THE ORIGIN OF NUMERICAL CONCEPTS: EARLY MEANINGS OF 'ONE', 'TWO', AND 'THREE' AMONG BASQUE- AND SPANISH-SPEAKING CHILDREN

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Abstract

This study examines the conceptual origins of the meaning of the first number-words and what role language can play in developing the notion of number. The original hypothesis is related to the idea that the meaning of the number-words "one", "two" and "three" is supported by the conceptual framework of grammatical numbers, rather than that of integers (Sarnecka, Kamenskaya, Yamana, Ogura & Yudovina, 2006).
To that end the counting abilities of Spanish and Basque monolingual children and Spanish-Basque bilingual children are tested, because the Spanish and Basque languages express grammatical number in different ways (Perea, Urkia, Davis, Agirre & Carreiras, 2006).
On the one hand, the findings are in line with the initial hypothesis and with Sarnecka's work (Sarnecka et al., 2006), and on the other hand with a growing body of evidence that shows that the meaning of the count list appears from mapping numerals onto numerical cognitive representations produced by early core systems of number (Le Corre & Carey, 2007; 2008).
Key words: *scientific education, mathematics, early education, number cognition, cognitive development, language, Basque, counting, number-words.*

Introduction

Counting as a cognitive ability is certainly of great theoretical interest. On the one hand it touches on the very core of human cognitive development (Spelke & Kinzler, 2007; Feigenson, Dehaene & Spelke, 2004), as some of the most genuinely "human" skills concerned with mathematical and scientific knowledge and with the deployment of language abilities develop around counting (Condry & Spelke, 2008).

On the other hand, it is also of enormous importance for education (Butterworth, 2005). The use of number-words and the earliest notions of mathematics are at the heart of many efforts to design education systems for early learners, to bring the youngest children into contact with the world of science for the first time (Kamii, Rummelsburg & Kari, 2005; Klein, Starkey & Ramirez, 2003).

The study presented here examines these earliest numerical manifestations in very young children, and contributes to the discussion on how these mathematical notions develop and what relationship exists between language and the development of counting skills.

In the current state of the art, it is highly important to study the relationship between language and the earliest manifestations of counting, as explained below. In this line of work, it is certainly important to clarify how the children begin to attribute numerical meaning to the first number-words: "one", "two" and "three".

The Origin of Counting

Our current understanding of how human beings acquire their earliest scientific and mathematical notions is due largely to the work of Swiss epistemologist Jean Piaget (1896 - †1980).

Piaget is known to have been very interested in numerical expressions as manifested throughout the early years of human development, especially in the conceptual meaning of these mathematical expressions in childhood (Piaget & Szeminska, 1965).

His pioneering experiments on this question led him to conclude that before the concept of number can be grasped there must be a logical basis, without which number-words lack any true mathematical significance even though they may be used in childhood for certain numbering tasks (Bryant, 1996; Kamii et al., 2005; Labinowicz, 1986). Piaget held that it was at the end of the pre-operational stage, at the age of six or seven, that the development of logical operations of classification, ordering and conservation enabled the conceptual background of the notion of number to be understood. From this perspective, he therefore saw early numerical expressions as being of scant importance.

However, several interesting publications by professors Rochel Gelman and Randy Gallistel (Gallistel & Gelman, 1992; Gelman & Gallistel, 1978; Gelman & Gallistel, 2004) have put forward a substantially different view of counting, closely linked to early verbal counting tasks which appear between the ages of 2 and 4.

They hold that numerical representations before the age of seven are linked essentially to the manifestation of three basic counting principles which are not necessarily connected to an understanding of the logical basis of the concept of number: (a) a stable order of words for counting; (b) the cardinal principle (CP), in the sense of the significant value of the last word-number in characterising a set; and finally (c) correspondence, in the sense that all the objects in the set must be counted, and only once (Bryant, 1996).

By contrast with Piaget, Gelman and Gallistel base their proposals on an innate concept of counting principles, and hold that the verbal count-list is the result of the assigning of number-words to numerical representations made by a pre-verbal cognitive system (Gallistel & Gelman, 1992; 2000).

Gelman & Gallistel consider a pre-verbal numerical system which they call the *analogue magnitudes system* –which has been found to exist in babies (Féron, Gentaz & Streri, 2006; Xu, Spelke & Goddard, 2005; Xu & Arriaga, 2007) and in non-human primates (Cantlon & Brannon, 2006; Flombaum, Junge & Hauser, 2005), and which generates approximate numerical representations coded as continuous magnitudes depending on their ratio (Brannon, 2006) – to be the most suitable and perhaps indeed the only candidate for constructing the meanings of number-words (Le Corre et al., 2007; 2008).

