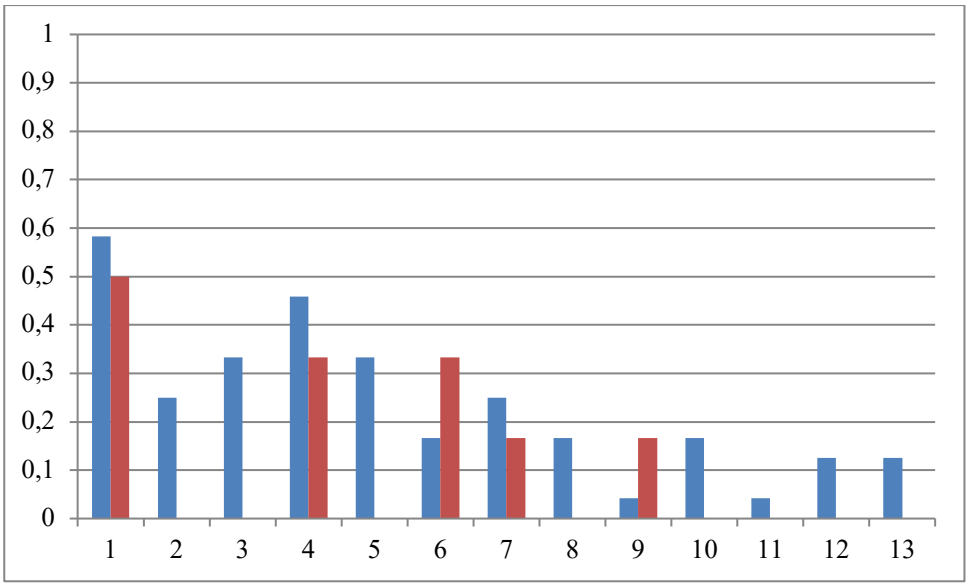
What follows is an analysis of 5-year-old children overall performance on the ordinals tested where no distinction was made in terms of condition under which ordinals where presented.



Graph 8: performance of age 5 children

Graph 8 underlines what has already been mentioned in paragraph 4.2: 5-year-old children are those who performed the best, even if their performance does not reach the adult-like behaviour. They are now able to understand, at least partially, every ordinal that has been tested.

Out of the 10 5-year-old children tested, only 2 did not show knowledge of the cardinality principle and were classified as 4 knowers.



Graph 9: age 5 CP (blue) and subst (red) performance

Considering 5-year-old CP and subset knowers, it is even more striking the importance of the cardinality principle knowledge. Graph 9, in fact, shows how limited and poor the subset knowers' performance is in relation to that of CP-knowers.

4.3.4. Summary of age

Summing up what has been said so far, age seems to have a strong influence on performance as it strongly improves moving from age 3 to age 5. This result is in line with what has been found by other studies on the acquisition ordinal modifiers (Lei, 2019; Meyer et al, 2018; Trabandt et al 2013; Miller, 2000).

Moreover, even within the age subsets it is possible to notice the importance of cardinality principle knowledge. Apparently, those who own it are able to understand higher ordinals and score higher accuracy rates. However, not only those who do not own it are still able to understand ordinals but can also go past the knower-level threshold. For example, we can see how 4-knowers can go way beyond *fourth.*

	ordinals												
Knower levels	1	2	3	4	5	6	7	8	9	10	11	12	13
1	33,3	0,0	33,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	42,9	14,3	23,8	4,8	4,8	0,0	4,8	0,0	0,0	4,8	0,0	4,8	0,0
3	42,9	19,0	42,9	14,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
4	50,0	0,0	0,0	33,3	0,0	33,3	16,7	0,0	16,7	0,0	0,0	0,0	0,0

Table 15: % of correct answers of NON-CPs divided into knower levels. Blue cells represent the ordinals for the cardinal the already know, purple ones are the additional ordinals they can understand.

Lastly, it is extremely interesting to analyse individual knower-level performance. It has already been brought to attention the peculiarity of certain behaviours that would not be expected. For example, the only 1-knower is able to understand the ordinals for *first* and *third.* One may expect that, since cardinal acquisition proceeds stepwise, so does ordinal. Contrarily, table 11 reports that M_R was not able to understand *second.* The same goes for some of the 2-knowers to which *second* seems to create some difficulties. It is curious how, throughout each knower level, correct rates stop right after four (even though in very few cases correct answers have been reported for higher ordinals, such as *settimo* – twice out of seventeen NON-CP knowers, *quinto* – just once).

Knower groups	1													2												3												4												
Ordinals	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
A_C																																								1	0	0	1	0	1	0	0	1	0	0	0	0
A_S																											1	1	1	0	0	0	0	0	0	0	0	0	0												
B_D														1	1	1	0	0	0	0	0	0	0	0	0	0																								
E_T														1	0	1	0	0	0	0	0	0	0	0	0	0																								
E_D_T																											0	1	1	1	0	0	0	0	0	0	0	0	0												
G_M														1	0	1	0	0	0	0	0	0	0	0	0	0																								
M_T																											1	0	1	0	0	0	0	0	0	0	0	0	0												
M_C														1	0	1	0	0	0	0	0	0	0	0	0	0																								
M_V																											0	0	1	0	0	0	0	0	0	0	0	0	0												
M_R	1	0	1	0	0	0	0	0	0	0	0	0	0																																						
S_B																											1	1	1	1	0	0	0	0	0	0	0	0	0												
S_A														1	1	0	0	0	0	0	0	0	0	0	0	0																								
T_B														0	0	1	0	1	0	1	0	0	0	0	0	0																								
T_R														1	1	0	1	0	0	0	0	0	1	0	1	0																								
U_V_S																											1	0	1	0	0	0	0	0	0	0	0	0	0												
V_M																																								1	0	0	0	0	1	1	0	0	0	0	0	0
V_Z																											1	0	1	0	0	0	0	0	0	0	0	0	0												
Total	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**

Table 16: individual performance analysis. 1 for correct answer, 0 for wrong.

