Development of SFON in Ecuadorian Kindergartners

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Article published in European Journal of Psychological Education, (2016)

DOI 10.1007/s10212-016-0306-9

Abstract

This study explored the development of Ecuadorian Kindergartners' spontaneous focusing on numerosity (SFON) during the Kindergarten year, as well as the contribution of early numerical abilities to this development. 100 Kindergartners coming from 10 classrooms received two SFON tasks, one at the beginning and one at the end of the school year, and an early numerical abilities achievement test at the beginning of the school year. Results first demonstrated limited SFON development during the Kindergarten year, with inter-individual differences in and intra-individual stability of children's SFON tendency. Second, both children's SFON tendency and their early numerical abilities at the start of the Kindergarten year were predictively related to their SFON tendency at the end of the year. Our results do not only add to our theoretical understanding of SFON in young children, but also inform educational policy and practices in the domain of early mathematics education in Ecuador, as they provide building blocks for optimizing the educational goals and curricula for Kindergarten mathematics.

Keywords: SFON; early numerical abilities; Kindergarten

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Introduction

Prior research on early numerical competencies has shown that most children develop a wealth of foundational numerical competencies before school entry (Clements and Sarama 2007; Kilpatrick, Swafford, and Findell 2001). The development of these early numerical competencies is very heterogeneous among children even as early as Kindergarten entry (Anders, Grosse, Roßbach, Ebert, and Weinert 2012; Duncan et al. 2007). This heterogeneity at young ages is of great concern, given that it has been well documented that children's initial number competencies are strong predictors of later school mathematics achievement (Clarke and Shinn 2004; De Smedt, Verschaffel, and Ghesquière 2009; Duncan et al. 2007; Jordan, Kaplan, Ramineni, and Locuniak 2009; Krajewsky and Schneider 2009).

Early numerical competencies have been differently defined across studies. Hence, Berch (2005) reported a list including 30 different definitions of early numerical competencies, with definitions focusing on either abilities (e.g., the knowledge and skills to compare numerical magnitudes), or inclinations (e.g., the desire to make sense of numerical situations), or both (e.g., the desire and ability to represent a number in multiple ways depending on the context and the purpose of the representation). In view of this lack of conceptual clarity, we will use in the present article the following three different terms: (a) *early numerical abilities*, to refer to knowledge and skills only; (b) s*pontaneous focusing on numerosity (SFON)*, to refer to inclinations only; and, (c) *early numerical competencies*, to refer to both children´s early numerical abilities (i.e., the ability element) and their SFON (i.e., the inclination element).

Despite its importance, information on early numerical competencies in Ecuador is currently missing. Studies at older ages demonstrate that Ecuadorian students perform problematically low in the domain of mathematics in national (Ministerio de Educación 2012) and international (UNESCO 2008) assessments. Analyzing Ecuadorian Kindergartners' numerical competencies represents an important starting point to understand to what extent they are developing competencies that set the basis for future mathematics learning, and to offer building blocks for both improving our theoretical understanding of (early) mathematics development in Ecuadorian children and optimizing educational policy and practice in this domain. Therefore, we aimed at investigating Ecuadorian Kindergartners' SFON development in relation to their early numerical abilities.

Hereafter, we present a review of previous work on SFON and the developmental relations between SFON and early numerical abilities, followed by our major research goals and questions.

Spontaneous Focusing on Numerosity

Spontaneous focusing on numerosity (SFON) has been defined as a process of spontaneously paying attention to the exact number of a set of items or incidents when exact numerosity is utilized in action (Hannula, Räsänen, and Lehtinen 2007). Measures of SFON tendency are an indicator of the amount of a child's spontaneous practice in using exact enumeration in her or his natural surroundings (Hannula and Lehtinen 2005). As discussed by Hannula (2005), SFON is a specific attentional process that differs from more general attention processes, enumeration skills or perceptual skills, and implies that children voluntarily recognize and utilize the exact number of objects *without being prompted (by others) to do so*, in situations that are not explicitly numerical. Hannula and

Lehtinen (2005) found that, although 4- to 6-year-olds already possess a conceptual understanding of one, two, and three, and master the enumeration skills required to count sets of one, two and three objects, a substantial group of them does not spontaneously focus on the aspect of number when confronted with novel, not explicitly numerical, tasks that involve collections of these numbers. In fact, previous SFON studies revealed remarkable individual differences in SFON tendency among young children (Hannula and Lehtinen 2005; Hannula, Lepola, and Lehtinen 2010; Hannula, Mattinen, and Lehtinen 2005; Hannula et al. 2007), meaning that children substantially differ from each other in the frequency with which they spontaneously pay attention to the numerical aspects of their surroundings. Furthermore, these studies reported within-subject stability in children's SFON tendency across different task contexts and time.