From the perspective of these authors, the first counting words are filled with significance: they are not mere learning-by-heart but rather the earliest explicit representation of natural numbers.

Recently, however, researchers Mathieu Le Corre and Susan Carey (Le Corre & Carey 2007, 2008; Le Corre, Van de Walle, Brannon & Carey, 2006) have put forward an alternative view based on the papers by Wynn (1990, 1992) which revealed the existence of a period of between 12 and 15 months which elapses from when children begin to recite counting words to when they actually begin to use them as a representation of natural numbers.

Indeed, using tasks which proposed the determination of sub-sets of objects (e.g. asking children to help a puppet fetch 1, 2, 3, .. objects) Wynn (1992) recorded that the process of assignation of exact quantities to counting words is a gradual one, which takes place in two stages:

- The "set-knower" stage, in which every 4 or 5 months approximately the ability is gradually acquired to delimit sets, initially containing 1 object, then 2 objects and finally 3 objects. This is characterised by subitizing to determine quantities, normally without resorting to the verbal count-list.

- The "CP-knower" stage. At the age of around three years and six months (range 2–11 to 4–0) subitizing is replaced by the use of number-words in numbering tasks, respecting the principles of stable order, correspondence and the cardinal principle indicated above. The ability to select sets of four and more objects appears at around the same time.

From this finding that children need from 12 to 15 months to progress from being set-of-one-knowers (the first period of the set-knower stage) to CP-knowers, the idea emerges that this process is not suited to the aforesaid innatism of counting principles, but rather suggests a process of gradual cognitive elaboration (Sarnecka, Kamenskaya, Yamana, Ogura & Yudovina, 2007; Condry et al., 2008; Le Corre et al., 2006).

Le Corre & Carey (2007, 2008) see the counting principles proposed by Gelman & Gallistel as being not so much immanent in nature as the consequence of a process of assignation of the first number-words ("one", "two" and "three"), initially learned by heart with no numerical significance, to internal representations of sets of objects created by two cognitive systems.

The first of those systems is linked to the ability to distinguish between sets, and supports the linguistic use of quantifiers (Barner, Thalwitz, Wood, Yang & Carey, 2007; Le Corre et al., 2007). The second is linked to the exact representation of small quantities and is known, depending on the cognitive mechanism attributed to the system by the authors, as the *parallel individuation system* (Le Corre et al., 2007; 2008) or the *object files system* (Feigenson & Carey 2005; Kobayashi, Hiraki, Mugitani, & Hasegawa, 2004; Xu, 2003).

The Link Between Counting and Language

As mentioned above, children discover the meanings of "one", "two" and "three" in the course of their development before they really become CP-knowers, i.e. before they discover that a series of numbers is a succession in which each element corresponds to one more than the previous element. This means that, paradoxically, there is a short period in childhood when the first three number-words take on meaning (in the sense that sets of 1, 2 and 3 elements can be identified) but children do not yet know that "three" is one more than "two" or that "two" is one more than "one".

Sarnecka et al (2006) suggest that the meaning of number-words is in fact learned in the sense of grammatical number markers (single, dual, trial, plural) before children enter the CP-knower stage, based possibly on the cognitive-perceptive *parallel individuation system* (Le Corre et al., 2007; 2008).

This hypothesis leads to the assumption that children who learn in languages in which the plural is marked to distinguish it from the singular may develop more quickly into one-knowers than those who learn in a language that does not mark grammatical number, since the presence of such markers in names, pronouns and verbs should facilitate the explicit representation of the distinction between "one" and "more than one".

Sarnecka et al (2006) show that this is in fact the case in a comparison of sample populations of Japanese children (who characteristically seldom or never distinguish singular from plural) with samples of populations who learn in English (a language which clearly marks the plural). Indeed, they observe that these same differences are maintained in the frequency levels of two-counters and three-counters, which leads them to consider that the singular/plural mark seems to give some advantage in attributing the meaning "two" to the internal representation "dual" and "three" to "trial", etc. (Sarnecka et al., 2006, p. 24).

