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An Exploration of Development of Children's Numerical Ability

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Abstract

Nowadays, children's early education has been popularized in this competitive society. Every parent wants their future generation to learn more and know more, and mathematics ability is always a key aspect. Previous study has shown 3.5 years old is the earliest age for children to show calculating and counting ability. However, before developing counting ability, we believe children always know numbers but they just can not say it out loud. This study's purpose is to find out when the children can describe things by numbers correctly. This study will use pictures of different numbers of items and ask the question of "how many". We expect children from 2 to 3 can show some understanding of numbers from 1 to 10 but may have troubles afterwards. Children older than that will fit the results of previous study. This study can contribute to future studies in early education and development and help researchers to know the young children's math ability.

Keywords

Infants; Number learning; Correlation coefficient; Early education.

1. Introduction

When researchers studied the counting ability of numbers, they found that babies could do some simple calculations. In the experiment, the children are able to use the law of conservation and show surprise when they see one apple and another apple went under the curtain and show up with three apples. With some simple tasks (Wynn K, 1990 [1]), the mean age of success in those tasks is 3.5 years old which suggests children younger than that did not develop cardinal word principle and they did not fully learn the counting ability.

However, counting numbers regularly seems to be a more developed ability than the simple usage of numbers which means children can use numbers to describe the objects. For example, children may be able to use "two " to describe objects. They may understand what "one" or "two" are but they may not formulate a whole understanding of basic numbers from one to nine. In general, this study wants to find out when the children can describe things by numbers correctly.

2. Background

Brain science research shows that 0-3 years old is a period for children to develop the human brain rapidly. The stimulation of the external environment can promote the growth and development of brain cells, and the most effective stimulation is early education(Barry& Cantor, 2000[2]). If taught in the appropriate period of time, cultivate children's interest in learning

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numbers, can promote the growth of brain cells, expand children's thinking ability, and play a great role in promoting future learning. For children, this is a gradual process in which they establish the concept of numbers and step by step form logical thinking. At this time, children's mathematical thinking is very active. With this mathematical logic, children will germinate the interest and enthusiasm to solve problems, laying a good foundation for children's future learning, so we should correctly grasp this critical period and provide suitable education for children.

Previous study showed that numbers can help children further develop the flexibility and generality of thinking, so as to cultivate children's preliminary logical ability (Schaeffer.B, Eggleston.V.H. & Scott.J.L, 1974[3]), but it did not mention what we should do to cultivate these skills, or when we should take actions. If we can find out the best time for children to learn numbers and give suitable teaching, we can help children gradually have more awareness and think on their own. Also, while having classes, children can be inspired by communicating with their parents or teachers, which can help better promote the development of their brains. With this precondition, we come out with the question: what time is more efficient for children to learn numbers during their babyhood?

3. Proposed Study

The proposed study is targeted to investigate whether there is an age limit which the children are able to grasp the knowledge of numbers. In this experiment, we set the boundaries of knowing the numbers by correctly identifying while able to use it with simple counting techniques. We want to discover if children are able to learn this faster than normal teenagers or adults. Since counting is proven to be learned after 3 years old, using numbers itself may not be as easy as we thought. If the ability of using numbers is learned, this may lead to further study on mathematics. The answers should help understand relevant learning like counting or calculation and set base for further studies on mathematics learning and cognition.

4. Method

After detailed background research, we want to recruit children from 1.5 years old to 3.5 years old. Children younger than that age are barely able to use one to two words and they are unlikely to show number skills. And Wynn K's (1990[1]) study has shown that children developed counting ability around 3.5 years old so the usage of numbers must have developed before that age. We want to eliminate any unrelated factors to ensure the validity of our study. So the background of the participants will be strictly controlled. We want to limit the background as English speaking monolingual children in Canada. With consideration of budget and time, 30 male participants and 30 female participants will be selected and different age groups should all be covered. The family SES background is not meant to be controlled and this background can be used to conduct further study on SES's impact on related language learning.

The main purpose of our experiment is to test if the child being tested shows ability to use numbers correctly. We will take children in a room with parents aside for a comforting reason. The participants will be presented with 10 pictures with different numbers of the same items. This item would be a cube with the same outlook and weight. The range of numbers of this cube would vary from 1 – 20. There will be no order while presenting the number. At first, we will discuss the purpose and instruction of this experiment to the children as clearly as possible. We want to ask the question of "How many '' so they can say the number out loud when we present a picture with "two apples" for example. Although different children may have different reactions and understanding on those instructions, we want to keep our script similar in all testing so we will not spend too much time trying to "push" out an answer we want.