In the past years numerous international studies have related children's mathematical achievement to specific aspects of their early numerical competencies (e.g., De Smedt et al. 2009; Geary 2011; Hannula et al. 2010; Hannula et al. 2007; Hannula-Sormunen 2015; Hannula-Sormunen, Lehtinen, and Räsänen 2015; Jordan et al. 2009; Mazzocco, Feigenson, and Halberda 2011). Interestingly, SFON was demonstrated to contribute to both the development of children's early numerical abilities and their later school mathematical achievement. Accordingly, a positive relationship was reported between young Finnish children's SFON tendency and their development of cardinality recognition, number sequence, subitizing[1], and arithmetic competencies (Hannula and Lehtinen 2005; Hannula et al. 2010; Hannula et al. 2007). Furthermore, Hannula and colleagues provided empirical support for the contribution of children's SFON to later mathematical achievement, as it was found that children's SFON in Kindergarten predicted arithmetic skills at the end of second grade (Hannula et al. 2010), was positively related to the development of numerical competencies up to the end of primary school (Hannula-Sormunen 2015), and even predicted mathematical performance in Grade 5 (Hannula-Sormunen et al. 2015). Moreover, they reported a reciprocal developmental relation between SFON and early numerical abilities, since SFON at the age of 4 predicted numerical abilities at the age of 6, and numerical abilities at the age of 3.5 years predicted SFON at 6 years (Hannula and Lehtinen 2005). The relation between children's SFON and early numerical ability development is hypothetically explained by Hannula and Lehtinen (2005) on the basis of the assumption that if children spontaneously focus on the aspect of number in their surroundings, they may get practice in recognizing and producing numbers; this, in turn, is assumed to improve their quantifying skills, further promoting SFON, and so on. In view of the pivotal role of children's SFON in their early numerical and later general mathematical development, we focused on young children´s SFON development during the Kindergarten year.

The Present Study

As outlined above, previous studies on SFON indicate both within-subject stability across different tasks, contexts and time, and large individual differences in SFON development in the preschool years. Prior studies also provide empirical support for the reciprocal relation between children's SFON acquisition and their development of early numerical abilities, as well as the contribution of young children's SFON to their later mathematical development. Unfortunately, up to now (almost) all previous studies on preschool children's SFON were conducted in Finland (cf. Rathé, Torbeyns, Hannula-Sormunen, De Smedt, and Verschaffel in press), making it difficult to generalize previous findings on SFON to other countries that differ in their general cultural and educational characteristics from Finland. As a developing country (United Nations 2016) Ecuador arguably differs in its general cultural and educational context from Finland. Given the important contribution of SFON to Finnish children's early numerical and later general mathematical development, on the one hand, and the serious difficulties of Ecuadorian primary and secondary school children in the domain of mathematics compared to their peers worldwide (UNESCO 2008), on the other hand, we aimed at investigating the development of SFON in Ecuadorian Kindergartners, with special attention for the association between this development and children's early numerical abilities. In line with previous (Finnish) studies on SFON (e.g., Hannula and Lehtinen 2005), our first goal was to examine Ecuadorian 5-6-year-olds' SFON development throughout the Kindergarten year, focusing on both individual differences and stability in children's SFON development during this one-year time period. Again in line with previous work on SFON (e.g., Hannula et al. 2010), we aimed at analyzing the relationship between Kindergartners' SFON development and their early numerical abilities as the second goal of our study.

In line with our twofold goal, we formulated two research questions:

(1) Does Ecuadorian Kindergartners' SFON develop between the start and the end of the Kindergarten year?