4.4. Conditions

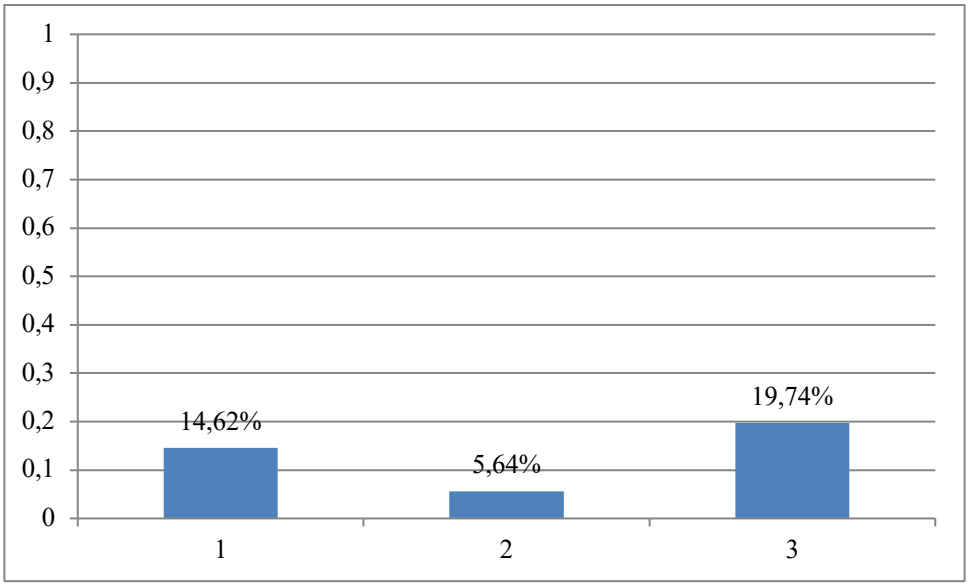
It has already been discussed how our study differs from the previous in terms of the conditions under which ordinals have been tested. Just to give a little context for the results, we will give a brief summary of them.

CONDITION 1: it only involves the target object (TO). It allows us only to examine pure ordinal comprehension without giving any insight on the scope relation inside the DP.

CONDITION 2: it depicts a biased, intersective reading. Here TO and distractors (D) are used to see if a child goes for an intersective reading of the commands. Under this condition, a TO is positioned both on the absolute and in the relative position. It is important because, contrarily to condition 1, depicting a biased scenario would shed light over the scope relations of the DP constituents. Under this condition, in fact, if a child consider *book* and *third* in the sentence *give me the third book* as two coordinated properties (intersective reading), then they would pick the absolute third TO (hence, the answer would be considered wrong).

CONDITION 3: it depicts an unbiased condition where the answer to an intersective reading is not available. In fact, under this condition, a child would find a TO only in the relative position and not in the absolute. It is to say that in *give me the third book*, a child would only be able to find the third among books (restrictive reading) and no TO will be placed in the third position on the scale.

Let's now move on to the data analysis for each condition. Graph 9 shows the correct response rates for each condition. This time we considered both CP and NON-CP knowers' answers. It is interesting to see that condition 1, which should be the easiest since it only involves TO and no D, is not the one with the highest number of correct answers. As one would expect, condition 2 is the one with the lowest accuracy meaning that children, when allowed to, go for an intersective interpretation. This piece of finding, however, contrast with that found for condition 3 which forced children to go for an adult-like reading, and it is the one with the highest number of correct answers.



Graph 10: correct CP and subset knower response rates for each condition

Unsurprisingly, splitting data for CP and subset knowers it is possible to underline one more time the importance of cardinality principle knowledge. Not only did CP-knowers perform better overall, but they also went for an adult-like reading of condition 2 more times than NON-CPs as it is shown in table 16.

Conditions	CP-K	SUBSET K.
1	24%	07%
2	08%	03%
3	25%	15%
Total	19%	08%

Table 17: mean accuracy rates split for CP and NON-CP knowers for every condition

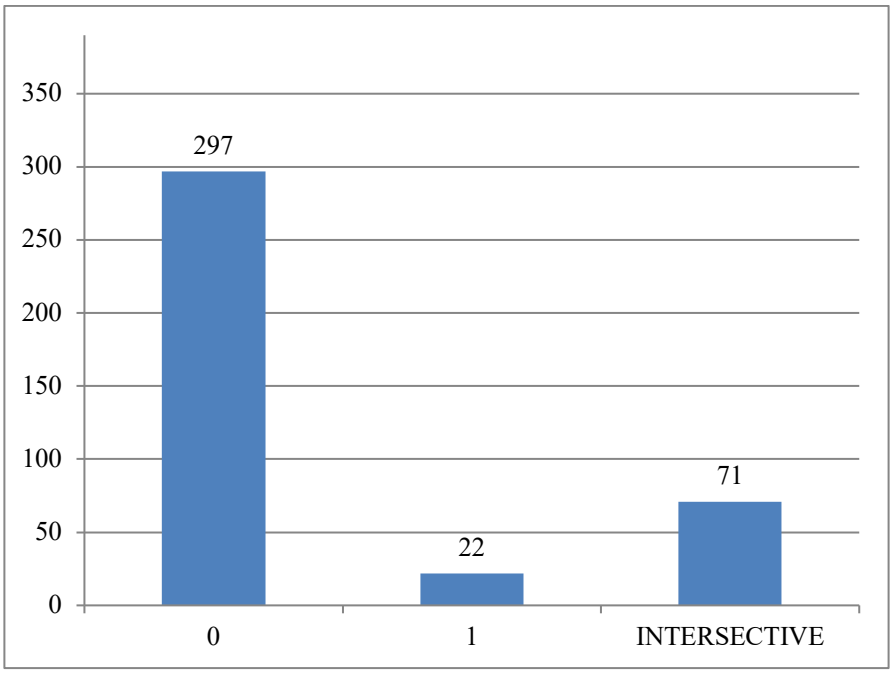
Table 17 below highlights the results of CP knowers for each ordinal under every condition. No matter which condition, accuracy levels tend to lower as we go up the count list and, for the majority of the ordinals tested, children' scores are higher for condition 3.

Cond	1	2	3	4	5	6	7	8	9	10	11	12	13
1	92,3	30,8	30,8	38,5	23,1	23,1	15,4	7,7	7,7	15,4	7,7	7,7	15,4
2	0,0	15,4	7,7	38,5	15,4	15,4	0,0	7,7	7,7	0,0	0,0	0,0	0,0
3	84,6	38,5	38,5	23,1	23,1	7,7	30,8	23,1	0,0	23,1	0,0	23,1	15,4
Total	**59,0**	**28,2**	**25,6**	**33,3**	**20,5**	**15,4**	**15,4**	**12,8**	**5,1**	**12,8**	**2,6**	**10,3**	**10,3**

