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PAPER

Spontaneous non-verbal counting in toddlers

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Abstract

A wealth of studies have investigated numerical abilities in infants and in children aged 3 or above, but research on pre-counting toddlers is sparse. Here we devised a novel version of an imitation task that was previously used to assess spontaneous focusing on numerosity (i.e. the predisposition to grasp numerical properties of the environment) to assess whether pre-counters would spontaneously deploy sequential (item-by-item) enumeration and whether this ability would rely on the object tracking system (OTS) or on the approximate number system (ANS). Two-and-a-half-year-olds watched the experimenter performing one-by-one insertion of 'food tokens' into an opaque animal puppet and then were asked to imitate the puppet-feeding behavior. The number of tokens varied between 1 and 6 and each numerosity was presented many times to obtain a distribution of responses during imitation. Many children demonstrated attention to the numerosity of the food tokens despite the lack of any explicit cueing to the number dimension. Most notably, the response distributions centered on the target numerosities and showed the classic variability signature that is attributed to the ANS. These results are consistent with previous studies on sequential enumeration in non-human primates and suggest that pre-counting children are capable of sequentially updating the numerosity of non-visible sets through additive operations and hold it in memory for reproducing the observed behavior.

Research highlights

- We devised a novel version of a puppet-feeding imitation task to assess pre-counters' spontaneous sequential (item-by-item) enumeration up to 6 items.
- Many children showed that they attended to the numerosity of the food tokens despite the lack of any explicit cueing to the number dimension.
- The response distributions centered on the target numerosities and showed the classic variability signature that is attributed to the ANS.
- Pre-counting children are capable of sequentially updating the numerosity of non-visible sets through additive operations and hold it in memory for reproducing the observed behavior.

Introduction

Increasing evidence suggests that humans are able, since their first hours of life, to discriminate the numerosity of object sets (Antell & Keating, 1983; Izard, Sann, Spelke & Streri, 2009). Two mechanisms have been highlighted as foundational for the ability to perceive and represent numerical information: the Object Tracking System (OTS) and the Approximate Number System (ANS; Feigenson, Dehaene & Spelke, 2004; Piazza, 2010). The OTS is a domain-general mechanism devoted to tracking a limited number of objects (around 3–4) in space and time. When the OTS is deployed for numerical purposes, it allows fast and exact enumeration of small sets, a phenomenon known as *subitizing* (Cutini, Scatturin, Basso Moro & Zorzi, 2014; Mandler & Shebo, 1982;

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Pylyshyn, 2001; Trick & Pylyshyn, 1994). The ANS, in contrast, is a domain-specific system that yields an approximate representation of numerosity, conceived as a distribution of activation on a putative mental number line (Dehaene, Piazza, Pinel & Cohen, 2003). The overlap between distributions of activation increases with numerical magnitude, either due to scalar variability or compression of the number line (Gallistel & Gelman, 2000; Izard & Dehaene, 2008; Stoianov & Zorzi, 2012); accordingly, discrimination between two numerosities is modulated by their numerical ratio, thereby obeying Weber's law (Dehaene, 2003). This ratio-dependent effect in numerosity comparison is considered to be the signature of the ANS (Halberda, Mazzocco & Feigenson, 2008; Piazza, Izard, Pinel, Le Bihan & Dehaene, 2004). Crucially, the ability to discriminate between numerosities, known as number acuity, improves throughout childhood (Halberda & Feigenson, 2008; Halberda, Ly, Wilmer, Naiman & Germine, 2012; Piazza, Facoetti, Trussardi, Berteletti, Conte *et al*., 2010). Dramatic changes in number acuity have been observed even within the first years of life. For instance, 6-month-old infants can reliably discriminate between sets with a ratio of 1:2 but fail with a 2:3 ratio (Xu, Spelke & Goddard, 2005; Xu & Spelke, 2000). A few months later, 10-month-old infants discriminate sets with a 2:3 ratio but still fail with 4:5 ratio (Xu & Arriaga, 2007). It is worth noting that both OTS capacity (i.e., subitizing) and number acuity seem to play an important role in the acquisition of formal numerical competences and they have been linked to mathematical achievement (Butterworth, 2010; Halberda *et al*., 2008; Lourenco, Bonny, Fernandez & Rao, 2012; Mazzocco, Feigenson & Halberda, 2011b; Schleifer & Landerl, 2011; Sella, Lanfranchi & Zorzi, 2013; Starr, Libertus & Brannon, 2013; vanMarle, Chu, Yaoran & Geary, 2014).