Context of the Research: Basque and Spanish

The research presented below was conducted in the context of the Basque Autonomous Community (known in the Basque language as *Euskadi*), an area located in the north-east of the Iberian peninsula, bordering to the north on the Bay of Biscay and France. Politically, the Basque Autonomous Community (BAC) is one of the 19 autonomous communities and cities that make up the Spanish state. It has legislative autonomy, executive and administrative powers.

A distinguishing feature of the BAC is that it has two joint official languages: Spanish (which it shares with the other autonomous territories of the Spanish state) and Basque, a pre-Indo-European agglutinative language which is currently used by around 900,000 people in the Basque Autonomous Community, the Regional Community of Navarre (also in Spain) and south-western France (Perea, Urkia, Davis, Agirre & Carreiras, 2006).

In the context of this research, the use of grammatical number constitutes a fundamental difference between these two languages.

In that sense, consider the examples in table 1.

In Basque, when the nominal syntagm is not delimited (as is the case in the examples given, where it is not specified *what* cars, *what* boys or *whose* cats we are talking about) only the verbs have plural markers, and even then they are optional. This is because Basque has not only singular and plural cases but also an indefinite case (Laka, 2000; Zubiri & Zubiri, 2000).

Table 1. Examples of uses of the plural in Spanish and Basque (grammatical number markers are underlined).

Spanish	*Basque*
Hay un coche *(There is one car)*	*Kotxe bat dago*
Hay dos coches *(There are two cars)*	*Kotxe bi dago/daude*
Total plural markers associated with cardinal number (*dos – bi*)	
2	0 / 1

Spanish	*Basque*
Está viniendo un chico. *(One boy is coming)*	*Mutil bat dator*
Están viniendo tres chicos *(Two boys are coming)*	*Hiru mutil dator/datoz*
Total plural markers associated with cardinal number (tres – *hiru*)	
2	0 / 1

Spanish	*Basque*
Hay un gato bonito *(There is one beautiful cat)*	*Katu polit bat dago*
Hay muchos gatos bonitos *(There are many beautiful cats)*	*Katu polit asko dago/daude*
Total plural markers associated with the quantifier (muchos – *asko*)	
3	0 / 1

This case is used in Basque particularly to refer to quantifiers (many, few, some, etc) and numbers, in situations when the intention is normally to stress the quantitative aspects of the message and speakers do not wish or are unable to delimit other, non-quantitative aspects of the nominal syntagm.

Spanish has only the singular and plural cases, so references (specific or otherwise) to more than one object usually carry several markers to indicate their plural nature. But in Basque the existence of the "indefinite" numeral means that a high proportion of communications lack such references altogether or at least contain fewer, even when referring to more than one object.

Methodology of Research

To the best of our knowledge there have been no previous studies of the counting abilities of children in the context in which this research is conducted. Our first objective is therefore to analyse the numerical skills of children aged between two and three and determine whether the patterns found in other populations (Wynn, 1992; Le Corre et al., 2007) can be generalised or not to cover the population of the sample area.

In this regard, the intention is to check for the presence of various types of subset-knowers. This is of interest in so far as it provides an opportunity to reaffirm earlier observations concerning the existence of a period of development in which the meaning of the first three number-words is not connected to the counting principles proposed by Gelman and Gallistel (Gallistel & Gelman, 1992; Gelman & Gallistel, 1978; Gelman & Gallistel, 2004).

As a result, on the one hand the frequency of the various subset-knowers should be related to the age of the subjects in the sample, and on the other hand (given that no evidence to the contrary has so far emerged) the sex of the subjects should not be a factor in the level of development of their numerical comprehension.

Our second objective is to analyse the potential influence of language profile on the development of numerical thinking.

In line with the proposal by Sarnecka et al (2006), our initial hypothesis is that exposure to a greater number of linguistic plural markers should result in earlier discrimination between singular and plural and, therefore, an earlier grasp of the first level of numerical comprehension (the one-knower stage).

Since Basque is a language with three grammatical groups, and since it marks the plural associated with cardinal numbers and linguistic quantifiers less frequently than Spanish, we would expect to find that the frequency of one-knowers is lower among Basque speakers, and that the proportion of children who have not yet begun this stage of development (no-numeral-knowers) is higher.

This leads to an assumption that the lower frequency of subset-knowers will be carried over into other categories (two- and three-knowers).

The sample also includes bilingual subjects (whose native language is Spanish but who are educated in Basque, as indicated in the Method section) who may be expected to be exposed to intermediate levels of plural markers and are therefore expected also to show intermediate levels of development of numerical thinking.

