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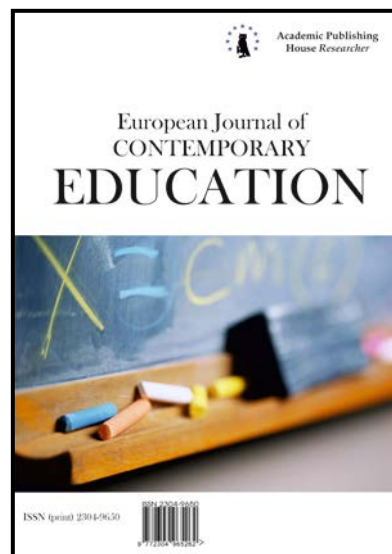
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Piagetian Conservation Tasks in Ghanaian Children: the Role of Geographical Location, Gender and Age Differences

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Abstract

The study investigated the influence of geographical location, gender and age on the performance of Piagetian Conservation tasks. Four conservation tasks; conservation of liquid, length, substance amount and number respectively were administered to children [4-6 years] from rural and urban Ghana and their performance on each task were recorded. Results indicated that there were no significant relationships among the performance of Piagetian conservation tasks and geographical location. Similar trends were noted in the performance of gender and age differences on Piagetian conservation tasks. Nonetheless, older children performed better on the conservation of liquid in a glass than younger children. Based on the results, both quantities and perceptual comparisons can be applied in future studies to examine some possible variations in children's cognitive development.

Keywords: Piaget; conservation; cognitive development; age; geographical location; gender; pedagogy; experiment; Ghana.

Introduction

"Which weighs more; a ton of lead or a ton of feathers"? In order to answer this question, some form of scientific reasoning is needed to draw a conclusion. Fundamental to all scientific

thought, whether executed in a controlled laboratory or in daily life experience, is the principle of conservation. Psychologist Jean Piaget developed a cognitive developmental theory based on the assumption that early development occurred in a specific stage-like manner. Significant within this theory is the concept of conservation. Conservation can be defined as the credence in the permanence of certain attributes of objects or situations not regarding superficial changes (Santrock, 2012). According to Piaget, the conservation task among children is a reliable pointer of cognitive functioning (Piaget, & Inhelder, 1959; Piaget, 1995).

It is vital for the child to recognise the invariance of number and quantity, which forms the root of Piaget's theories of concept development. According to Piaget's Stages of Cognitive Development, there are certain achievements, activities, and limitations that correspond to each stage and approximate age (Durr, 2001). In effect, children at the preoperational stage cannot conserve. Conservation acquisition is the ability to recognize that though a particular amount has changed its appearance, it is still the same amount. Piaget indicated that this ability marks the end of the preoperational stage and the beginning of the concrete operational stage (Dworetzky, 1990).

Piaget's theory since its development has proven to be useful in many aspects of developmental sciences, pedagogy and psychology till today. Nonetheless, the validity of conservation tasks had been critiqued widely by several authors. While some studies in the past had observed that children across cultures achieve certain Piagetian tasks just about the predicted ages and order (Brainerd, 1978; De Lemos, 1969), others had implied that children perform better when measured on quantities rather than perceptual comparisons (Roazzi, & Bryant, 1997). According to Bryant and Trabasso (1971), children's failure in conservation task can be attributed to memory constraints rather than the quality of reasoning. The problem of language of instruction during the task performance, other than the lack of reversibility of thought had been proved also, as the cause for lack of conservation among children. Weight conservation among Zambian children was in effect measured using a non-verbal approach to escape this problem (Heron, & Simmomsson, 1969). In our study, we rather used a two-way verbal communication approach. This method allowed the children to give verbal justifications for their choice of answers to the verbal questions of researchers. Thus, we sought to provide an in-depth analysis unlike other previous studies.