Table 18: mean accuracy rates (%) split for each ordinal and for every condition

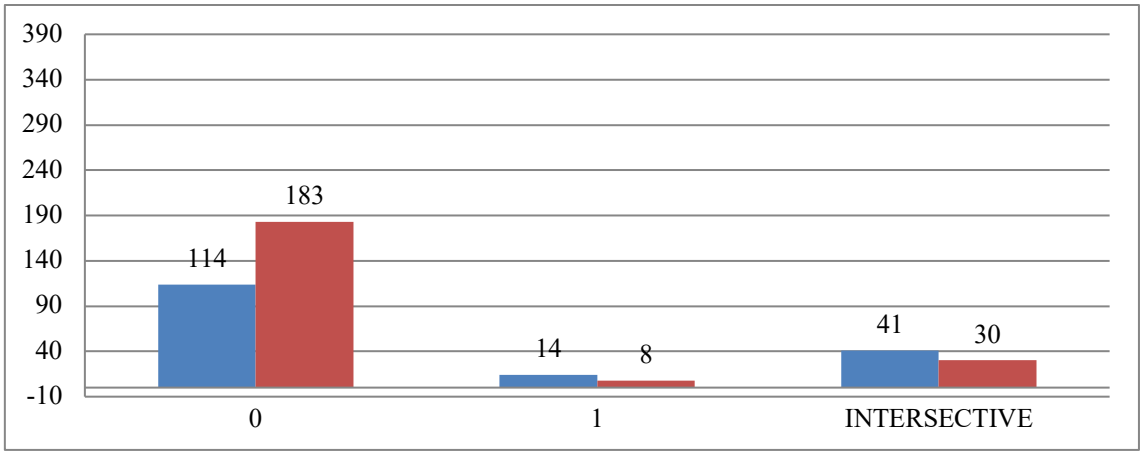
4.4.1. Scope

Within condition 2, we then moved to count the times children (both CP and subset) went for an intersective reading of the sentences. Out of 390 total answers, 297 showed a wrong scope relation within the DP constituents (ordinal + item). This is when children picked the item corresponding to a wrong ordinal (e.g. *give me fifth car* and they would pick the seventh). 22 answers were correct, which translate into an adult-like reading of the sentences (hence, children went for a restrictive reading even under condition 2) and 71 answers showed an intersective reading which means that children took the two properties as coordinated and symmetrical.



Graph 11: answer count for each SCOPE level (0 for wrong, 1 for correct, INTERSECTIVE for intersective)

Splitting CP and subset knowers' performances it is striking to see that CP-knowers' intersective responses are more than those of the subset knowers which, to some extend would be counter intuitive also because CP-knowers are less than NON-CP knowers (13 against 17).



Graph 12: answer count for each SCOPE level split between CP and subset knowers (0 for wrong, 1 for correct, INTERSECTIVE for intersective)

Since we have seen a tendency for children to go for an intersective reading if the scenario allows for it, we moved to analyse individual-level performances to see if it was possible to find any pattern in the scope reletions (e.g. if there were children that only go for an intersective or non-intersective reading or, alternatively, mix the scope relations).

Table 18 below shows the number of times every child went for an intersective or a non-intersective reading. In the table, children are divided into CP or subset knowers (and into knower levels).

		0	**1**	**INTERSECTIVE**
cp-k				
4				
	cp-k			
	DANIELE_RONCARATI	11		2
	DAVIDE_GOVONI	8	1	4
	DIEGO_MANDINI	10		3
	GIULIA_MARTINI	9	1	3
	THOMAS_GIULIANI	11	1	1
5				
	cp-k			
	DANIELE_TADDIA	4	4	5
	EDOARDO_GAROFALO	11		2
	FRANCESCA_TOSELLI	8		5
	GABRIEL_PISTORIO	9	2	2
	GIULIA_GOVONI	11		2
	MATTIA_FORNI	6	3	4
	NICOLA_TRIOLA	7	2	4
	SOFIA_GIGLIOLI	9		4
non cp-k				
3				
	1			
	MATTIA_ROSSETTI	11		2

2				
	BIAGIO_DIANA	10		3
	EMANUELE_TASSI	11		2
	GIORGIA_MILANI	11		2
	SIMONE_ALBERGHINI	11	1	1
	TOMMASO_BLO	12		1
	TOMMASO_RONCARATI	11	1	1
3				
	ENEA_DI_TURI	10	3	
	MARTINA_VECCHI	11		2
	UGO_VENTO_SARTI	11		2
4				
2				
	MARTINA_CIPRIANI	11		2
3				
	ASIA_SPAGNOLI	11		2
	MARCO_TONI	11		2
	SAMUEL_BALBONI	11	1	1
	VITTORIA_ZANFINI	11		2
5				
4				
	ANNA_COPPOLA	9	1	3
	VITTORIA_MANZI	10	1	2

Table 19: count of scope relation choices (only for condition 2) for every children divided into CP and NON-CP knowers and sub-grouped into age groups and knower levels

Despite the panorama is not crystal clear, we can see a tendency in children's behaviour: CP-knowers' responses, especially older ones, are generally mixed even though we have already underlined that the intersective ones are more than the non-intersective. Contrarily, subset knowers' responses are generally more targeted toward a clear division: either incorrect (hence, coded as 0) or intersective.

4.4.2. Age and conditions

The following paragraph will analyse the performance combining two parameters: age and conditions.

Age groups / conditions	**1**	**2**	**3**	**Total**
3	5,4%	3,8%	13,8%	7,7%
4	13,1%	3,1%	17,7%	11,3%
5	25,4%	10,0%	27,7%	21,0%
Total	14,6%	5,6%	19,7%	13,3%

Table 19: % of correct responses for every age group (CP and NON-CPs) under each condition

Table 19 can be read in two directions. Firstly, we can read each raw and the first fact that is to be noted is that performance lowers from condition 1 to condition 2 which

is probably due to intersective scenario depicted which may deceive (or allow) a child to go for an intersective reading. Condition 3 is the one under which children performed the best which has already been noted in the previous paragraph. The second way to read Table 19 is by columns. Generally, performance under each condition generally gets better as children get older, which again has already been mentioned.

	1		2		3	
Ordinal	**cp-k**	**non cp-k**	**cp-k**	**non cp-k**	**cp-k**	**non cp-k**
1	92,3%	58,8%	0,0%	0,0%	84,6%	70,6%
2	30,8%	0,0%	15,4%	11,8%	38,5%	29,4%
3	30,8%	11,8%	7,7%	5,9%	38,5%	70,6%
4	38,5%	5,9%	38,5%	23,5%	23,1%	5,9%
5	23,1%	0,0%	15,4%	0,0%	23,1%	5,9%
6	23,1%	5,9%	15,4%	5,9%	7,7%	0,0%
7	15,4%	0,0%	0,0%	0,0%	30,8%	11,8%
8	7,7%	0,0%	7,7%	0,0%	23,1%	0,0%
9	7,7%	5,9%	7,7%	0,0%	0,0%	0,0%
10	15,4%	0,0%	0,0%	0,0%	23,1%	5,9%
11	7,7%	0,0%	0,0%	0,0%	0,0%	0,0%
12	7,7%	5,9%	0,0%	0,0%	23,1%	0,0%
13	15,4%	0,0%	0,0%	0,0%	15,4%	0,0%
Total	**24,3%**	**7,2%**	**8,3%**	**3,6%**	**25,4%**	**15,4%**

Table 20: % of correct responses for every age group (split for CP and NON-CPs) under each condition