Method

Characteristics of the Sample

Age & Sex Variables

The sample was 80 children aged between 2 and 3 in the first stage of infant education.

8 of the 80 interviews (10%) were discarded due to difficulties involving children's participation in the counting tasks proposed (lack of interest, inhibition, anger, etc.).

Of the 72 valid interviews, 35 were conducted with girls and 37 with boys. Their average age was 34.7 months. Table 2 shows the age make-up of the sample considered.

Table 2. Age groups in the sample considered.

Age: years & months		N	%
Between 2 and 2–6	(24-30 months)	16	22.2
Between 2–7 and 3	(31-36 months)	24	33.3
Between 3–1 and 3–6	(37-42 months)	32	44.4
		72	

Language Profile

To conduct this research, four infant schools in towns with more than 15.000 inhabitants were visited. Table 3 outlines the characteristics of the towns to which the schools involved in the study belong.

Table 3. Origin of the sample.

Municipality	Autonomous Community	Population in 2007 (Spanish Statistical Office 2008)	Official language(s) of the Community	Percentage of Basque speakers (Basque Statistical Office 2008)
San Sebastián	Basque Autonomous Community	Over 100,000	Basque & Spanish	40
Vitoria			Basque & Spanish	25
Mungia		Over 15,000	Basque & Spanish	56
Castro	Autonomous Community of Cantabria		Spanish	

Three of the four are in municipalities belonging to the Basque Autonomous Community: San Sebástian, Vitoria and Mungia. At these schools, children are educated entirely in Basque, which enjoys joint official language status with Spanish there.

The fourth school studied is located in Castro, a municipality belonging to the Autonomous Community of Cantabria, where Spanish is the sole official language. Children at the school are educated entirely in Spanish.

Table 4 shows the origin of the sample used in terms of the city where each infant school analysed is located, and the language profile of the education given.

Table 4. Origin of the sample.

	N	%	School language model
San Sebastián	15	20.8	Basque
Vitoria	25	34.7	Basque
Mungia	12	16.7	Basque
Castro	20	27.8	Spanish
	72		

Table 5 breaks down the population analysed in terms of the percentage of speakers of each language.

Table 5. Language profile of the children in the sample.

	N	%
Basque	17	23.6
Bilingual	35	48.6
Spanish	20	27.8
	72	

Children are considered as non-bilingual (Basque-only or Spanish-only speakers) if the language used at school is the same language used by both parents at home. In other words, only those children whose parents speak to each other in Basque and who attend a school where education is in Basque are considered as having a Basque-only language profile. Likewise, only those whose

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parents speak to each other in Spanish and who attend schools where education is given in Spanish are considered as having a Spanish-only language profile.

Children are allocated to the bilingual language profile when their mother tongue is not the language in which they communicate at school. In the sample population studied, this group is made up entirely of children who receive their infant school education in Basque but have at least one parent who does not speak the language.

The language characteristics of families were recorded on the basis of information provided by teachers at the schools visited, which information was obtained at meetings with families.

Counting Tasks

Counting abilities are examined via what is known in the relevant literature as the *Give a number* (*GN*) method (Le Corre et al., 2006; Sarnecka et al., 2006; Wynn, 1990,1992).

In this method children are asked to select a subset containing a given number from a set of objects. The experimenter presents children with a container full of toys and asks each child to help him/her to select between four and six objects in various tests. When a child is found to be able to select x objects correctly, he/she is asked for $x + 1$ in the next attempt. If the child is unable to select $x + 1$ correctly, he/she is asked to select x again in the following test.

In the research presented here a symbolic set of food items (plastic sausages suitable as toys for children aged under three) was used. Following a brief conversation with each child about their favourite foods, they were asked to gather different subsets of "sausages" and place them on various coloured plates.

In this way each child underwent two types of test: the *GN* test for determining subsets as indicated above, and the task of counting the sets of objects selected.

Following the method proposed by Sarnecka et al (2006), in the *GN* test each child was presented with 15 objects ("sausages"), and three blocks of five tests were carried out. Each block of tests began with the child being asked to select a single object, and then to select two or three (alternately from block to block). Finally, children were asked to select subsets of four and five or more objects.

As in Wynn (1992), the children were considered to have obtained a given level of counting when they demonstrated the ability to select the number of objects required for that level and that same number of objects was not selected when different subsets were requested. A maximum of one error was permitted in each case.