The need for a good conservation capacity among children is indeed essential for several academic tasks, for example, in the study of mathematics and other scientific subjects. Such subjects are dependent on the cognitive ability of children to maintain reversibility of thought (Chaplin, & Johnson, 2006). Children of African-American descent who were thought of being in the preoperational level of cognitive development performed poorer in mathematics compared to children of Caucasian decent (Cooper, & Schleser, 2006). Additionally, although conservation capacity of most children improves along with age (Bisanz, Dunn, & Morrison 1995), it is not a direct attribute of age (Ginsberg & Opper, 1969). In effect, the recognised assumption that the relationship between the conservation task and the quality of reasoning among children is not at all as simple as Piaget's theory presumed (Baucal, & Stepanović, 2006).

Taking into consideration the concerns raised by the studies discussed above, we raise the research question, "what is the connection between individual factors (like age and gender) as well as the geographical location (rural and urban) on conservation acquisition of children on different tasks (liquid, length, substance amount and number)?" The absence of an experiment among Ghanaian children that will take into consideration the content analysis of participants' motivation for decisions or choice of answers was a great opportunity for us to embark on this research.

Method

Participants

One-hundred and twenty children each of equal number of males and females from ages four to six were selected randomly from Nsakina Municipal Assembly School (rural children) and the University of Ghana Primary Schools (urban children) to participate in the experiment. This was because children with these ages were more likely to the characteristics of pre-operational stage of cognitive development (which is between 2 and 7 years old), where conservation is one of the predominant challenges (Dworetzky, 1990; Piaget, 1951, 1952). Reference of their age distribution can be referred from Tables 1, 2, 3 and 4.

Materials

The apparatus used included three glasses, two of the same size and a third one of differing size and height and a coloured drink to fill the glasses. In addition two sticks of equal length labelled A and B, ten stones of similar size and shape, plasticine were moulded and scoring sheets were used to record the children's performance on the Piagetian Conservation Tasks.

Procedure

Approval to proceed with experiment was obtained from the Department of Psychology at the University of Ghana, Nsakina Municipal Assembly School and the University of Ghana Primary Schools.

Subsequently, written consents were obtained from all parents and teachers of the children following the verbal agreement of willing children, who were randomly sampled. Four conservation tasks; conservation of liquid, length, substance amount and number respectively was administered to each child and their performance on each task recorded. Using a two-way verbal communication approach, children were offered the tasks and subsequently allowed to give their responses and rationale for their choices. For each correct response, a participant is scored one point. The total points for each child were added up to obtain the raw total conservation score. Simple classification rule of raw scores included the following: participants with scores above three correct points out of the four tasks were classified as good conservers. Those with scores of two points were classified as moderate conservers while scores below two points were classified as non-conservers.

Design

The experimental design was between-subject design. A between-subject design is an experimental design in which different groups of scores are obtained from separate groups of participants. This experimental design was chosen in order to obtain different groups of scores from rural and urban children and also male and female children (Charness, Gneezy, & Kuhn, 2012). The test consisted of four tasks, each having four steps. Therefore, there were sixteen steps in all.

The following describes the conservation tasks which were administered:

Task 1 Conservation of Liquid in a Glass

Two identical glasses labelled A and B each filled with the same amount of liquid were presented to the child. The child was to agree that they were of equal amount. The liquid in glass B was poured into a glass C which is taller and thinner than A and B, while the child is looking on. The child was asked "Which glass has more water A or C, or do they both have the same amount?" They were then asked why they gave such an answer.

Task 2 Conservation of Length

Two sticks of equal length were placed in front of the child so they are parallel. The child was to agree that they are of equal length. One stick was then moved over, while the child is looking on. The child was asked "Which stick is longer or are the sticks of equal length?" They were then asked why they gave such an answer.

Task 3 Conservation of Substance Amount

Two identical plasticine balls were centered in front of the child. The child was to acknowledge that they are equal amounts of plasticine. One of the balls was rolled out into a sausage shape, while the child is looking on. The child was then asked "Which plasticine ball has more, or do they both have the same amount?" They were asked why they gave such an answer.