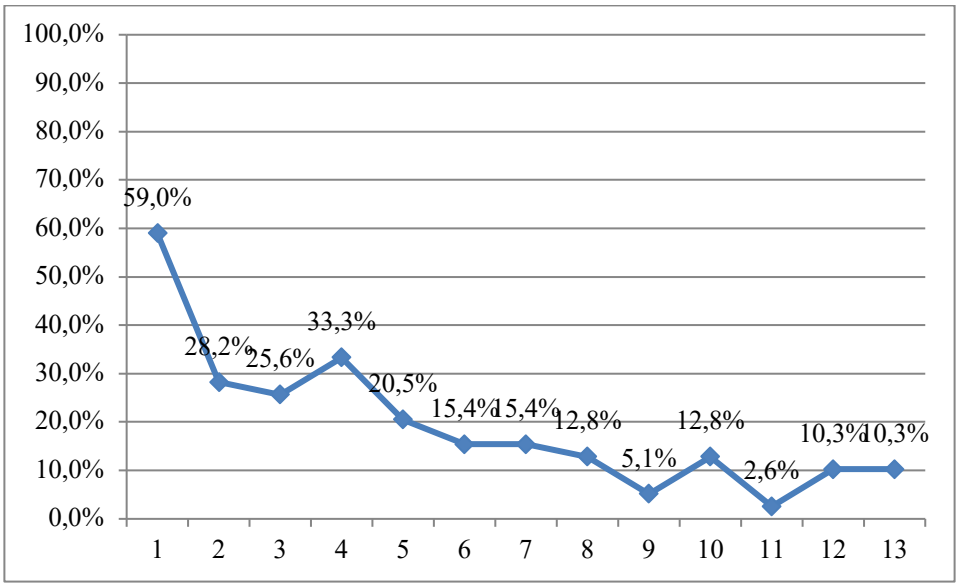
Splitting performances for CP and subsets, it is possible to note that it significantly rises just by acquiring the cardinality principle. It is interesting to point out the fact that in some cases under condition 2 and 3, the cardinality principle makes no difference. It is the case of *decimo, undicesimo, dodicesimo* and *tredicesimo*, *settimo* e *primo* under condition 2 or *nono* and *undicesimo* under condition 3.

4.5. Ordinals

It has already been brought up in other paragraphs, but the topic of single ordinals accuracy deserves to have a space of its own.

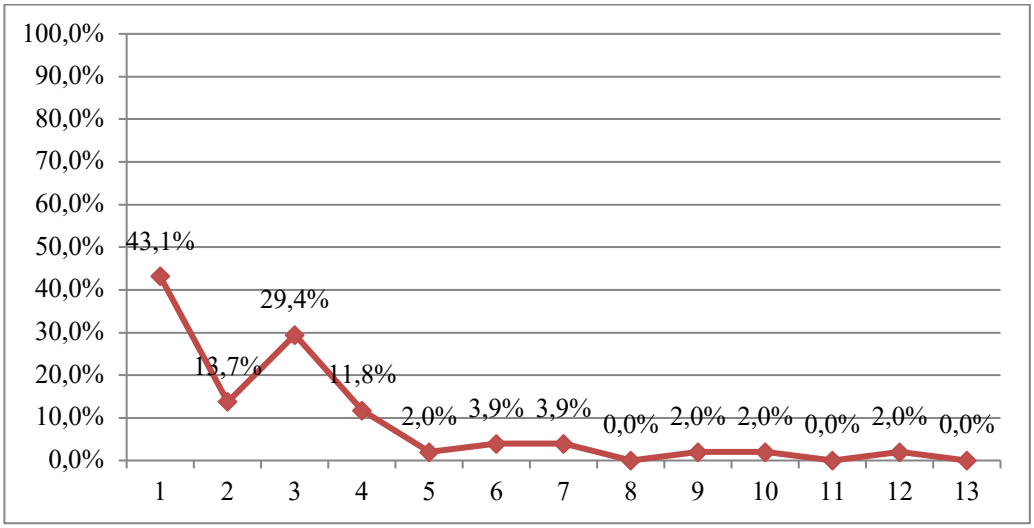
Graph 13 depicts CP-knowers' accuracy for every ordinal we tested. It is interesting to see how correct rates tend to lower as the count list moves on. *Primo* is the ordinal with the highest rates, followed by *quarto.* In general, however, ordinals up to five seem to create fewer difficulties in children, nonetheless none of them reaches ceiling. From *sesto* on the rates fall down until *nono* which, together with *undicesimo* are those with the lowest scores. On the highest side of the scale, two things are worth of

interest: the first being the peak at *decimo* and the second is the rising of correct response rates from *undicesimo* to *tredicesimo.*



Graph 13: CP-knowers' average accuracy rates for single ordinals

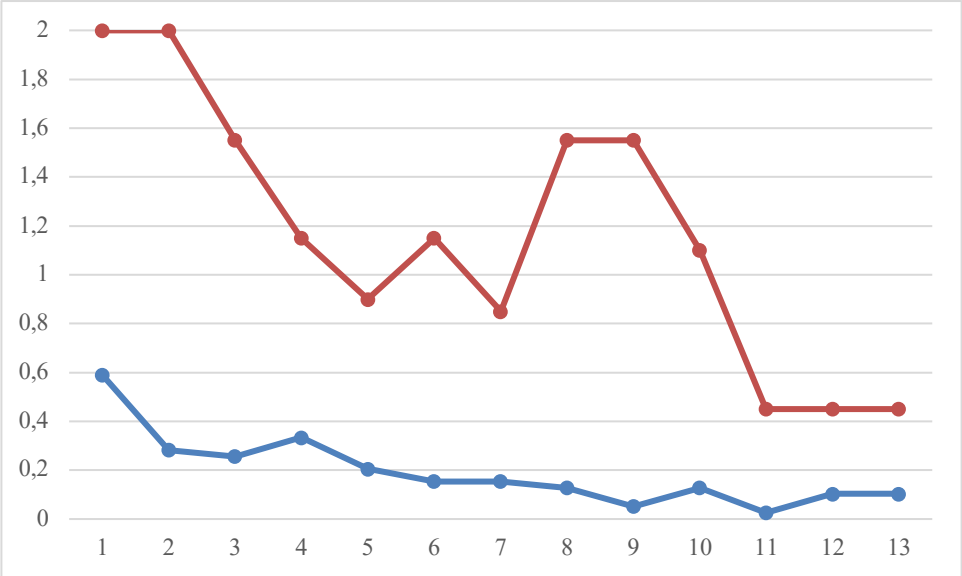
If we then consider only subset knowers, data are even more striking: not only overall accuracy rates are lower but the fall in accuracy begins earlier. In fact, while CP-knowers were able to give to correct answers to every ordinal, NON-CP knowers from 3 to 5-years of age do not score any correct answer for ordinal such as *ottavo, undicesimo* and *tredicesimo*, not to mention that the overall performance for ordinals higher than *fourth* is almost 0.