Research on infants' numerical skills mainly relies on habituation and violation of expectation paradigms, whereas older children are tested with tasks that usually entail the manipulation of concrete objects or the discrimination between visual sets. While the age group of 3 and above has been widely investigated, including in connection to the acquisition of verbal counting skills (Gallistel & Gelman, 1992; Wynn, 1990, 1992), the study of numerical abilities in pre-counting toddlers (around 2 years of age) is rather sparse and has received much less attention, possibly because testing children in this age range can be particularly challenging. Brannon and Van de Walle (2001) trained 2–3-year-old children on the comparison between 1 vs. 2 objects and then tested them with novel numerosities up to 6. Children showed the ability to discriminate numerosities even when the two sets were matched for total area. While their study implied an explicit numerosity comparison, a recent study by Cantlon, Safford and Brannon (2010) showed that older children, around 3–4 years of age, spontaneously attended to numerosity when they were asked to match a target set to a sample set that was different for number but not for total surface area. Both studies suggested that the children deployed the ANS to perform the task. In contrast, studies employing sequential presentation of objects (Feigenson, Carey & Hauser, 2002; Feigenson & Carey, 2003) showed that 12–14-month-old children failed to search for the correct number of objects that were hidden in an opaque box when the numerosity was larger than 3, thereby suggesting that toddlers relied on the OTS to track salient stimuli in this specific context.

The spontaneous encoding of numerical information in children has also been extensively studied by Hannula and colleagues using an imitation task (Hannula & Lehtinen, 2005; Hannula, Lepola & Lehtinen, 2010; Hannula, Rasanen & Lehtinen, 2007). Children as young as 2.5 years old were introduced to an animal-like puppet (e.g. a bird) that had to be fed its favorite food (i.e. colored tokens). After a brief period of familiarization with the puppet, the experimenter inserted a small number of food pieces (between 1 and 3) in the puppet's mouth and then asked the child to imitate the feeding action. Importantly, the experimenter never mentioned number at any time during the experiment and carefully avoided introducing the task as a number game. Children showed large variability in attending to the numerical dimension of the imitation task. While some children focused on the number of tokens inserted into the puppet, other children fed the puppet with an unrelated amount of food (e.g. a handful or all of the available tokens). Interestingly, an index of the Spontaneous Focusing on Numerosity (SFON) was found to be a good predictor of future numerical abilities (Hannula *et al*., 2010).

In the present study, we adapted the SFON imitation task to investigate sequential enumeration in 2-year-old pre-counting children. Indeed, at this stage of development, children do not master the counting procedure and can verbally count one element at most (Sarnecka & Carey, 2008; Wynn, 1990). Children display competent counting skills only around 4 years of age (Sarnecka & Carey, 2008) with some variability due to linguistic context (Almoammer, Sullivan, Donlan, Marušič, Žaucer *et al*., 2013).

In our modified version of the task, the elements inserted into the puppet ranged from 1 to 6 and the task included many trials in order to obtain a reliable distribution of responses for each target numerosity.

This version of the task retains the ecological validity of the original SFON task because there are no instructions or feedback regarding the numerical aspect of the imitation task. Accordingly, we expected to observe both focusing and non-focusing children, in line with the previous studies (Hannula & Lehtinen, 2005). Nevertheless, our task allows us to characterize the performance of focusers in terms of distributions of responses and therefore determine which pre-counting mechanism is used to encode numerical information. If focusers rely on the OTS, they should be able to accurately mimic the experimenter's behavior in trials with up to three food items and fail with larger numerosities, in line with the findings obtained with the manual search paradigm (Feigenson & Carey, 2003). Conversely, if focusers rely on the ANS and estimate the number of elements fed to the puppet, imitation accuracy should decrease systematically with increasing numerosity. Crucially, the distribution of responses should be centered on the target number and characterized by scalar variability. In summary, the productive nature of the task can provide new insights into the numerical abilities of pre-counting children and expand the knowledge provided by more typical visual discrimination tasks.

