LEARNING COUNTING STRATEGIES: A COMPARISON OF DEAF CHILDREN

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Abstract: This study investigates the evolution of counting strategies used by the deaf children of deaf parents compared with those of hearing parents. The strategies were compared using an intervention with two 6-year-old children: a native signing boy and a girl who came into contact with sign language at the age of two years. **Objective:** understand the transition from more time-consuming to faster counting strategies, particularly retrieving facts from memory. **Method:** descriptive case study with data collected at three times: pre-test, final post-test, and extended final post-test three months after intervention. **Results:** the strategies used by the subjects studied changed from the pre-test to post-test stage. Both participants began the intervention using the counting-all strategy. After the intervention, the child of deaf parents showed a 60% improvement, with a 40% advance in retrieving facts from memory and 20% in the counting-on strategy, while the child of hearing parents improved by 70%, with 40% progression in retrieving facts from memory and 30% in the counting-on strategy. **Conclusion:** the children achieved similar levels in the use of counting strategies, indicating that progress in the development of counting strategies seems to be independent of their native language.

INTRODUCTION: The mathematical education and especially numerical learning of deaf children and adults are fairly new subjects in the literature. The primary concern of educators in the deaf community centers is the literacy of deaf children, possibly due to the evolution of the different paradigms created over the history of deaf education. It can be said that at times the focus has been on vocalization and at others, on writing or signing. In the current context, this qualitative case study with pedagogical intervention analyzes the counting strategies used by deaf children in order to understand the transition from more time-consuming to faster strategies, primarily the retrieval of facts from memory. Participants were two six-year-old children, a boy and a girl, with severe to profound bilateral sensorineural hearing loss. The boy is the child of deaf parents and the girl was born of hearing parents. Both children attended special schools for the deaf: the boy studied at a public school and the girl at a private education facility. Both schools apply a bilingual philosophy and the two children used Brazilian Sign Language (LIBRAS) to communicate. The girl also communicated orally, wore a hearing aid and was only introduced to sign language at the age of two years, where as the boy, born to deaf parents, communicated solely through LIBRAS. Data collection was carried out using a research protocol applied at three different times to assess counting strategies. The entire assessment including the pedagogical one was filmed and transcribed into Portuguese with the help of a LIBRAS interpreter accredited by PROLIBRAS[1].The assessment protocol involved the first part of Geary et al.'s (2000) counting procedures test, adapted by Corso(2008), with slight changes made by the investigator according to the characteristics of the children studied. The protocol was applied individually in pre-test, final post-test and final extended post-test phases,

[1]National Exam for Certification of Proficiency in the use and teaching of Libras, in accordance with Decree 5625/05, which regulates Law n° 10436 of April 24, 2002.
http://www.prolibras.ufsc.br.

with the last application occurring three months after completion of the eight intervention encounters.

Nunes and Bryant (1997) emphasize the importance of counting in understanding the numerical system. To some extent the authors agree with Piaget (1971), who reports it is not enough to know how to count if children are unable to use counting as a problem-solving tool, that is, if they do not understand the usefulness of counting. After all, children often know the total amount of a set, but are unable to understand the concept of cardinal numbers.

According to Piaget(1971), understanding the meaning of a number occurs when children can make the logical connection between ordering, classification and the bijective relationship. This enables the child to understand equivalence relations and the resulting meaning of the number. The author observes that it is only based on these relationships that children are capable of counting with meaning and that construction is organized step by step, in line with the gradual formation of inclusion systems.

There is a controversy in the literature about early arithmetic concepts regarding counting and matching numbers. While authors such as Gelman and Gallistel (1978) and Geary(2000) suggest that counting knowledge is a combination of biological factors and experience, others, including Dorneles (2004) and Fuson et al.(1985), indicate that counting principles are not innate and develop by practicing counting strategies and procedures, which are constructed in social relationships.

It is important to note that the authors of this article consider counting strategies (GEARY, 2004, 2000) to be similar to the counting strategies of Nunes and Bryant (1997).

In counting a numerical sequence, it is important to consider that when a child counts a set of numbers or is asked to reproduce the number of objects in a set presented to them and then removed from their field of view, they must have a mental image of the number in order to answer correctly (NUNES, 2004).Hearing children use phonological encoding to remember the number of objects presented, since it is useful in preserving the order of items. Deaf children, however, use visual encoding, which helps them memorizing the location of items. This leads to the understanding that deaf children's success depends on whether information is presented spatially or sequentially (temporally) (Nunes, 2004).

The visual format is certainly essential for deaf students, who perform the same as, better as or worse than hearing students depending on the specific type of visuospatial task used. For example, deaf students that use sign language exhibit relatively better performance in some aspects of visual perception.