Graph 14: subset knowers' average accuracy rates for single ordinals

Going back to our point, we claimed that the great variety of ordinal types could determine a delay in the general process of acquisition of ordinals. In addition, we were convinced that higher degrees of opacity (both of the root and in terms of productivity of the suffix) would translate into greater difficulties in understanding each ordinal. It is to

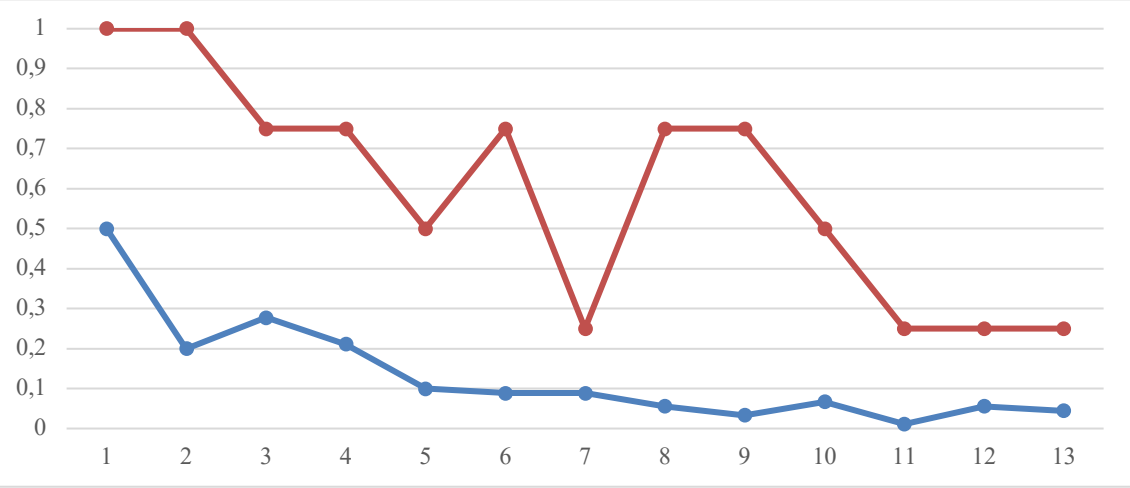
say that, given that *terzo* is more difficult to link back to its cardinal due to the fact that it is a suppletive form with respect to *tredicesimo*, children would find it more difficult to understand the former than the latter. We assessed these questions and results are displayed in the graphs below. Graph 15 displays in red the distribution of the weights of each ordinal along a scale and in blue the mean of the correct answers



Graph 15: correlation of ordinal weights (red) and the mean of CP-knowers' correct answers (blu)

Data seem controversial. What we see is that *primo* is the ordinal which is understood the most despite being one of the heaviest. On the other hand, more regular ordinals such as *dodicesimo, tredicesimo* are among the lowest in accuracy.

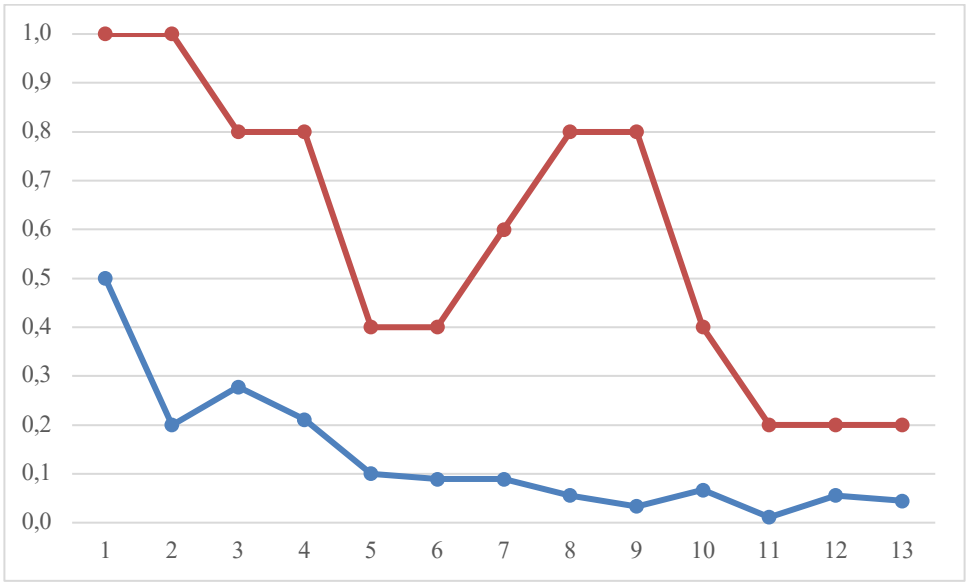
In our analysis, we tried to split productivity of the suffix and the transparency of the root to see if one of the two parameters influenced the acquisition the most. Graph 16 represents in red the weight given to the different types of roots we have found and in blue is the average accuracy scores for each ordinal.



Graph 16: average accuracy rates (blue) in comparison with the weight attributed to the types of base

Even if *primo* is the heaviest as far as roots are concerned, it is still the one on which children performed the best. It is also interesting to note that despite *quinto* and *sesto* show the different root weights, the results of the performance are almost the same. The same goes for transparent roots such as those of *settimo, undicesimo, dodicesimo* and *tredicesimo*: their roots have the same weight but accuracy results are different.

Graph 17, on the other hand, addresses the alternative scenario (e.g. where a child uses the productivity of the suffix for the acquisition). Again, the blue line represents the average accuracy rates but this time the red one shows the weight of the suffixes.



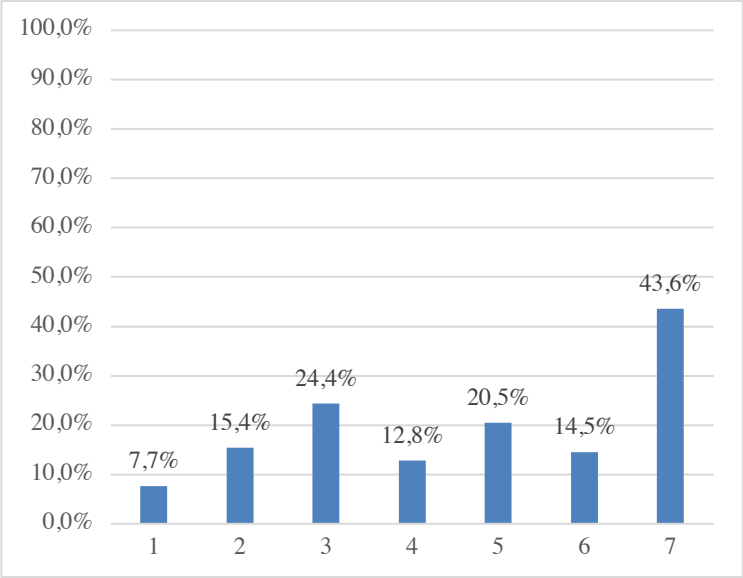
Graph 17: avarage accuracy rates (blue) in comparison with the weight attributed to the types of suffix

Primo still is the one with the highest accuracy rates, again what we want to point out is that even if *terzo, quarto, ottavo* and *nono* show the same suffix weights, performance proves to be better on *ottavo.* Equally, suffix weight for *decimo* is higher than that of *undicesimo* but children performed better on the former than the latter.

At this point, we moved to the ordinal grouping outline in chapter 2[15] and the results are showed in Graph 18 below.