Method

Participants

Forty-four preschool children (19 boys, $M_{\text{months}} = 30$, $SD = 3$, range = 24–37) took part in the study after parents gave their informed consent. They were all native Italian speakers of middle socioeconomic status from north-eastern Italy.

Materials

Different puppets were used to test sub-samples of children. The puppets varied in color and the character represented (e.g. bird, penguin) but all were crafted according to the following constraints: (i) its size was sufficient to easily contain all the tokens (i.e. 'pieces of food'); (ii) the puppet's mouth was large enough to easily swallow the tokens; (iii) the puppet was opaque, to prevent children seeing the pieces already inserted. The tokens were easily graspable cubes of identical color and dimensions.

Procedure

Undergraduate research assistants (RAs) were trained for 3 hours on administering the task and collecting the data. RAs crafted their own material and were then supervised in a simulated situation on how to administer the task. RAs visited each child individually at home, and they met in a quiet room for three sessions with 11 days on average between sessions (range: 2–24). Each child completed the task three times. The task was presented as a game, no time limit was given and items or questions could be repeated if necessary but neither feedback nor hints were given to the child. Children were free to stop the task either for an extra break or to terminate the testing session. Each experimenter introduced the child to an animal-like puppet called SFON that had to be fed with its favorite food. The experimenter explained the game to the child as: '*Look here, this is my little friend SFON* [showing SFON]*! And this is its favorite food* [pointing at the pieces of food]*! Now look carefully at what I do and when it's your turn just do exactly as I did*.' Then the experimenter took *n* pieces of food and put them in the puppet's mouth. The child was invited to do the same: '*Now it's your turn, do exactly what I did*.'

During the entire task, the experimenter never referred to the numerical dimension of the feeding action and children were not explicitly told that they would play a number game. In each session, the experimenter gave the puppet between 1 and 6 elements. Each numerosity was repeated three times in each session for a total of 54 trials over the three sessions. The task always started by feeding the puppet with 2 pieces of food, while the numerosities for the following trials were randomly presented. There were 18 pieces of 'food' available at the beginning of each trial; the pieces from the previous trial were returned in the starting position as soon as the children gave their response. Thus, when the experimenter gave one piece to the puppet, the child had 17 pieces available for answering and when 6 pieces of food were inserted by the experimenter into the puppet, the children had the remaining 12 pieces of food available. Children's responses were recorded on a score sheet for every single trial indicating the number of pieces given to the puppet.

Results

The results section is divided into three parts. First, we classified participants as focusers or non-focusers based on their overall performance. Indeed, a non-focuser would feed the puppet with a random number of food pieces (e.g. all the available tokens). Second, we analysed focusers' accuracy for target numerosities from 1 to 3 to assess whether they displayed a high and stable performance that would be expected from tracking the tokens using the OTS; alternatively, a systematic decrease in accuracy would suggest the use of approximate estimation (i.e. ANS). Third, we analyzed children's distribution of responses to formally assess the presence of the variability signature predicted by the deployment of the ANS. All the analyses were conducted in the R environment (R Core Team, 2013) using the 'ez' package (Lawrence, 2013) and the 'ggplot2' package (Wickham, 2009).

Focusers vs. non-focusers

In our version of the SFON task, chance level varied in each trial depending on the target numerosity because the available tokens decreased as a function of the elements inserted by the experimenter. Chance level for correct answers was calculated through a random re-sampling method (100,000 repetitions) generating a random distribution of accuracy for target numerosities from 1 to 3. We restricted the calculation of chance level to small numerosities because we expect children who focus on numerosity to be able to reproduce the experimenter's feeding behavior at least for numbers from 1 to 3. We adopted the 95th percentile (i.e. 15% of correct answers) of the distribution as chance level. We identified 37 focusers (16 boys; $M_{months} = 30$, $SD = 3$) who exceeded the chance level, and seven non-focusers (three boys; $M_{months} = 31$, $SD = 3$). There were no age differences between the groups ($p = .601$). Non-focuser children were adopting a non-numerical response strategy as they were often feeding all the available elements. On average, these children were feeding all available tokens in 89% of the trials (see Figure 1, panel a).