Task 4 Conservation of Number

Two groups of small stones of similar sizes, five in each group were lined up about two inches apart in the center in front of the child. The child was to acknowledge that they are equal in number. One group was brought close together such that the stones were about half an inch apart, while the child is looking on. The child was asked "Which group has more stones, or do both groups have the same number of stones." They were then asked why they gave such an answer.

Content Analyses of Reasons Offered for their Choice of Answers

This provides a tabular summary of content analyses of the children responses offered for their choices during the experiment.

Table 1: Task 1

TASK 1 RURAL	AGE	A>C	C>A	A* = C*	A1≠C1	C1>A1
	4	18	4	12	5	1
	5	14	7	12	2	4
	6	21	7	5	4	4
TOTAL		53	18	29	11	9
TASK 1 URBAN	4	16	8	12	1	1
	5	12	10	10	3	2
	6	20	6	8	4	1
TOTAL		48	24	30	8	4

Notes: A → Glass A; C → Glass C; A1 → Liquid in Glass A; C1 → Liquid in Glass C; A>C → Glass A is bigger/taller/longer than Glass C; C>A → Glass C is bigger/taller/longer than Glass A; A* = C* → Glass A/Liquid in Glass A and Glass C/Liquid in Glass C are the same.

Table 2: Task 2

TASK 2 RURAL	AGE	A>B	B>A	A=B	A≠B
	4	20	6	11	4
	5	20	6	7	7
	6	19	6	11	3
TOTAL		59	18	29	14
TASK 2 URBAN	4	15	6	12	8
	5	17	5	8	10
	6	25	8	3	3
TOTAL		57	19	23	21

Notes: A → Stick A; B → Stick B; A>B → Stick A is longer/bigger than Stick B; B>A → Stick B is longer/bigger than Stick A; A≠B → Stick A is not the same as Stick B.

Table 3: Task 3

TASK 3 RURAL	AGE	B>SS	SS>B	B=SS	B≠SS
	4	2	10	6	19
	5	4	15	9	12
	6	5	9	9	20
TOTAL		11	34	24	51
TASK 3 URBAN	4	4	7	8	21
	5	2	16	9	14
	6	4	6	11	18
TOTAL		10	29	28	53

Notes: B → Ball-shaped plasticine; SS → Sausage-shaped plasticine; B >SS → Ball-shaped plasticine is bigger than Sausage-shaped plasticine; SS>B → Sausage-shaped plasticine is bigger than Ball-shaped plasticine; B=SS → Ball-shaped plasticine and Sausage-shaped plasticine are the same.

Table 4: Task 4

TASK 4 RURAL	AGE	S>C	C>S	S=C	S≠C
	4	9	4	13	14
	5	5	7	11	17
	6	10	8	10	12
TOTAL		24	19	34	43
TASK 4 URBAN	AGE	S>C	C>S	S=C	S≠C
	4	7	5	13	16
	5	9	8	13	10
	6	8	5	10	16
TOTAL		24	18	36	42

Notes: *S* → Spaced-out stones; *C* → Clumped-together; *S>C* → Spaced-out stones are more than those clumped together; *C>S* → Stones clumped together are more than those spaced-out; *S≠C* → Stones spaced out are not the same as those clumped together; *S=C* → Stones spaced out are the same as those clumped together.

Results

Geographical location and Conservation Tasks Hypotheses

Hypothesis 1a. The first hypothesis under this theme explored the effect of geographical location differences in the performance of children on the conservation of liquid in a glass. It was hypothesised that “urban children were more likely to perform better in Task 1 than rural children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) showed that this hypothesis was not significant, [$\chi^2_{(1)} = 0.089, \rho = 0.766$]. Hence, there is no significant difference in the performance of urban and rural children on the conservation of liquid in a glass. Figure 1 shows a scatter plot of geographical location and Task 1.