[15] Which we report for reading convenience

1. A completely transparent base + a productive and regular suffix: undicesimo, dodicesimo, tredicesimo;
2. A completely transparent base + a suffix which is shared by one and only one ordinal: settimo;
3. A base which is modified by a single morpho-phonological process + a suffix which is shared by more than one ordinal: quinto;
4. A base which is modified by a single morpho-phonological process + a suffix which is shared by one and only one ordinal: decimo;
5. A weak suppletive base + a suffix which is shared by more than one ordinal: sesto, quarto;
6. Weakly suppletive forms: terzo, ottavo, nono;
7. Totally opaque forms: primo, secondo.



Graph 18: average accuracy for every ordinal group

Group 1 is the one with the highest degrees of transparency and productivity, but also the one with the lowest accuracy rates. Contrarily, group 7 is where we find the suppletive forms (hence, completely opaque and unproductive) but it is also where we find the highest accuracy scores. Interestingly, however, if we compare groups 5 and 6 it seems that children find it easier to understand forms where only the base is suppletive but the suffix is shared with even only one ordinal.

5. DISCUSSION

The following chapter will give an explanation of the results outlined in the previous one in relation to the theoretical background discussed in chapter 1 and 2.

Before moving on to the test-specific discussions, it has been reported that children in the age span of interest are able to distinguish cardinals and ordinals. In chapter 1 the semantic properties of cardinals (e.g. they refer to sets of objects, rather than to properties of objects) and ordinals (e.g. describing the order of single items in relation to the others within said set) has been addressed. From the data, it is possible to conclude that children as young as 3-years-old are aware of this difference in meaning and are able to shift from a cardinal to an ordinal scenario with little to no problem. In fact, there has never been a case where a child performed actions not related to the ordinal task at hand (e.g. named objects or simply counted the set as in the pretest)

In addition to that, children have never picked out more than one object in response to the examiner's commands. This piece of finding is in line with what Meyer and colleagues (2018) report and contrasts with the results in Lei (2019), which is exactly what one would expect. Along the line of what Meyer and colleagues conclude, we take this piece of data as evidence that children are also sensitive to singular *versus* plural concord. It has already been addressed the fact that our test items were made of DPs with singular N (i.e. *give me the third book* and never *give me the third scissors*). The sensitivity to the fact that single nouns refer to only one entity never prompted to take more than one object. Contrarily, Chinese morphology does not require number marking on the nouns, so children made more "multiple-item" mistakes.

5.1. CP versus subset knowers

When comparing CP and subset knowers' performances it is striking the importance of the cardinal principle knowledge. In fact, it has been reported that not only are children who own the principle able to count further, but they also score higher results in terms of accuracy. We have been referring so far to this as *CP-knowers' advantage* in order to underline the improvement in performance that the owning of the principle implies. This is probably due to the implementation of the successor function which is what really differentiates CP and NON-CP knowers (Sarnecka & Carey, 2008). If the function allows children to understand that the numeral denoting *n+1* will be somewhere after the numeral denoting *n* in the numeral list. The same reasoning could also be applied

to ordinals: building up on cardinal knowledge, CP-knowers are therefore able to understand ordinals that NON-CP knowers are not able to.

However, it would be incorrect to argue that subset knowers are not able to understand ordinals at all. In fact, it is true that owning the principle has a huge impact on performance, but it is also true that it is not fundamental since data report that also subset knowers are able to understand ordinals. Paragraph 5.2.1. will continue on the topic.

5.2. Age

From the data we gathered, it is clear how the parameter of age plays an important role in the development of the ordinal competence. Subset 3-year-old children could only understand a very limited number of ordinals, while 5-yeard-old children who acquired already the cardinality principle are those who performed the best, but still not as an adult would. Nonetheless, it is evident how development translates into higher accuracy levels which is in line with what has been reported in previous studies (Lei, 2019; Meyer et al, 2018; Trabandt et al 2013; Miller, 2000). At this point, we could consider age and the owning of the cardinality principle as two main sources of performance improvement.

However, other studies found adult-like understanding of ordinals earlier. To draw a comparison, Trabandt and col. (2015)showed how adult-like comprehension of small ordinals in German started around age 5. This is not true for Italian speaking children whose comprehension of the same ordinals is sometimes even under chance level. Even more striking is the results in Lei (2019) whose findings report that even 3-year-old Chinese-speaking children are able to understand ordinals the same way adults do.

5.2.1. Knower levels

The parameter of age goes hand in hand with that of knower level. What has been said for age, in fact, relates to knower levels as well since as children get older, they are able to understand different cardinals moving from one knower level to the next one.

From the data we have gathered we can conclude that cardinal and ordinal acquisition do not follow the same steps. It is well known that cardinal acquisition precedes in a stepwise fashion (hence, Wynn's knower level classification). This is not true for ordinal acquisition since we have reported that some 4-year-old 2-knowers are

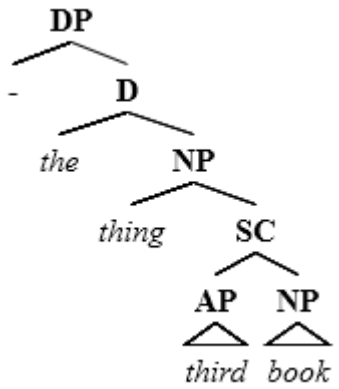
able to understand *third* but not *second.* This still applies to higher ordinals as well since we have found 2-knowers who understood *fifth* and *seventh* but not *sixth* the same way they didn't understand ordinal *ninth* but did so with *tenth.*

Moreover, we have reported that, on the one side, 3-year-old 2-knower could reach higher ordinals that 3-knowers with the same age, while on the other 3-knowers showed higher accuracy levels.

5.3. Conditions

Out of three conditions, number 1 and 3 are those where children scored the highest rates (CP-knowers especially). Since, as it has been explained earlier, condition 1 purely tests ordinal comprehension and condition 3 depicts a restrictive scenario where the only possible interpretation is the adult-like one, it would be possible to conclude that children are able to understand ordinals just like adults would.

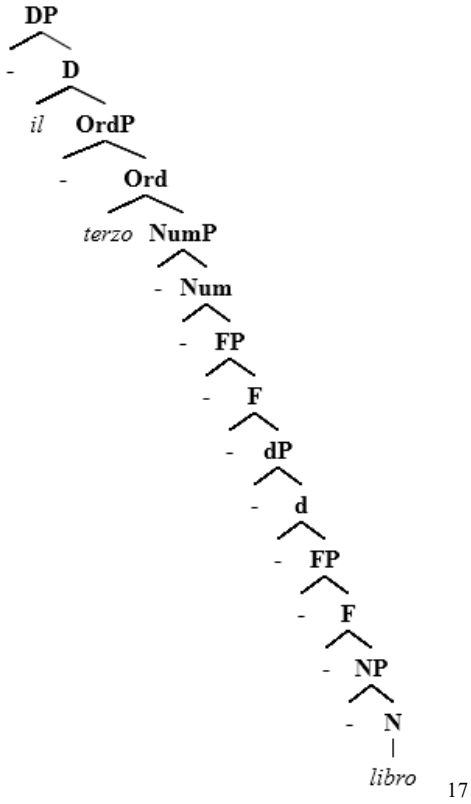
However, analysing results from condition 2, it is evident who their interpretation differs from that of the adults. In fact, both CP and NON-CP knowers' scores are extremely low under condition 2: this means that they have wither picked the items in the absolute position or a picked the item in a totally wrong position. If their interpretation were adult-like, one would expect scores in condition 2 to be just as high as in the others. Recalling that this condition depicts a biased scenario[16] where a child could either go for a restrictive reading or an intersective one, data prove that children, if allowed to, still interpret sentences like *give me the second book* intersectively. This means that *second* and *book* are two coordinated properties with no scope relations one over the other. Rather, they equally refer to a silent *thing* as shown in the structure below.