For example, consider the case of a girl who responded as follows in the three blocks of the *GN* test: she picked up one object when she was asked for one, two when she was asked for two, three when she was asked for three, five when she was asked for four and, finally, five when she was asked for five. This girl would be categorised as a three-knower, as she correctly selected subsets of up to three objects and did not select subsets of 1, 2 or 3 objects when asked for other numbers. However, although she selected five objects when asked for five she also selected five when asked for four. She did this repeatedly in all three blocks of tests. It cannot therefore be concluded that this child is really able to distinguish between subsets of more than three objects.

As a result of this test children were grouped by their abilities to make up subsets according to the following criteria:

- as no-numeral-knowers if they were incapable of establishing any subset correctly;
- as one-knowers, two-knowers or three-knowers if they were able to make up subsets of one, two or three objects, respectively;
- as CP-knowers if they showed the ability to select subsets of four or more objects.

The frequency of each set-knower is presented in the table 6.

Table 6. Frequency of set-knowers (*GN* task).

	N	%
No-numeral-knower	20	28
One-knower	21	29
Two-knower	13	18
Three-knower	12	17
CP-knower	6	8
	72	

After the *GN* test a verbal counting test was conducted. In such tests, children are asked to make up three blocks by numbering sets containing 1, 2, 3, 4 or more than 4 objects selected by the examiner from among those used in the previous test.

Here also, children are allocated to levels of verbal counting ability in line with their specific, correct use of the cardinal corresponding to the number-words in at least two out of the three blocks of counting. As proposed by Sarnecka et al. (2006), children may express the cardinal for a set in different ways:

- simply by stating how many objects there are, without counting them out loud, e.g. “five!”;
- by counting and stopping at the last number-word, e.g. “1, 2, 3, 4, 5”;
- by beginning to count out loud, switching to silent counting and finally stating the cardinal for the set, e.g. “1, 2, …. 5!”.

In this study, presenting the cardinal by showing fingers was also considered as valid, even if children did not count out loud or utter the number-word, i.e. when children responded to the question “how many are there?” by raising the correct number of fingers to indicate the cardinal for the set. This form of counting was admitted in the wake of several studies which have shown that there is a close relationship between the acquisition of counting principles and finger gnosis both at neurological level and at the level of arithmetic knowledge (Gracia-Bafalluy & Noël, 2008; Kaufmann, 2008; Noël, 2005). Table 7 outlines the results of the verbal counting test and presents the frequency of number-words.

Table 7. Frequency of number-words (counting task).

	N	%
None	33	46
One	7	10
Two	7	10
Three	11	15
Four	8	11
Five and more	6	8
	72	

By contrast with the proposal of Sarnecka (2006), the verbal counting test was always conducted after the *GN* test. This was done because the children studied showed a strong tendency to shyness when faced with verbal counting tasks, but were much more dynamic and resolute when dealing with the task of selecting subsets. Over the course of this research differences in children’s predisposition towards these two types of task were observed, as discussed below.

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Collection & Processing of Data

All the infant school visits and interviews were conducted by the same examiner, in the second quarter of 2008. Permission to conduct interviews was obtained from the management of each school, and the interviews took place at the schools during normal classroom hours, in the language usually used at each school.

Data were processed via chi-square tests to study the association between nominal variables, via a nonparametric Kruskal-Wallis H-test for comparison of means (ANOVA variance analysis was not used because the sample did not meet the requirements for such tests) and finally via Spearman's p coefficient to study correlations (Milton & Tsokos, 1987).

The level of significance used in the study was $p<0.05$ and statistical work was done using SPSS version 15 software.

Results of Research

The results of the investigation are presented below, with the relationship between the sex and age variables and counting abilities presented first, and then the relationship between counting abilities and the language profiles of the subjects.

Age & Sex Variables

No significant differences were found between boys and girls in the sample studied as regards verbal counting (Chi-Square =10.11, $p < 0.072$) or the ability to form subsets (Chi-Square = 6.06, $p < 0.171$).

Table 8 outlines the relationship between verbal counting ability and the age of the test subjects. The differences found are statistically significant (Kruskal–Wallis H-test = 26; $p < 0.001$).

Table 8. Descriptors for frequency of verbal counting related to age.