OTS vs. ANS

Focusers' behavior was hypothesized to show either an individuation or an estimation strategy to encode and track the elements that were fed to the puppet. If children deployed an individuation strategy, we expected higher and stable accuracy for numerosities up to 3 compared to accuracy for larger numerosities. Conversely, if children adopted an estimation process, within the same range (i.e. up to 3), accuracy was expected to decrease because of increased variability of the representation for larger numerosities.

We analyzed the percentage of correct responses with a repeated measures ANOVA with target Numerosity (N1, N2, N3) as within-subjects factor. Missing sphericity in the ANOVA was adjusted using the Greenhouse-Geisser formula (i.e. $p_{[GG]}$). We also report generalized eta-squared (Bakeman, 2005) and *r* (Rosenthal, 1991) as measures of effect size (Field, Miles & Field, 2012). The main effect of Numerosity was significant ($F(2, 72) = 19.32$, $MSE = 0.05$, $p_{[GG]} < .001$, $\eta^2_g = 0.15$) and planned *t*-test comparisons revealed a gradual decrease of accuracy (N1: 77%, N2: 63%, N3: 46%) from numerosity 1 to 2 ($t(36) = 2.56$, $p = .015$, $r = 0.15$) and from numerosity 2 to 3 ($t(36) = 4.62$, $p < .001$, $r = 0.37$).

The systematic decrease in accuracy within the small number range supports the hypothesis that children adopted an estimation strategy rather than an object-tracking strategy to encode the numerosity of tokens inserted into the puppet.

ANS signature: analysis of response distribution

The group of focusers included all children who were able to score above chance level for small target numerosities, without considering whether the responses were systematically related to the numerosity of the target. If children deployed an estimation strategy for all numerosites, we should expect a positive correlation between the number of tokens fed to the puppet by the experimenter and the number inserted by the child. We therefore selected a sub-group of focusers ($N = 24$) who showed, in addition to above-chance accuracy for small target numerosities, a significant linear slope in individual regression analyses of the mean estimates as a function of target numerosity (mean $b = .93$, 95% CI = [0.8, 1.1]).[1] Accuracy of these children was still above the chance level (computed with the same resampling method described above) when considering the full range of target numerosities. Accordingly, these children rarely inserted all the available tokens into the puppet (5% of trials), thereby suggesting a reliable distribution of their responses. If children indeed relied on the ANS to estimate the number of tokens, the distribution of responses should be centered on the target numerosity, with increasing variability as a function of number size (i.e. scalar variability).[2] This pattern of responses

[1] To assess whether the repetition of the imitation task across the three sessions progressively enhanced children's focusing on numerosity, we analyzed the response accuracy in a repeated measure ANOVA with Session (First, Second, Third) and Numerosity (N1, N2, N3, N4, N5, N6) as within-subjects factors. The analysis confirmed the significant effect of Numerosity ($F(5, 115) = 46.03$, $MSE = 0.11$, $p_{[GG]} < .001$, $\eta^2_g = 0.39$), whereas the main effect of Session ($F(2, 46) = 2.96$, $MSE = 0.07$, $p = .062$, $\eta^2_g = 0.01$) and the interaction Numerosity × Session ($F(10, 230) = 1.21$, $MSE = 0.05$, $p = .287$, $\eta^2_g = 0.02$) did not reach significance.

[2] Note that the decrease in number of available tokens as a function of target numerosity could be expected to produce the opposite pattern of response distribution, with variability decreasing as a function of target numerosity.