[16] As in Matthei (1982). We call it *biased* since it gives children a chance to go for an intersective reading with the presence of the TO in the absolute X position.

The motivations to this could be essentially of two types. The first one may be that children would normally go for a non-intersective reading but would give an intersective one only if deceived to. The second, instead, would see children's standard interpretation to be intersective. The fact that the scores for condition 3 are high would be due to the fact that they are forced to go for a restrictive reading since it is the only possible solution (in fact, in condition 3 the TO is placed only in the relative position – the Nth among TO – and not in the absolute one).

We think that the second motivation is the right one. In fact, the structure below implies a more articulated and fine-grained structure, which may not be already available for children.



[17]

First, having an ordinal in Ord means that said ordinals c-commands the N of the DP. Moreover, it also means that the ordinal and the N enter a scope relation which is what sparks the non-intersective reading *the Nth among the objects of the same kind.* Note that the insertion of additional material such as in the examples in (3) and (4) would make the scope and c-commands relations even harder to handle.

(3) Il terzo bel libro

[17] (Cinque, 2010)

The third good book

(4) La nostra quarta canzone

The our fourth song

Our fourth song

Taking the example in (3), a child would need to understand that the set is made of books, but not books in general: the good books. At this point there would be another sub-classification to carry out: within the subset of good books, we are talking about the third among the good books.

Bearing in mind that Italian-speaking children even at 5-years of age still find it hard to understand ordinals, it would be that an intersective reading may help them disentangle the relations, or better, they would avoid the need to build hierarchies of properties and simply compute them as coordinated.

Contrarily, a structure such that of the intersective reading would still allow the insertion of material but it would not add relations or hierarchical structures. The child would only need to compute the element of the DP and treat them as properties of a silent *thing* (as we have seen, *third, good* and *book* could be considered as element of a nominal predicate – *Take a thing. The thing is third. The thing is good. The thing is a book*). Cognitively speaking, we could say that an intersective reading is the one children go for because that's the only one they can handle for sentences such as those used in our test. Hence, from an acquisitional point of view, it would be possible to conclude that (at least from what our experiment underlines), non-intersective readings develop later in children, precisely when they are able to build the required relations among the elements of a DP (see Table 18).

5.4. Ordinals and morphological structure

In the previous chapters, we have outlined some parameters that may influence the acquisition of ordinals. One of these is the morphological structure of Italian ordinals which is different from that of the previously tested languages. In chapter 2, ordinals have been classified and they were given a hypothetical weight based on the form of the root (e.g. weather it goes through morpho-phonological modifications or not) and based on the type of suffix used (e.g. productive and transparent, opaque, shared, etc.). If the morphological structure (Graph 15) was the factor that influences the most the acquisition, we would expect ordinals from *undicesimo* on to be those with the highest

rates and this does not happen; using this background it would not even be possible to explain why *decimo*, being heavier than *undicesimo*, shows higher correct rates. The same also applies for the lower side of the scale where we find *primo* and *second* being the most elaborate from a structural point of view but also those with the highest accuracy rates.

At this point one could even argue that it is not a matter of the ordinal as a morphological unity, but rather it could be that children base their process on the transparency of the base (where with *transparency* we mean the possibility to immediately recall the cardinal base) or the productivity of the suffix. Data, however, proved booth these assumptions wrong.

Even if we look at the broader picture and try to find patterns in the grouping of the ordinals we drew, the task is still hard. If the transparency of the base were the parameter that drives the acquisition of ordinals, we would expect the highest rates to be those of group 1, 2 and 3 (the most transparent) which actually prove to be those with the lowest. If the productivity of the suffix was what matters, we would expect performance for the ordinals in group 1 to be the highest and, again, this is not the case.

The conclusion is that the morphological structure of the ordinals is not *the* factor that drives the acquisition of ordinals. However, we cannot say that this does not influence at all. In fact, if we take Lei's Chinese-speaking children whose performance is already adult-like in the same age span of our Italian-speaking children, the only factor that would explain such a difference is, indeed, that of morphological transparency. Nonetheless, our study is still not able to tease apart where the influence of age and cognitive developments stops and where that of transparency and productivity begins. One last important piece of evidence come from graph 17: what this graph underlines is the fact that groups 5, 7 and 9 are those with the highest accuracy rates. The fact that the ordinals *primo, secondo, terzo* and *quarto* belong to these groups is what convinces us to claim that either frequency in speaking, the position on the count list or the correlation of both is what influences the acquisition of ordinals the most.

5.6. Research questions

Q1: what are the timing and patterns of the acquisition of ordinal adjectives for Italian speaking children?

Q2: can a *subset-knower* (a child who has not reached the *CP-knower* level yet) derive rules for the ordinals from the cardinals they already know?

In chapter 2, we predicted that the timing of ordinal acquisition is delayed with respect to the findings of previous studies on the topic. Our data prove this prediction true as we have seen that even 5-year-old children' performance was not like that of the adults. With regard to the possible reasons of this delay, we have outlined two: a) cognitive development and age, b) the inner morpho-phonological structure of the paradigm of Italian ordinals. It has been already discussed that our study is not able to separate exactly the extent to which age influences the acquisition with respect to the one of the morpho-phonological structure. In particular, it is not clear how the particular morphological structure of each ordinal could influence the acquisition of said ordinal. For example, we are not able to discuss if the acquisition of an opaquer form such as *primo* differs from that of a more transparent one, such as *tredicesimo.* However, it is clear that maximizing the linguistic differences with the already-tested languages has proven that Italian children from 3 to 5 years of age are not ready to handle such a diversity in terms of derivation processes. It is to say that the cognitive development of Italian-speaking children even as old as 5 years does not allow them to understand such a variety of processes and forms. Hence, the delay.

Answering the second part of Q1 involved speculating on two patterns of acquisition: a lexical-based pattern by which lexical items are acquired as already-made entities devoid of any derivational processes, and a rule-based one which, instead, relies on the awareness of and the ability to perform the required operation to form ordinals from their corresponding cardinals. Our data prove that children acquire ordinal by a lexical-based pattern. If we assumed that children were aware of the processes involved, then we would expect ordinals with the same suffix and root operations to be acquired at the same time. For example, we would see no difference in the correct response rate between *quarto* and *quinto* or between *undicesimo, dodicesimo, tredicesimo.* However, this is not our case since, just to report one example, performance for *undicesimo* is lower than that on *tredicesimo.* The same type of pattern needs to be taken in consideration for opaquer forms such as *primo* and *secondo* where there is no structural recall of the cardinal base.