(2) Do Ecuadorian Kindergartners' early numerical abilities at the start of the school year contribute to their SFON tendency at the end of the Kindergarten year?

Method

Participants

The sample consisted of 100 Ecuadorian children (52 boys, 48 girls) randomly selected from 10 schools of the three major school types in Ecuador (about 10 children per school), resulting in 29 Kindergartners attending public urban schools (14 boys; 3 schools), 32 Kindergartners attending public rural schools (15 boys; 3 schools) and 39 children attending private schools (23 boys; 4 schools). All children within a school came from one class. At the beginning of the study, the mean age of the present sample was 5 years 3 months (*SD* = 3.7 months).

The Ecuadorian educational system comprises three levels: Beginning level (for children aged 3 to 5 years), Basic Education (for children aged 5 to 14 years) and High School (for students aged 15 to 17 years). Kindergarten education, aimed for children aged 5 to 6 years, corresponds to the first grade of Basic Education and is compulsory nationwide. The Basic Education level is regulated by a mandatory national curriculum and is provided by mainly the public (urban and rural) and private sectors. During the Kindergarten year children spend five days per week at school, from 7:30 in the morning till 12:30 in the afternoon. The classroom schedule typically includes activities related to the different national curricular domains, i.e., (a) identity and autonomy, (b) living together, (c) natural and cultural environment awareness, (d) mathematics, (e) language, (f) art, and (g) physical education. Kindergarten teachers' education level widely varies, with some teachers holding a high school degree, others holding a technical degree (two years of study after high school), and still others holding a teaching degree at bachelor level.

Materials and Procedures

To address our two research questions, we administered two different instruments, namely (a) two SFON Imitation tasks (Hannula and Lehtinen 2005; Hannula et al. 2005) to assess children's SFON tendency at the start (Test 1) and at the end (Test 2) of the school year; and (b) the Test of Early Number and Arithmetic (TENA; Bojorque, Torbeyns, Moscoso, Van Nijlen, and Verschaffel 2015) to assess children's early numerical abilities at the start of the school year. The SFON and TENA were individually administered to the children, in a quiet room at their own schools, by two trained test administrators. To ensure children's spontaneous focus on numerosities at Test 1, the TENA was offered after the SFON task. Likewise, at Test 2, children received a visuo-motor precision task preceding the administration of the SFON task to guarantee spontaneous focus on numerosities in the latter task. In the remainder of this section, we describe all instruments and procedures in more detail.

Spontaneous focusing on numerosity tasks.

Children's SFON was measured using the Spanish version of two Imitation tasks (Hannula and Lehtinen 2005), i.e., the Parrot Imitation task (Test 1) and the Mail-box Imitation task (Test 2).[2] The examiner made sure that the child's attention was fully on the task while the trial was performed. She carefully avoided the use of any phrases or other contextual hints that could have suggested that the task was somehow mathematical or quantitative. She did not give any feedback about the child's performance during the task situation. The tasks included only very small numbers of items (i.e., 1-3), which all children should be able to enumerate accurately, thus allowing differentiation of the variable of SFON from enumeration skills.

Parrot Imitation task (Test 1). The materials of the Parrot Imitation task consist of a pink parrot (capable of swallowing small glass berries), placed in front of the child on the table, and eight cases containing a different color of eight glass berries each. The examiner starts the task by placing a case of eight red glass berries on the left, and a case of eight blue glass berries on the right, in front of the parrot, and by introducing the materials saying: "This is Elsi bird, she likes berries. Here are red berries and here are blue berries (pointing to the cases). Now, look carefully, what I do, and then you do exactly like I did". In the first trial the examiner puts two red berries and one blue berry into the parrot´s beak, one at a time, and they drop into the parrot´s stomach, making a bumping sound. Then the child is told: “Now you do exactly like I did”. The number of berries in the second item are three green and two yellow; in the third item, two white and three brown; and in the fourth item, one transparent and two light blue.