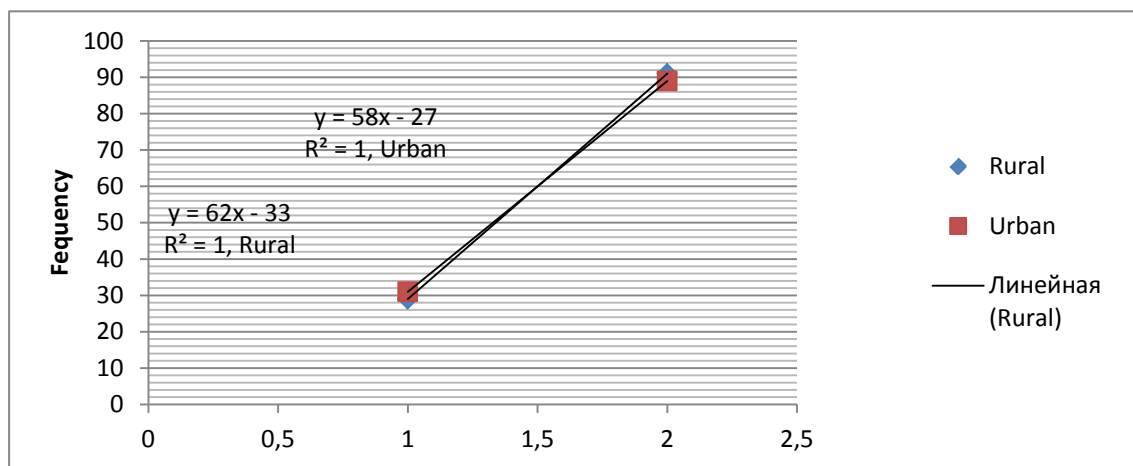


Fig. 1. Scatter Plot of Geographical location and Task 1

Hypothesis 2a. The second hypothesis also explored the effect of geographical location differences in the performance of children on the conservation of length. It was hypothesised that “urban children were more likely to perform better in Task 2 than rural children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) indicated that this hypothesis was also not significant, [$\chi^2_{(1)} = 1.617, \rho = 0.204$]. Consequently, there is no significant difference in the performance of urban and rural children on the conservation of length. Figure 2 displays a scatter plot of geographical location and Task 2.