Touching on the topic of opaqueness versus transparency, we have already said that our study does not shed light over the interaction of the morpho-phonological structure of every ordinal and their acquisition. However, what our data show is a decreasing in accuracy as ordinals get higher. This means that children find it more difficult to understand *undicesimo* rather than *third* not really because of their

morphological structure, which would actually bring one to assume the opposite, but because of their position on the count list or frequency.

The answer to Q2 comes from the observation of Table 15 in chapter 4. It shows the percentage of correct answers for every ordinal given by NON-CP knowers. It is striking that not only they do understand the ordinals for the cardinals they already know (except for *second* and *third* for the 4-knowers) but they are also able to understand cardinals that go beyond the threshold of the cardinals they know.

From a qualitative point of view, it is relevant to quote what M. said after one of our sessions. He admitted that the task was easy because the only thing he had to do was counting. He said, for example, that if he was asked to give the eight element (*ottavo*) then he just had to count to eight. However, when he was asked how far he had to count to reach the fifth element (*quinto*), he said he did not know. This little piece of conversation reveals some important aspects that future studies could investigate further and others that support our proposal:

a) M. is able to tell that there is a link between *eight* and *eighth* and that, to reach the eight element, what he has to do is counting. This evaluates the finding that children are aware of the differences between cardinals and ordinals.

b) M. can go backwards and link *ottavo* to its cardinal *otto* but not *quinto* to *cinque.* This is related to our classification of ordinals: the base of *ottavo* is more transparent hence, M can put the two into a relation. What makes the topic even more interesting is the fact that M is a CP-knower so should have no problem neither with eight nor with five. What follows is that our idea that different morphological structures influence the acquisition could be proved true.

c) the fact he knows what *ottavo* means but not *quinto* supports our proposal for a lexical-based learning which does not follow a stepwise fashion.

6. CONCLUSIONS

Our study tests the comprehension of ordinal modifiers in 3-to-5-year-old Italian speaking children (30 in total, 11 males and 19 females). Ordinals from *primo* (first) to *tredicesimo* (thirteenth) were tested using a *give-me* task involving concrete and countable objects represented on laminated cards and displayed on rows (e.g. give me the third book). The test comprised of three different conditions mixing target objects (TO) and distractors (D). The first condition involved only the TO and tested only the comprehension of the ordinals, the second condition depicted an intersective scenario where, in addition to the object in the correct position, another TO was placed in the absolute position along the scale, the third condition depicted a restrictive reading where the only solution available was the adult-like reading (e.g. give me the third among the books).

Testing Italian-speaking children was key to our study since we wanted to investigate the acquisition of ordinals in a totally different linguistic background with respect to that of the previous study on the topic. Italian ordinals are formed via derivation process from cardinals and the results are lexical items whose root can be highly modified, and sometimes even suppletive, and whose suffixes are varied and with highly specific distributional patterns. What follows is that in some cases Italian ordinals do not have an overt reference to the cardinal base.

Our proposal was that due to the high degree of morpho-phonological microvariation, the acquisition of ordinal was delayed with respect to the finding reported in literature. As a consequence of the microvariation, we argued that at least at some stages of the process, the acquisition followed a lexical-based pattern which is the opposite to the rule-based one could suggest for Chinese.[18] To make this point clearer, it is important to underline that Chinese and Italian are, in relation to the topic of ordinal formation, at two opposite positions since the first simply uses a "one-fits-all" derivational suffix to for ordinals from cardinals.

Our data highlight the fact that even 5-year-old children are not able to understand ordinals as adults would with scores that sometimes are even below chance level. These findings contrast with the timing found for other languages, in particular it underlines a severe delay in the acquisition. What our data suggest is also that acquisition does not

[18] In her paper, Lei never argues in favor or against one of the patterns we outlined. However, it would be possible to speculate in favor of a rule-based one for Chinese due its limited morphological rules.

follow steps like those found for cardinal acquisition (e.g. children do not learn ordinals in their natural order but may, for example, understand *seventh* earlier than *fifth*). Moreover, there is no evidence that children are sensitive to derivational patterns (e.g. they do not learn all the ordinals ending in *–esimo* first or those with a transparent root). Taken together, these findings suggest that the acquisition follows a lexical-based pattern, rather than a lexical-based one.

Consequently, we take age and the morpho-phonological structure of Italian ordinals to interact together and determine both the delay and the acquisitional pattern. In fact, we believe that children's cognitive system needs to develop further in order to handle such a variety of forms, not to mention the variety of roots and suffixes.

The last piece of finding regards subset knowers' performance. We have argued the importance and the effect of owning the cardinal principle in the understanding of ordinals, however we have also pointed out that it is not fundamental. In fact, NON-CP knowers proved to understand ordinals, especially those on the lower side of the count list. What is also interesting is that their understanding does not regard only ordinals corresponding to the cardinals they already know (e.g. 3-knowers do not understand only ordinals up to third, 4-knowers do not understand only ordinals up to fourth and so on), but this goes way beyond this threshold.

Lastly, even if our study goes together with others to fill the gap in the literature about ordinal acquisition it leaves some aspects open for discussion. Future studies could investigate into more depth the influence on the acquisition that the differences in the types of ordinals (see Table 2) could have. Moreover, what our study does not find is the exact age at which children start to understand ordinal like adults. It would be worth it, then, to extend the age span of children in order to see the size of the delay. In addition to that, since several points have been made against the use of *how-many* tasks to test cardinal knowledge (e.g. not pragmatically plausible that after counting a set of objects – one-to-one correspondence principle – one is asked how many items they have just counted)[19], scholars could find alternative ways to address the topic.

Cross-linguistic studies could also contribute to unify the studies carried out so far. In fact, ours is the only study that investigates such a wide range of ordinals. We are convinced that proper conclusions can be made only when the whole panorama is taken into consideration. Filling the gaps in the count list and investigating ordinals cross-

[19] For an in-depth discussion about the topic, see Wynn, 1990; Sarnecka, Carey, 2008.

linguistically could finally find an answer to the question regarding the role of morphological and typological differences on the acquisition.

One last way our study could be developed regards the investigation of impaired population, in particular patients affected by acalculia. It has been argued in the previous chapters that the perception of numerosity is a fundamental prerequisite to numeral acquisition. This ability seems to be highly impaired in patients affected by acalculia (Butterworth , 2011). Upcoming studies may investigate the relation between the deficit and the ability to use ordinals correctly. This, in fact, would shed light over the relationship between a deficit considered to be purely mathematical and higher cognitive abilities such as language. Reporting data from patients with acalculia would be essential not only to understand the atypical behaviour *per se*, but also the typical developing.

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