Mail-box Imitation task (Test 2). The materials of the Mail-box Imitation task are a mail-box, placed in front of the child on the table, and two piles of closed blank envelops of a different color each. For the first trial, a pile of eight red envelops is placed on the left, and a pile of eight blue envelops is placed on the right, in front of the mail-box. The examiner starts with the task by saying: “This is a mail-box, and here are red envelopes and here are blue envelopes (pointing to the piles of envelopes). Now, please look carefully what I do, and then you do exactly like I did”. The examiner puts two red envelopes and one blue envelop into the mail-box. Then s/he says to the child: “Now you do exactly like I did”. For the second item, the examiner puts three green and two yellow envelopes, for the third item, two white and three brown envelopes, and for the last item, one orange and two light blue envelopes.

As described in more detail in Hannula and Lehtinen (2005), items in both Imitation tasks were scored dichotomously: A score of 1 was assigned if the child spontaneously focused on numerosity, a score of 0 if the child did not focus on numerosity (maximum score = 4). In each trial, the child received a score of 1 if s/he responded with putting in the correct exact number of berries/envelopes and/or if s/he was observed doing one or more of the following quantifying acts: (a) lip movements for numbers, (b) showing number with fingers, (c) counting, (d) saying number words, (e) giving comments referring to either quantities or counting, and (f) interpreting the goal of the task as quantitative. By contrast, in each trial, the child received a score of 0 if s/he did not respond by putting in the correct exact number of berries/envelopes and did not present any of the aforementioned (a-f) quantifying acts. We used different versions of the SFON Imitation task at the two measurements to prevent that children would associate the SFON Imitation task at the second measurement with a quantitative situation based on their memories of this task on the first measurement. Both tests were administered individually and were checked for the quality of the task administration on the basis of the video recordings at both measurement times. Cohen’s Kappa inter-rater reliability (on 10% of the data) of SFON scores was $K = .96$, $p < .001$ at Test 1; at Test 2, we obtained a perfect match.

Test of Early Number and Arithmetic.

Children’s early numerical abilities were measured using the Test of Early Number and Arithmetic (TENA; Bojorque et al. 2015). TENA is a test based on the Ecuadorian national standards for Kindergarten number and arithmetic. The test consists of 54 items distributed among nine subscales (with 6 items per subscale), namely (a) quantifiers, (b) one-to-one correspondence, (c) order relations more than/less than, (d) counting, (e) quantity identification and association with numerals, (f) ordering, (g) reading and writing numerals, (h) addition, and (i) subtraction.

The test has two parts, namely (a) an individual part with 29 items that mainly require an oral response (12 tasks require the use of small blocks for children to manipulate or for the examiner to present the task); and (b) a collective part with 25 items that require the use of paper and pencil to complete.

Items are scored dichotomously: for each item, a score of 1 is assigned for a correct answer and a score of 0 for an incorrect answer (maximum score = 54). A study focusing on the psychometric qualities of the TENA (Bojorque et al. 2015), conducted with 127 Ecuadorian Kindergartners, demonstrated, first, high overall reliability of the test (Cronbach’s $\alpha = .91$), but lower reliabilities at the subscale level, ranging from Cronbach´s α = .27 to Cronbach´s α = .79. Second, TENA’s concurrent validity with the Early Numeracy Test (ENT; van de Rijt et al. 1999), was high ($n = 50$, $r = .89$, $p = .01$). Third, a panel of 10 experts in the domain of early number arithmetic (supervisors, school principals, teacher trainers, Kindergarten and Preschool teachers) provided evidence for TENA’s content validity, as all items were judged as measuring the curriculum content at a very good level. For the present study, Cohen’s Kappa (on 10% of the data) for the TENA scores revealed strong inter-rater reliability, $K = .92$, $p < .001$.

Results

Results are presented in two parts. We first present the descriptive statistics and analyses of the SFON and TENA scores. Next, we address the two research questions.

Preliminary Analyses

Table 1 presents the descriptive statistics of children’s SFON both at the beginning and the end of the Kindergarten year and their early numerical abilities at the beginning of the Kindergarten year. These data, together with the number of children per SFON score at Test 1 and at Test 2 visualized in Figure 1, first reveal that there were clear individual differences in children’s SFON tendency both at the beginning and at the end of the school year. Moreover, they show that the SFON tendency of Ecuadorian children at both measurement points was rather low. A closer examination of the SFON data reveals that only 37% of the Kindergartners made progress in their SFON tendency throughout the Kindergarten year, as indicated by their higher SFON score at Test 2 than at Test 1; 44% of the children did not make any progress between these two measurement times, revealed by their same SFON score at the two measurement moments; 19% of the Kindergartners decreased in SFON scores from Test 1 to Test 2. Furthermore, the correlation between children’s SFON scores at the two measurement points was statistically significant

(*Spearman's rho* = .40, *p* = .01), providing evidence for the consistency of the SFON construct.