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Privacy policy will be strictly followed, and no names and personal information will be presented in the results, while the results are for this experiment only.

5. Safety Configurations

Due to the fact that our experiment involves actual human beings being teste, a human consent form would be required (see the attachment) in order to ensure the full legitimacy of this experiment. Moreover, the object we would be using to illustrate the number (a Cubic) would be strictly selected through the standard of UN regulations and will be approved by all the families involved in the test.

While at the same time, we would also ask professional agencies that have the certificate of teaching and leading children to oversee and be the experimenter for this experiment during the data collection section to ensure the safety of both our staff and the children. This could also reduce the probability of being questioned about legitimacy.

6. Result

If the answer is correct, the subject will be recorded as 1. If the answer is wrong, the subject will be recorded as 0. The sum of 10 results of each subject is calculated as ∑k, and the age of the subject is recorded as n. The formula is as follows (the followings are calculated by SPSS statistical software)

$$r_{xy}=\frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}},\ r_{xy\in[-1,1]}$$

$$\bar{x}=\frac{1}{n}\sum_{i=1}^{n}x_i \qquad \bar{y}=\frac{1}{n}\sum_{i=1}^{n}y_i$$

Where x is ∑k and Y is n.

6.1. Analysis of Result

If r=1, then age and ∑k are completely positive correlation; if r=-1, age and ∑k are completely negative correlation; if 0<R<1, age and ∑k are positively correlated; if-1<R<0, age and ∑k are negatively correlated; if r=0, there is no linear correlation between variables, but the possibility of nonlinear relationship between variables is not excluded.

6.2. Hypothesis Testing

In order to judge the representativeness of R to the population, we can test the hypothesis of R. The idea and process of hypothesis testing areas follows:

(1) assume that hypothesis H_0 is no significant linear correlation between two variables, which is the population r=0; hypothesis H_1 is a significant correlation between the two variables.

(2) The corresponding statistics are calculated to obtain the corresponding associated probability P. If P<the designated significance level a, H_0 is rejected and the two populations are considered to have significant linear correlation; otherwise, no significant linear correlation is considered.

6.3. Expected Result

The expected result is that r values are meaningful by hypothesis testing and r is greater than 1. This shows that children's ability to learn numbers increases with age. By searching the literature (Lin Chongde,1980 [4]), Children around the age of 3 have mastered the use of numbers. Children around the age of two initially learn individual numerals, such as"1" and "2", but are often not correctly used to indicate the number of items. When asking them how many objects there are, some children often answer with two. A small number of children between the ages of two and three can be used up to 10 or more, but there is also the phenomenon that children can not use numbers, and most children over three can use the number up to 10.

7. Conclusion

Overall, this study aims to find out the approximate age of children who adopt the ability to use numbers correctly. If an average result can be found, it will contribute to future studies on preschool education and mathematics learning. A few limitations of this study may help future research conducted as similar subjects. For example, the difficulty to define the ability to use numbers correctly and the method used to test that concept are surprisingly challenging. The children may understand numbers but can not verbally express or can not understand the instruction. Or the children may understand the number system but not the language usage yet. These can be studied in much more details. Also, this study only focused on English speaking children in Canada and different languages and cultures may lead to distinct results.

7.1. Future Expect

For future studies, more studies should be conducted on preschool learning. Usage of numbers is only one aspect of the learning process. For example, cognitive ability may be trained during this time so the children may have high levels of cognition in future. Also, the learning number itself has many aspects left for future studies like the influence from parental input or type of education the children accept. In general, this small aspect can lead to deeper understanding of children's learning in early age.

7.2. Researching Significance

We should improve teaching methods and develop the children's concept of numbers. Teaching methods should be suitable for children's age characteristics, make full use of games and interesting activities, guide children to recognize numbers, make children interested in recognizing numbers, and accept mathematics education .To determine the scope and requirements of children's teaching, it should be noted that children generally do not need to work hard to achieve. As Japan clearly states in the kindergarten syllabus, children should not be allowed to remember too many numerals and too many numbers.

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