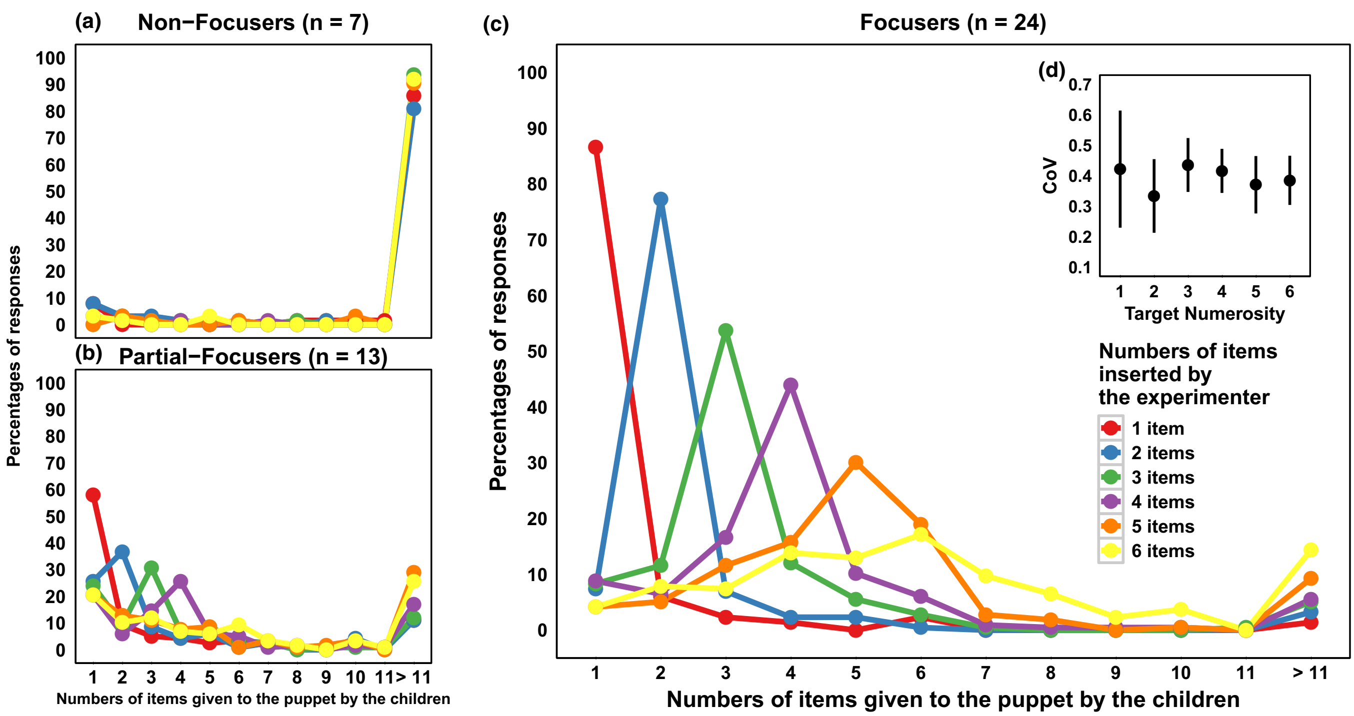

Figure 1 *Distribution (in percentage) of the number of elements inserted into the puppet by Non-Focusers (Panel a), Partial-Focusers (Panel b), and Focusers (Panel c) for each target numerosity (from 1 to 6). (Panel d) Focusers' coefficient of variation plotted as a function of target numerosity (black bars represent 95% within subjects CI; Morey, 2008).*

indicates that the representation of numerosity is approximate and it becomes noisier with increasing target numerosity (Gallistel & Gelman, 2000; Izard & Dehaene, 2008; Whalen, Gallistel & Gelman, 1999).

The property of scalar variability can be indexed by a constant Coefficient of Variation (CoV), that is the ratio between the mean estimate and the standard deviation of estimate (CoV = *SD* of estimate/Mean estimate). Therefore, if both terms proportionally increase, the CoV is expected to be constant for each target numerosity. In other words, the CoV represents the width of the bell-shaped curve centered on the mean estimate and it indexes the internal noise of the ANS. The average distribution of responses and the corresponding CoVs are plotted in Figure 1 (panels c and d). We analyzed the *SD* and CoV in repeated measures ANOVAs with Target Numerosity (N1, N2, N3, N4, N5, N6) as within-subjects factor. The effect of Target Numerosity was significant in the *SD* analysis ($F(5, 115) = 6.77$, $MSE = 1.02$, $p_{[GG]} < .001$, $\eta^2_g = 0.09$) and it was well described by a a significant positive slope in a linear regression analysis of the mean *SD* as a function of target numerosity ($b = .28$, $t(4) = 8.9$, $p < .001$). Conversely, the effect of Target Numerosity was not significant in the CoV analysis ($F(5, 115) = 0.46$, $MSE = 0.07$, $p_{[GG]} = .678$, $\eta^2_g = 0.01$). The average CoV ($M = 0.39$, 95% CI = [0.28, 0.5]) converted to closest round numbers provides a ratio of approximately 3:4.[3]