--Insert Table 1 about here--

--Insert Figure 1 about here--

Second, as demonstrated in Table 1, children's TENA scores were also - but not surprisingly given that the TENA primarily aims at measuring Kindergartners' mastery of the educational standards for mathematics at the end of the Kindergarten year - rather low at the beginning of the school year, with (again) large inter-individual differences in TENA scores.

Results Concerning the Research Questions

To answer our first research question, namely whether Ecuadorian Kindergartners' SFON develops between the start and the end of the Kindergarten year, we conducted a Wilcoxon signed-rank test[3] on children's SFON scores at the start (Test 1) and the end (Test 2) of Kindergarten. This analysis revealed a significantly higher SFON score at the end of the school year (*Mdn* = 1.50) than at the beginning (*Mdn* = 1.00), $z = -2.415$, $p = .02$, indicating a development in Ecuadorian Kindergartners' SFON tendency during Kindergarten.

Turning to our second research question, addressing respectively the contribution of children's early numerical abilities to children's SFON development throughout Kindergarten, we conducted multilevel analyses (with children nested within schools) using the SPSS Mixed software package (cf. Hayes 2006). We evaluated the adequacy of two models for predicting SFON at Test 2, namely, (a) SFON Test 1 (Model 1); (b) SFON Test 1 and TENA (Model 2). Table 2 summarizes the results per model.

--Insert Table 2 about here—

As summarized in Table 2, children’s SFON scores at Test 1 were predictively related to their SFON scores at Test 2. More specifically, children’s SFON scores at the start of the school year accounted for 17% of the variance in their SFON score at the end of the school year. Adding children´s early numerical abilities as a predictor to the multilevel analyses (Model 2) resulted in an increase of 19% of the explained variance in SFON scores at Test 2, meaning that children’s early numerical abilities at the beginning of the school year predict their SFON tendency at the end of the school year even when children’s SFON score at the start of the school year is statistically controlled for. However, the increase in explained variance in the model cannot be used as the sole indicator of the importance of a variable. To compare the relative contribution of the independent variables, the standardized beta’s (Everitt and Dunn 2010) were used. These indicate that children’s early numerical abilities at the start of the school year are most predictive for their SFON tendency at the end of the school year, compared to children’s SFON tendency at the start of the school year. Taken together, the results of our multilevel analyses indicate that children with higher early numerical abilities and, to a lesser extent, with higher SFON tendency at the start of the school year develop higher SFON tendency towards the end of the school year.

The analysis of the variance partitioning for the null and the full model (i.e., Model 2) is reported in Table 3. This analysis indicates that Model 2 explained 36.35% of the total variance, with 29.76% of the variance explained at the individual level and 57.23% at the classroom level.

--Insert Table 3 about here--

Discussion

The development of children's SFON tendency before the start of formal mathematics education plays an important role in their further mathematical development. Unfortunately, nothing is known about (the development of) Ecuadorian children's SFON tendency and its relation to their numerical abilities. As prior studies on the development of SFON have been conducted almost exclusively in Finland (Rathé et al. in press), their results cannot be generalized to Ecuador given the cultural and educational differences between (developed) Finland and (the developing country) Ecuador. We therefore aimed at empirically addressing Ecuadorian Kindergartners' SFON development throughout the Kindergarten year, with special attention to the contribution of their early numerical abilities to this development. To achieve this aim, we assessed children's SFON tendency at the beginning and at the end of Kindergarten, as well as their early numerical abilities at the beginning of the school year. To the best of our knowledge, this is the first study on the development of the early foundational SFON tendency in Ecuadorian Kindergartners in relation to their early numerical abilities. As such, our findings complement previous work on SFON development and provide new and important insights into Ecuadorian children's early numerical competency development. Moreover, our findings offer building blocks both for further research and for improving educational policy and practice in the domain of early mathematics in Ecuador and beyond.