According to Nunes and Bryant(1997), progression from the counting all to the counting on strategy represents an advance in the understanding of the decimal system. A child applying the counting all strategy to solving the sum 5 + 2 = 7, counts as follows:1,2,3,4,5,6,7, that is, the child counts all the numbers. On the other hand, in the same situation children using the counting on strategy count 6,7, counting in sequence from the highest number. The latter is a faster and more complex technique that is directly related to the age and experience of children.

The same authors suggest that, in addition to the abovementioned strategies, children can also retrieve basic adding facts from memory. This strategy enables children to quickly provide the answer to the sum without using immature procedures.

Geary(2004) and Geary et al. (2000) suggested that children rely on their knowledge of counting and counting strategies to solve simple arithmetic problems. Children sometimes use their fingers to support their counting (finger-counting) and at others use verbal counting, which, for deaf children means counting in LIBRAS.

Geary (2004) and Geary et al. (2000) report an evolution in the strategies children use to count: counting all, with the aid of fingers or concrete material: children need to portray all the numbers:2+3. They count: "One, two" on one hand and "one, two, three" on the other, and only afterwards begin counting: "one, two,

three, four, five"; counting all from the first number: the child starts counting from the first number, regardless of its magnitude; counting all from the highest number: children begin counting from the highest number. In the example 2+3, the child starts counting as follows: "One, two, three…four, five"; counting on from the first number:for the calculation 2+3, the child remembers that the first number is 2 and counts: "three, four, five", and counting on from the highest number: in the sum 2 + 3, the child realizes it is faster to start counting from the highest number, In the example:2+3, the child remembers the number three and counts: "four, five".

These strategies are described in hierarchical order according to their efficiency. The more children progress in these strategies the more often they employ faster strategies, allowing them to use more advanced strategies such as representing these facts in memory (Geary, 2004).This allows them to directly retrieve information from their long-term memory. In other words, in the example 2 + 3, children rapidly respond that the answer is five without using any other resource. Moreover, it enables decomposing, which involves reconstructing the answer by remembering a partial sum, that is, for the sum 2+3, the child remembers the known sum 2+2 and adds 1. These last two strategies are faster and more efficient.

Counting strategies can be classified from the least to most efficient and supported by counting: finger-counting, counting orally (or in LIBRAS for deaf children) and silent counting; or by memory: decomposing and retrieving facts from memory (GEARY, 2004; GEARY et al. 2000; CORSO, 2008). In decomposing, children break down one of the numbers into one that is easier and more familiar and add the missing units. For example:6+4, 6 is broken down into four plus two, grouped with 4+4=8 and 2 is added, resulting in ten.

The direct retrieval strategy is an automatic answer from long-term memory and requires confidence on the part of the child, who will respond when they are certain of the answer. (GEARY, 2004; CORSO, 2008).

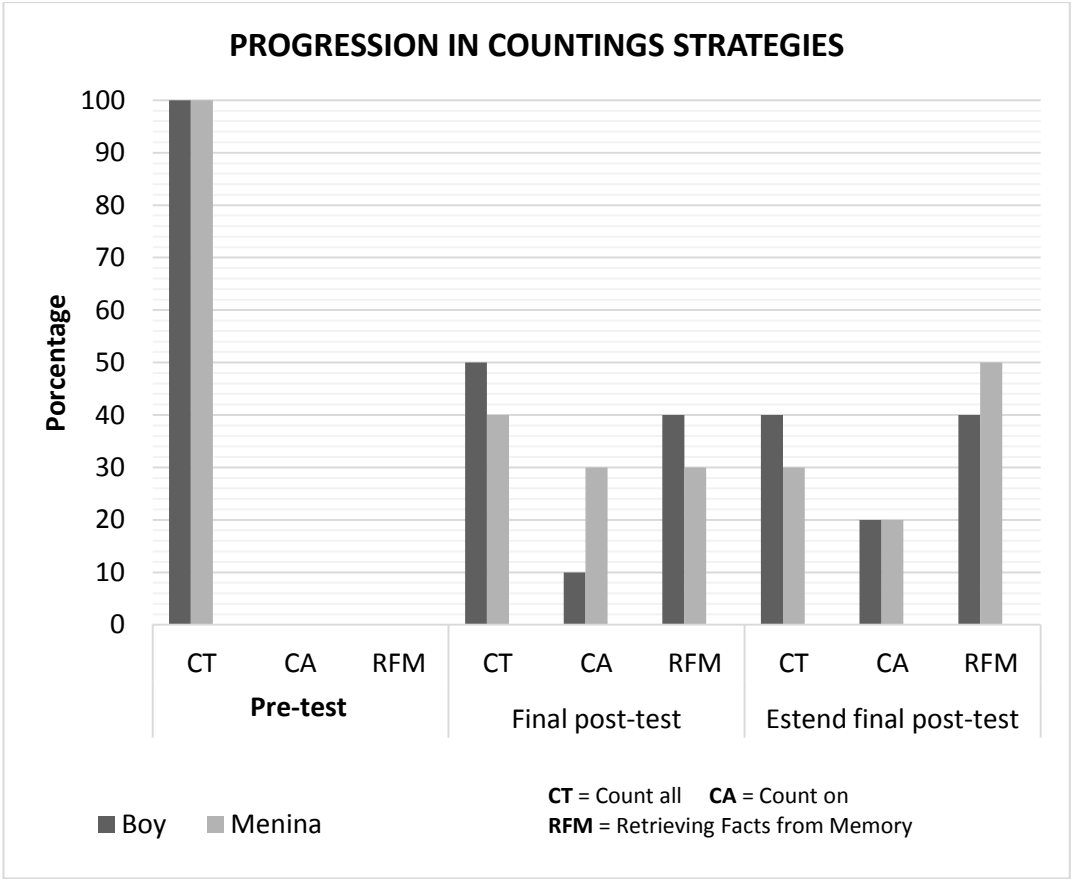
Children can employ one of the above mentioned strategies with different procedures depending on the development of their conceptual knowledge of counting.