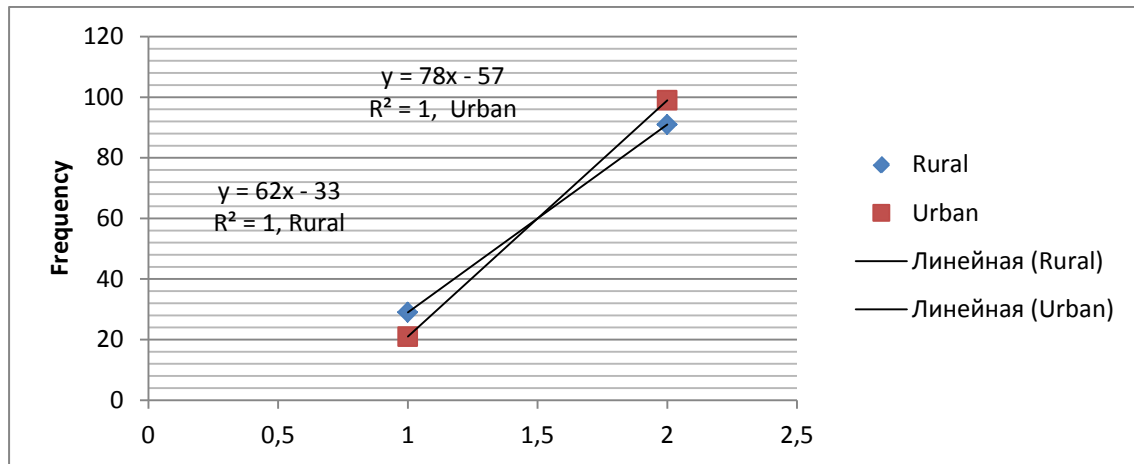


Fig. 2. Scatter Plot of Geographical location and Task 2

Hypothesis 3a. The third hypothesis however examined the effect of geographical location differences in the performance of children on the conservation of substance amount. It was hypothesised that “urban children were more likely to perform better in Task 3 than rural children”. A Chi Square Goodness of Fit Test with one degree of freedom (df) indicated that this hypothesis was also not significant, [$\chi^2 (1) = 1.187, \rho = 0.276$]. As a result, there is no significant difference in the performance of urban and rural children on the conservation of substance amount. Figure 3 shows a scatter plot of geographical location and Task 3.

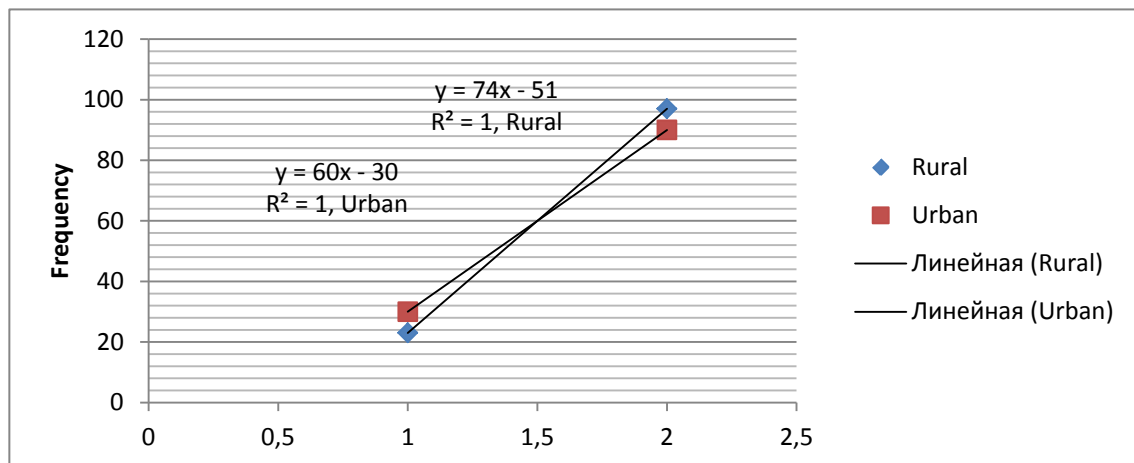


Fig. 3. Scatter Plot of Geographical location and Task 3

Hypothesis 4a. The fourth hypothesis under this theme examined the effect of geographical location differences in the performance of children on the conservation of number. It was hypothesised that “urban children were more likely to perform better in Task 4 than rural children”. A Chi Square Goodness of Fit Test with one degree of freedom (df) showed that this hypothesis was as well not significant, [$\chi^2 (1) = 0.726, \rho = 0.394$]. For that reason, there is no significant difference in the performance of urban and rural children on the conservation of number. Figure 4 shows a scatter plot of geographical location and Task 4.