Count-words	Average (months)	Sd
None	31.8	4.4
One	36.8	2.5
Two	35.6	3.5
Three	37.1	3.6
Four	37.9	2.3
Five & more	38.5	1.05

Finally, Table 9 outlines the variation with regard to age in the ability of the children in the sample to isolate subsets. The differences in average age found are significant (H-test = 14.62; $p < 0.006$).

Table 9. Descriptors for frequency of set-knowers related to age.

Set-knower	Average (months)	*Sd*
No-numeral-knower	32.4	4.3
One-knower	34	4.9
Two-knower	35.3	4.2
Three-knower	37.6	3
CP-knower	38	2.1

Considering the correlation that may exist between these variables and age, age is a significant, positive factor for both the counting task ($\rho = 0.58$ $p<0.001$) and the *GN* task ($\rho = 0.6$ $p<0.001$).

Finally, there is a positive correlation between the two variables (verbal counting and set-knower group) ($\rho = 52$, $p<0.001$).

Language Profile

The differences recorded between test subjects with different language profiles (Basque only, bilingual and Spanish-only) in regard to their use of number-words are not significant (Chi-Square = 17.5; $p<0.061$).

Table 10. Absolute frequencies of set-knowers per language profile.

Set-knower	Basque	Bilingual	Spanish
No-numeral-knower	8	12	0
One-knower	4	11	6
Two-knower	2	6	5
Three-knower	1	6	5
CP-knower	2	0	4
	17	35	20

Table 10 shows the frequency of each set-knower group in each language profile. The differences found are significant (Chi-Square = 18; $p<0.02$).

No significant differences were found between the three language profiles in terms of the age variable (H-test = 1.42; $p < 0.5$).

Discussion & Conclusions

The papers by Wynn (1992) and Le Corre et al. (2007) envisage a period of numerical thought prior to the acquisition of the counting principles proposed by Gelman and Gallistel (Gallistel & Gelman, 1992; Gelman & Gallistel, 1978) during which the meaning of the first three number-words is linked to grammatical categories.

According to these authors, this stage of development lasts around a year, with 4-5 month periods during which children gradually identify the meaning of “one”, “two” and “three” before eventually arriving at the meaning of a numerical series at around 42 months, via the principles of correspondence, cardinality and stable order.

The results of the research presented here match this profile of development in a sample from a population on which no explorations of this kind had previously been conducted.

On the one hand, as shown in Figure 1, most of the children in the test sample (64%) show some level of subset knowledge in the *Give a Number* (GN) task, characterised by the selection of sets of objects by subitizing, without resorting to a verbal count-list or following the principles of cardinality and correspondence. 28% of test subjects showed no comprehension of number, while 8% showed comprehension of the counting principles (CP-knower set).

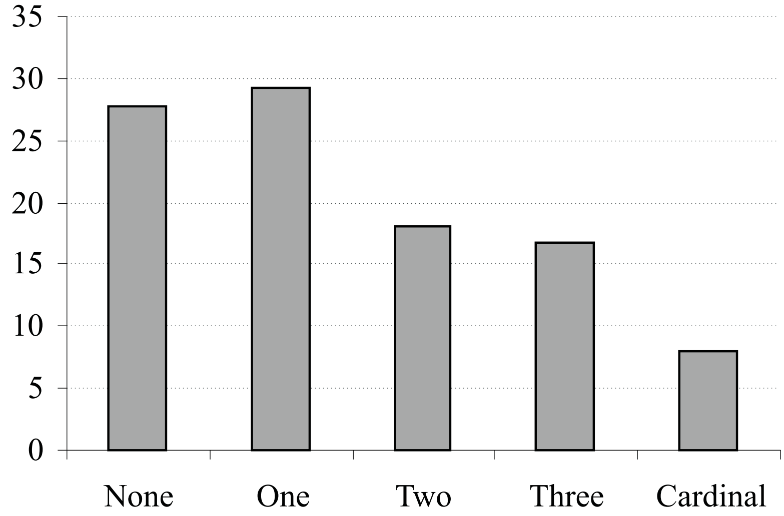

Figure 1. Relative frequency of each set-knower.

On the other hand, a positive correlation is observed between these set-knower groups and age ($\rho = 0.6$ $p<0.001$) so, as shown in Figure 2, the older the test subjects in the sample the better their level of achievement in the *GN* task.