This study opted to separate the more primitive finger-counting strategy (GEARY, 2004) into two procedures, that is, finger-counting and counting using concrete material. They were used separately given the age of the participants. An adjustment was also made to the verbal counting strategy, which was changed to counting using LIBRAS, since the children studied used this language.

METHOD: We conducted three assessments of both children: pre-test, before starting the pedagogical intervention; final post-test, after the last intervention; and extended final post-test, three months after the last intervention. Assessment involved ten adding situations to evaluate counting strategies. After the first assessment, carried out at the children's schools, they participated in a short intervention of eight sessions held over four weeks. The pedagogical intervention consisted of four enjoyable counting games played with the children. Observations were made of the videos and during the game itself to assess progress in the use of faster counting techniques. To better understand the intervention, see VARGAS and DORNELES (2013).

The protocol applied consisted of booklets containing 10 addition sums featuring single digit numbers from one seven, with the highest answer not exceeding 13. The booklet was presented and the child was asked to respond as they saw fit, using concrete material, counting on their fingers, counting in LIBRAS (which, according to Corso's (2008) protocol, is counting orally) or retrieving facts from memory. In accordance with the counting strategies used by the children, the counting process was also classified as: "counting all", which involves counting both the facts; and "counting on", which can include counting from the highest or the lowest number.

DISCUSSION OF RESULTS: We observed that in the first three intervention encounters both children predominantly used the counting all strategy, even in adding problems with an unknown (secret) number, which obliges the child to start counting from the unknown number. Both participants tended to immediately identify the value of the first number without counting; however, when the first number was joined to the second, both began counting from the first number, using the counting all strategy. According to Nunes and Bryant (1997), adding with an unknown number is considered a difficult task for hearing children aged five to six years, which was observed in the first sessions of this study. On the other hand, Geary (2004, 2000) explains that children aged six years and older with normal development are capable of using faster counting strategies, such as the counting on strategy. From the fifth encounter onwards, the children progressed from a slower counting strategy to occasional retrieval of facts from memory, though not firmly established. From the sixth to the eighth meeting there was a consistent evolution in their use of strategies. The children continued to prioritize the counting all strategy and retrieving information from memory. This was confirmed despite the fact that the girl still employed the count all strategy in the final session. During the process, the boy retrieved information from memory more often than the girl. Graph 1 shows the progression of the children from the pre-test to extended final post-test phase.



Graphic 1: Comparison of the strategies used between pre-test and extended final post- test.

Comparison of the counting strategies used by the children showed a slight variation in performance between them. Both participants began the intervention using the counting-all strategy. After the intervention, the child of deaf parents showed a 60% improvement, with a 40% advance in retrieving facts from memory and 20% in the counting-on strategy, while the child of hearing parents improved by 70% , with

40% progression in retrieving facts from memory and 30% in the counting-on strategy (Graph 1). Automatic retrieval of basic facts reduces the demands of working memory and seems to help solve more complex problems, including written ones (GEARY,2004). This may be a facilitator for deaf children, who experience difficulty solving written problems (ANSELL; PAGLIARO, 2006). When a child exposed to sign language (SL) early on was compared with a child only introduced to SL at two years old, the assumption that the former would perform better in the pedagogical interaction and in terms of mathematical knowledge was not confirmed.

CONCLUSIONS: As we written above there is no significant difference in the learning of the use of counting strategies between the two children. In fact, more similarities were found than differences. In this respect, the comparison between assessment tests and the children's progression during the intervention sessions showed that both improved in the development of faster counting strategies. This demonstrates that, regardless of the age at which they are introduced to SL, deaf children benefit from a pedagogical intervention designed to encourage the use of faster strategies. It is important to note that the greatest limitation of this study was the small sample size, which prevents the generalization of results.

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