Having established that focusers deploy the ANS to perform the imitation task, we also investigated the distribution of responses of those children who were intially classified as focusers (above-chance performance) but did not show a significant effect of numerosity in the regression analysis. We named this sub-group of children as partial-focusers ($N = 13$). We therefore analyzed partial-focusers' accuracy within the small number range in a repeated measures ANOVA with Numerosity (N1, N2, N3) as within-subjects factor. The main effect of Numerosity was significant ($F(2, 24) = 3.63$, $MSE = 0.07$, $p = .042$, $\eta^2_g = 0.14$) and planned *t*-test comparisons on mean accuracy (N1: 58%, N2: 37%, N3: 31%) revealed a significant difference only between numerosity 1 and 3 ($t(12) = 2.22$, $p = .046$, $r = 0.29$). The response distributions across the full range of numerosities is shown in

[3] When all trials in which focusers inserted all tokens were removed from the analysis (thereby considering these trials as lapses of attention) the pattern of results was virtually identical, apart from the expected small reduction in response variability. Accordingly, the CoV dropped from 0.39 to 0.33.

Figure 1, panel b. It can be noted that performance was virtually at random above 4 items, which might suggest reliance on the OTS. However, accuracy was relatively high only for one item and it dropped for the other numerosities within the small number range.

Discussion

In the present study, we investigated spontaneous sequential (item-by-item) enumeration in pre-counting children during an imitation task. As in previous studies that have investigated spontaneous focusing on numerosity during imitation (Hannula & Lehtinen, 2005), we observed that a sizeable subgroup of children fed the puppet with a number of tokens that was similar to the number inserted by the experimenter, thereby showing attention to the numerical dimension of the task (i.e. focusers). Crucially, our paradigm included a much larger range of numerosities than previous studies as well as many trials for each target numerosity. This allowed us to analyse the distribution of responses in order to investigate the nature of the underlying enumeration mechanism. First, we ruled out the possibility that children deployed the OTS to track the number of tokens fed by the experimenter, even for small numerosities (i.e. 1 to 3) within OTS capacity limit. Then, we showed that the distribution of responses displayed the classic signature of the ANS, that is scalar variability. Thus, it clearly appears that pre-counting (2–3-year-old) children spontaneously deploy a non-verbal counting process that relies on the ANS to encode and reproduce numerosity. It is worth noting that the CoV is a measure of number acuity (Mazzocco, Feigenson & Halberda, 2011a) that is equivalent to the widely used internal Weber fraction (Piazza *et al*., 2004, 2010). In this regard, the average CoV (0.39) in our sample corresponds to a discriminability ratio of roughly 3:4, which fits well with the developmental trajectory of number acuity as estimated in a review by Piazza (Piazza, 2010). The reliance on ANS as opposed to OTS in our imitation task does not speak against the notion of OTS per se. Reliance on ANS even for small numerosities has been reported in a previous study (Cantlon *et al*., 2010) and it might be a consequence of the task structure. First, the imitation task lacked any specific goal (apart from imitating) and there was no feedback to shape children's performance. Second, the OTS requires attentional resources (Burr, Turi & Anobile, 2010) and it is conceivable that its use could be triggered only with strong reinforcements or incentives. In this regard, our task is very different from manual search paradigms where children look for hidden items and the objects themselves represent an interesting reinforcement (Feigenson & Carey, 2003, 2005). Third, because the OTS is only suitable for tracking a small number of objects, the presence of both small and larger numerosities might lead children to encode all stimuli with the same mechanism (i.e. ANS).