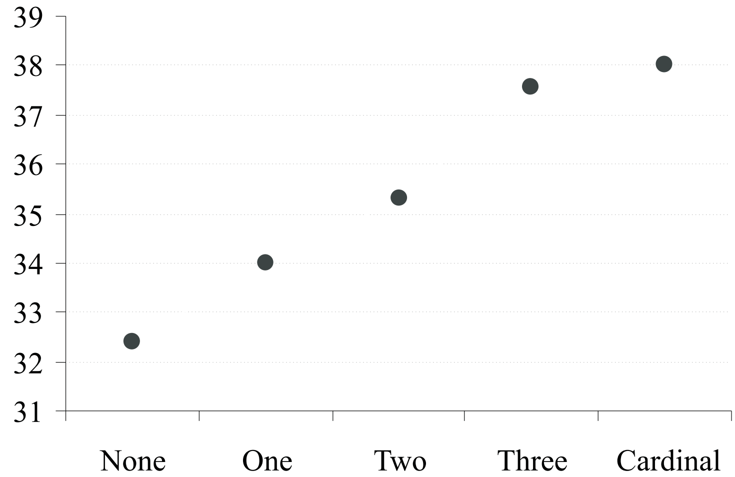

Figure 2. Average age (months) of set-knowers in the sample studied.

The average age for CP-knowers in the sample considered is three years and two months, which coincides with the findings in the relevant literature, where average age is put at 3-6 (range 2-11 to 4-0).

In general terms, the data found corroborate the assumption of Le Corre et al. (2007) that there is a stage of numerical comprehension that precedes the understanding of counting principles and is unconnected with an understanding of numerical series. Moreover, as stressed by Sarnecka et al. (2006), the quantitative meaning of number-words is learned in order (in the sense that to be counter of one subset, a child needs to have completed the previous subset counter stage) which is hierarchically arranged over time.

54% of test subjects showed some counting skills, and 34% were able to count three or more objects. Counting skills are also positively correlated with the subset-knower level ($\rho = 52$ $p<0.001$).

This differs from the results of the study by Sarnecka et al. (2006), in whose sample counting skills are found not to be related to the subject's set-knower group, and in general children are found to be able to count at a higher level than the set-knower group to which they belong.

However, in a wide-ranging study of the numerical skills of children aged between two and four which also combined two tasks – *Give a Number* and *What's on the card?* (WOC) (the latter being a task designed also to assess verbal counting skills) – Le Corre et al. (2006) find a clear link between the results for the two types of task.

The results of our study seem to point to a link between the two variables, though the possibility that the verbal counting skills recorded in this study might have been underestimated cannot be ruled out, since it is striking that 46% of the children interviewed showed no verbal counting skills when the proportion who failed to show any level of set knowledge was just 28%.

In this regard, it is worth stressing a non-quantitative observation resulting from the study: in general: the children studied showed interest and were eager to take part in the *GN* task, but many proved shy when asked to answer the question "*How many are there*?"

Some authors have pointed out that counting tasks where answers are elicited directly by asking "how many are there?" may underestimate the actual counting skills of small children, because the communicative context in which they take place may lead children to think that they are being asked to correct errors which they may have committed during counting (Gelma, 1993).

As regards the second objective of this study, i.e. to analyse the potential influence of language profile on the development of numerical thinking, the initial hypothesis is that exposure to a language such as Spanish (with just two grammatical groups) is a contributory factor to the development of numerical comprehension during the stage that precedes the understanding of counting principles.