To deepen our insight into Ecuadorian children's early numerical competencies and development, we first explored Ecuadorian Kindergartners' (development of) SFON tendency throughout the Kindergarten year (research goal 1). Our results first showed that children's SFON tendency was rather low at both the start and the end of the school year. Furthermore, we observed little progress in children's SFON tendency during the Kindergarten year, both in terms of increases in SFON scores and in terms of the number of children increasing their SFON scores between the start and the end of the Kindergarten year. Second, consistent with previous SFON studies (Hannula and Lehtinen 2005; Hannula et al. 2010; Hannula et al. 2007), our results indicated remarkable individual differences in children's SFON tendency both at the start and at the end of the Kindergarten year. Third, and also in line with previous findings (Hannula and Lehtinen 2005; Hannula et al. 2005), the presented study revealed that children with high SFON scores at the start of the Kindergarten year continued to score high at the end of that year, providing support for the stability of children's SFON tendency. Taken together, our research findings in Ecuadorian children are generally in line with previous findings in Finnish children, and more specifically previous findings on inter-individual differences but also intra-individual stability in SFON throughout its development. These similarities indicate that the same structures and mechanisms are underlying children's SFON development across different educational contexts.

Although this study constitutes a first important step in understanding Ecuadorian children's (early) mathematical development, it focused only on young children's SFON development during Kindergarten, leaving their early numeracy development prior to formal schooling as well as their general mathematical development during the formal mathematics education period unaddressed. Future studies are required to investigate the acquisition of Ecuadorian children's early numerical abilities and later general mathematical knowledge and skills, in relation to their SFON tendency at preschool ages (cf. Hannula et al. 2010; Hannula-Sormunen et al. 2015), to better understand the mathematical developmental trajectory of Ecuadorian children, and especially their difficulties in this domain at older ages (Ministerio de Educación, 2012; UNESCO 2008), and to validate the available (Finnish) findings on these topics in developing countries including Ecuador.

We also aimed at analyzing the association between children's early numerical abilities and their SFON development in the Kindergarten year (research goal 2). Results showed that children's SFON development throughout the Kindergarten year was positively related to their mastery of early numerical abilities at the start of that year. In line with previous studies in Finnish children (Hannula et al. 2010; Hannula-Sormunen 2015; Hannula-Sormunen et al. 2015), we found that Ecuadorian children's SFON development at the end of the Kindergarten year was predicted by their early numerical abilities at the start of the year. Interestingly, the contribution of children's early numerical abilities to SFON development was stronger than the contribution of their initial SFON tendency. These results present additional support for the bidirectional relations between SFON and early numerical abilities (cf. Hannula and Lehtinen 2005). The present findings generally replicate Hannula and colleagues' findings (Hannula and Lehtinen 2005; Hannula et al. 2010; Hannula-Sormunen 2015; Hannula-Sormunen et al. 2015) and provide the first empirical evidence on the mutual relation between the acquisition of SFON and early numerical abilities in Ecuadorian children. Again (cf. research goal 1), we found similar results in Finnish and Ecuadorian Kindergartners, despite their different cultural and educational backgrounds. These results again seem to indicate that SFON development relies on analogous developmental structures and processes in children coming from countries differing in cultural and educational characteristics. However, these results first need to be replicated and refined in other European and South-American samples, differing in general cultural and educational context, to allow more general conclusions.

A limitation of the present study was the low number of schools included in our sample, which did not allow us to systematically examine the educational context of Ecuadorian Kindergartens and to associate it to children´s SFON development. To the best of our knowledge, only the study of Hannula and colleagues (2005) already addressed the contribution of the educational context to children´s SFON development. In this study, the personnel of a day care center was guided to create rich learning experiences with a view to intentionally direct 3-year-old children’s attention towards small number of items. These changes in the educational environment of the day care center were found to enhance children’s initial SFON tendency as well as their cardinality and number sequence skills. These findings suggest that it is important to pay attention to the educationally enhanced acquisition of SFON in early mathematics education at (pre-) school, as they indicate that it is possible to stimulate young children’s SFON acquisition and, given the contribution of SFON to children’s further mathematical development, thus might help to prevent and overcome learning difficulties in mathematics in general (Hannula-Sormunen 2015). Therefore, future studies should focus on the relation between the quality of early mathematics education and SFON development, by including a larger number of schools and a larger sample of children. In these studies, the administration of an appropriate observation instrument such as the Classroom Observation of Early Mathematics Education and Teaching (COEMET) (Sarama and Clements 2009) to assess the quality of early mathematics education in a reliable and valid way is also needed. The results of these future studies may allow to pinpoint both strengths and weaknesses in current educational practices to make informed decisions in future educational reforms in Ecuador. Additionally, broadening the scope towards young children’s acquisition of early numerical abilities (next to and on top of their attentional processes in the domain of number) will provide a more comprehensive account of the (educationally enhanced) development of young children's early numerical competencies and later mathematical performances.