Spontaneous use of sequential enumeration in non-human primates was investigated in a seminal study by Hauser, Carey and Hauser (2000). Presented with one-by-one addition of apple pieces into two opaque containers, monkeys chose the container with the larger number when the comparison was limited to the small number range (i.e. up to 4) but failed with larger numerosities. Though this finding suggested OTS- as opposed to ANS-based enumeration, subsequent studies showed that chimpanzees can estimate the approximate number of items in sequentially presented sets for numerosities well beyond OTS capacity limit (Beran & Beran, 2004; Beran, 2007). Thus, both non-human primates (Beran & Beran, 2004) and pre-counting children are capable of sequentially updating the numerosity of non-visible sets through additive operations and hold this information in memory for use in a later task.

A possible caveat concerns the fact that the scalar variability signature might be the by-product of the processing of other continuous magnitudes rather than numerosity (Bonn & Cantlon, 2012; Bueti & Walsh, 2009; Rousselle, Palmers & Noël, 2004; Walsh, 2003). For example, children might base their estimates on the total amount of food inserted into the puppet without computing the number of elements. In this light, the sum of the physical size of food tokens (i.e. total volume) could have been the dimension that guided children in reproducing the same volume of food. We see this possibility as unlikely given that the puppet was opaque and children were not allowed to look inside it. Moreover, while computing total area requires simple first-order image statistics in the case of object sets (Stoianov & Zorzi, 2012), in the sequential presentation paradigm its computation poses the same challenge as that of estimating numerosity, that is summation/accumulation across discrete events (Meck & Church, 1983). Thus, attending to total area instead of numerosity would not yield any advantage. Alternatively, children might have encoded the total amount of time that the experimenter spent inserting the elements into the puppet's mouth. Then, children imitated the feeding behavior for a similar time duration without considering the number of tokens given to the puppet. Nevertheless, this hypothesis entails the unlikely situation in which children employed a time rate for inserting tokens comparable to the one adopted by the experimenter instead of using the available numerical information.

Future studies might indeed address the role of co-varying magnitudes. For example, time duration can be controlled by ensuring that the feeding actions of the experimenter are performed with variable time rate. In the same vein, the use of tokens with variable size would allow us to control for the total volume. However, we note that these changes would make the experimenter's demonstration of the feeding action far less ecological. More crucially, the simultaneous variability across multiple dimensions (i.e. number, time, and space) would make imitation far more challenging unless the child is explicitly cued to the numerosity dimension (e.g. 'give the puppet the same number of candies'). The latter scenario can be easiliy framed as a 'number game' but it would preclude the assessment of spontaneous focusing on numerosity. Finally, it is worth noting that Beran's (2007) study of sequential enumeration in chimpanzees ruled out that performance solely relied on non-numerical cues such as rate, duration, or cumulative amount.

Notwithstanding these possible caveats, we suggest that the focusers' ability to encode and reproduce target numerosities stems from spontaneous focusing on the numerosity dimension in the environment (Hannula & Lehtinen, 2005), which in turn triggers the mechanism that best suits the structure of the sensory information and the task demands. Thus, our paradigm would trigger the ANS because it involves numerosities beyond the small number range, whereas the classic SFON task involving 3 objects at most is well suited for a limited-capacity object tracking mechanism (i.e. OTS), as suggested by the correlation between SFON scores and subitizing-based enumeration (Hannula *et al*., 2007). Spontaneous focusing on numerosity has been found to be predictive of later mathematical achievement (Hannula *et al*., 2010). In this regard, our finding that focusers engage the ANS suggests that these children might be more prone to compare and estimate the size of numerical sets (e.g. 'you have more candies than me') and receive congruent feedback from adults and peers, thereby progressively training their number acuity, as already demonstrated to be possible in adults (DeWind & Brannon, 2012). This self-training might be one important source of the high variability in number acuity observed in preschoolers (Mazzocco *et al*., 2011b; Starr *et al*., 2013), which in turn is an early predictor of future math achievement (Halberda & Feigenson, 2008; Piazza *et al*., 2010). More broadly, the use of self-initiated focusing on numerosity may explain interindividual differences in numerical skills at the the early stages of development (Hannula-Sormunen, 2014). Prompting children on grasping and processing the numerical aspects of their surroundings (e.g. school, home) can be an excellent tool to improve numerical achievement and possibly prevent later math difficulties. Future research should therefore investigate the possible role of SFON in refining number acuity in early stages of development.

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