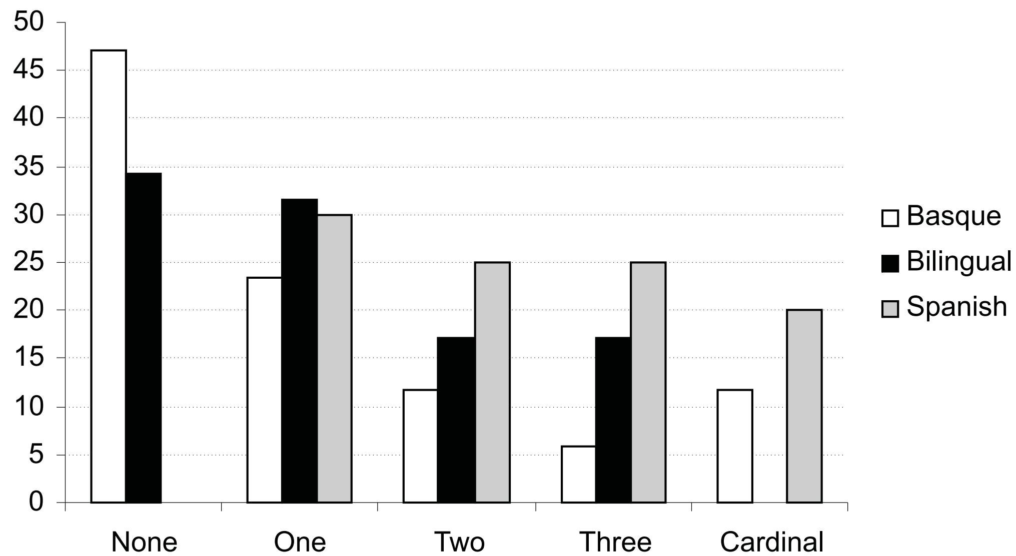

Figure 3. Relative frequencies of set-knowers in each language profile.

In line with this hypothesis, it is observed that 70% of the group of children with a Spanish-only language profile are classed as two-knowers or higher, while just 30% of those who learn in Basque both at home and at school attain that same level (see Figure 3). As a result, the frequencies at the lowest levels of numerical comprehension are complementary with the above cases, and the differences cannot be explained by the age factor because the children in the different language groups are all in the same age range.

The intermediate frequencies found among the bilingual language profile group, at least at the pre-CP-knower stages, also support this initial hypothesis.

The data obtained in this study are consistent with those presented by Sarnecka et al. (2006), who found that Japanese children (whose language typically does not mark plurals) take longer to reach the one-knower stage than children who speak English or Russian, which do use plural markers.

Similarly, they find that this difference is carried over into subsequent stages, as *"*...singular/plural marking, by helping children assign meanings of *singular* and *plural* to the number words earlier, would give children a head start on the next steps, which are to assign 'two' the meaning of *dual* and 'three' the meaning of *trial*..." (Sarnecka et al., 2006, p.24).

In short, our data attest to the existence of a stage of development in numerical thinking that precedes the understanding of counting principles and is conditioned by the linguistic moulds of the language in which children learn to count.

During that stage, number-words have a significance which is closer to that of grammatical structures than to that of integers. Thus, at the initial, one-knower stage, children distinguish between "one" as a singular and other numbers as "more than one" or "plural". At the two-knower stage, they distinguish between "one" as "singular", "two" as "dual" and other numbers as "plural". Finally, at the three-knower stage they distinguish between "one" as "singular", "two" as "dual" and "three" as "trial".

After that point, once they finally reach the CP-knower stage, the meaning of number-words comes to be linked with the abstract concept of the series N, N + 1, (N + 1) + 1, etc... Thus, for example, a typical CP-knower seems to understand that a set of five objects corresponds to the succession of number-words leading up to that number (principle of stable order), that each object corresponds to a number-word in counting (principle of correspondence) and that the last number-word defines the total (principle of cardinality).

The most plausible hypothesis put forward to explain the mechanism that underlies the influence of language and the creation of the earliest numerical meanings (one-, two- and three-knowers) is that it involves two perceptive-cognitive systems that operate in co-ordination with the development of language skills.

Barner et al. (2007) find a specific cognitive system for distinguishing between singular and plural which begins to deploy at around 22 months, concomitant with the acquisition of singular/plural morpho-syntax. It has been observed that through this cognitive mechanism non-adult humans (and non-human primates) distinguish between singular and "more than one", even though the system records no information on the magnitude of plurality (Le Corre et al., 2007; 2008). Sarnecka et al. (2006) maintain that this perceptive-cognitive system could be behind the early singular/plural discrimination by one-knowers between the number-word "one" and other number words.

Subsequent development to the two-knower and three-knower stages seems to point to the involvement of the parallel individuation system, a perceptive-cognitive system which enables exact representations of sets of two and three elements to be made (Condry et al., 2008; Le Corre et al., 2007; 2008), so that the assigning to number-words of the representations produced by the system enables those numerical meanings to take shape in the long-term memory (Le Corre et al., 2007)

However, other views of the process have also been put forward. Sarnecka et al (2006) point out that there is a need to check whether the cognitive system resorts to pre-verbal representations of duality and triality (along the lines found by Barner et al. -2007- for the distinction between singular and plural). Moreover, the possibility that the analogue magnitudes system may play a role in the formation of the earliest numerical meanings (Le Corre et al., 2008) has not yet been completely ruled out.

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