Notes

[1] Subitizing is defined as an ability to accurately and immediately recognize a small number of objects in a collection (Kaufman, Lord, Reese, and Volkmann 1949).

Children's subitizing skill can be clearly distinguished from their SFON, as the former refers to the *ability* component of their early numerical competencies (i.e., children's numerical knowledge and skills; see introduction to the manuscript) whereas the latter refers to the *inclination* component (i.e., children's attentional processes in the domain of number). As defined by Hannula and colleagues, SFON involves children's *spontaneous attention* for exact numerosity. To *determine* this exact numerosity, children can use their subitizing and/or their counting skills. Stated otherwise, after having spontaneously focused on the element of exact numerosity in the environment (SFON), children still have to actually determine the exact number of items and therefore rely on their subitizing and/or counting abilities.

[2] As it is not possible to administer children's *spontaneous* focus on numerosity at Test 2 via the same task as offered at Test 1, we selected to highly similar parallel versions of the SFON Imitation Task. As discussed in Hannula-Sormunen (2015) and in Rathé, Torbeyns, Hannula-Sormunen, De Smedt and Verschaffel (in press), the SFON Parrot Imitation and the SFON Mail-box Imitation Task are both designed to capture children's spontaneous attention for exact numerosity in non-mathematically focused situations and are characterized by exactly the same task requirements, procedures and materials, except from the overall context (namely feeding a parrot with berries versus posting envelopes into a mailbox). As indicated by a recent study (Hannula-Sormunen, Torbeyns, Kyttälä, Simms,

De Smedt, & Batchelor, in preparation), the SFON Parrot Imitation Task and the SFON Mailbox Imitation Task are of equivalent difficulty: A group of 87 4-7-year-old children who were offered both variants of the SFON Imitation Task at one measurement time, received an overall mean score of $M = 1.98$ ($SD = 1.54$) on the Parrot Imitation Task and of $M = 2.15$ ($SD = 1.64$) on the Mailbox Imitation Task, the difference between the two task scores being not statistically significant, $t(86) = 1.62$, $p > .05$.

[3] We used the non-parametric Wilcoxon signed-rank test as our SFON data do not follow a normal distribution.

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List of Tables

Table 1

Means, standard deviations and range of SFON and TENA scores

Measure	*M*	*SD*	Range
SFON (max. score = 4)			
Test 1	1.24	1.37	0–4
Test 2	1.66	1.61	0–4
TENA (max. score = 54)	25.42	9.30	8–49

Table 2

Multilevel model of predictors of SFON scores at the end of the school year

Model	Predictor	*Coeff*	*SE*	*df*	*p-value*	*Sig.*	*Stand. Beta*	*-2LL*
1	Intercept	1.140	0.285	13.102				353.378
	SFON Test 1	0.426	0.099	92.180	.000	***	0.363	
2	Intercept	-0.823	0.449	44.444				336.946
	SFON Test 1	0.222	0.099	93.984	.027	*	0.189	
	TENA	0.087	0.017	75.503	.000	***	0.501	

Note. R^2 = .17 (Model 1); R^2 = .36 (Model 2). The test for model comparison shows that the model improves significantly when adding the TENA, *Change LL = 16*.349, *df* = 1, $p < .001$.

Table 3

Variance partitioning of the null and the full model

	Variance Null Model	Variance Full Model
Individual level	2.016	1.416
Classroom level	0.636	0.272
Total variance	2.652	1.688

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