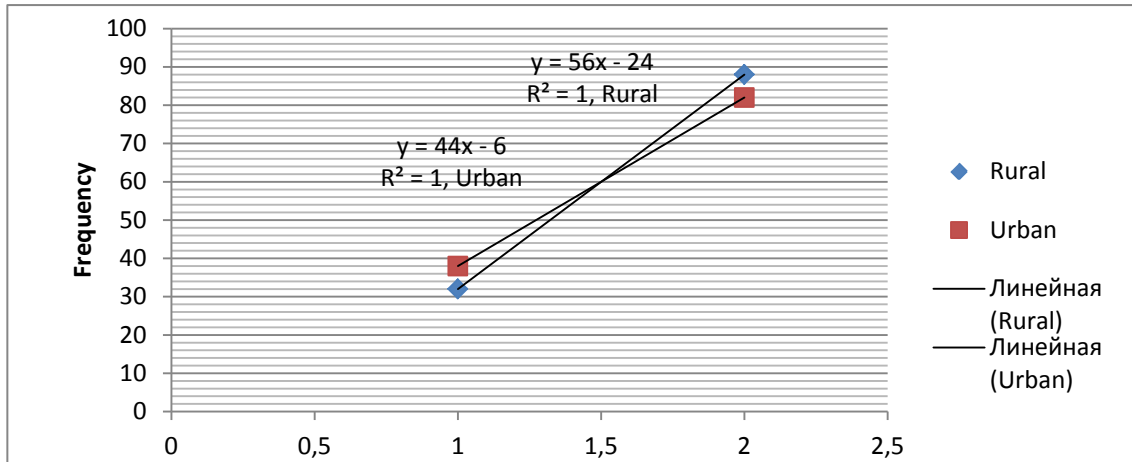


Fig. 4. Scatter Plot of Geographical location and Task 4

Gender and Conservation Tasks Hypotheses

Hypothesis 1b. The first hypothesis under this theme explored the effect of gender differences in the performance of children on the conservation of liquid in a glass. It was hypothesised that “male children were more likely to perform better in Task 1 than female children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) showed that this hypothesis was not significant, [$\chi^2 (1) = 1.422, \rho = 0.233$]. Hence, there is no significant difference in the performance of urban and rural children on the conservation of liquid in a glass. Figure 5 shows a scatter plot of gender and Task 1.

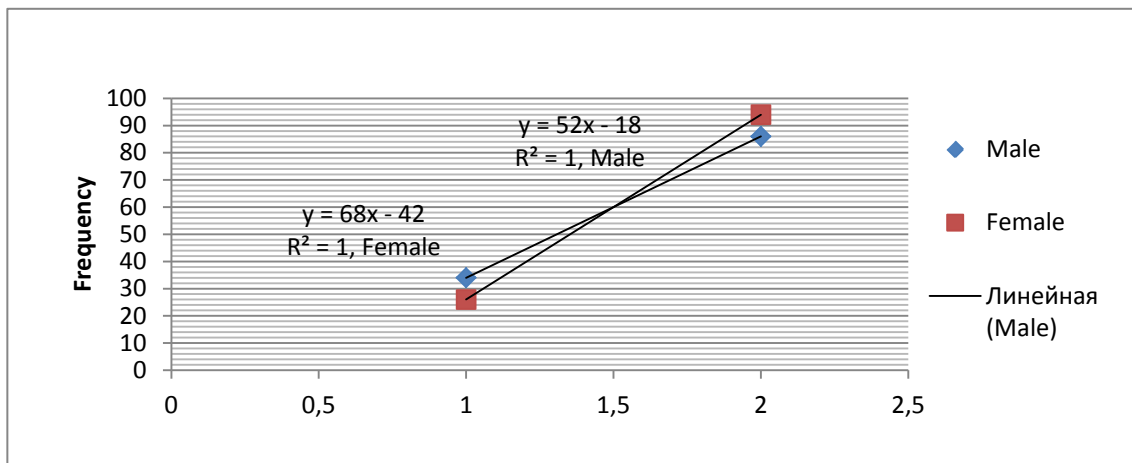


Fig. 5. Scatter Plot of Gender and Task 1

Hypothesis 2b. The second hypothesis under this category similarly examined the effect of gender differences in the performance of children on the conservation of length. It was hypothesised that “male children were more likely to perform better in Task 2 than female children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) indicated that this hypothesis was also not significant, [$\chi^2 (1) = 0.909, \rho = 0.340$]. Thus, there is no significant difference in the performance of urban and rural children on the conservation of length. Figure 6 illustrates a scatter plot of gender and Task 2.

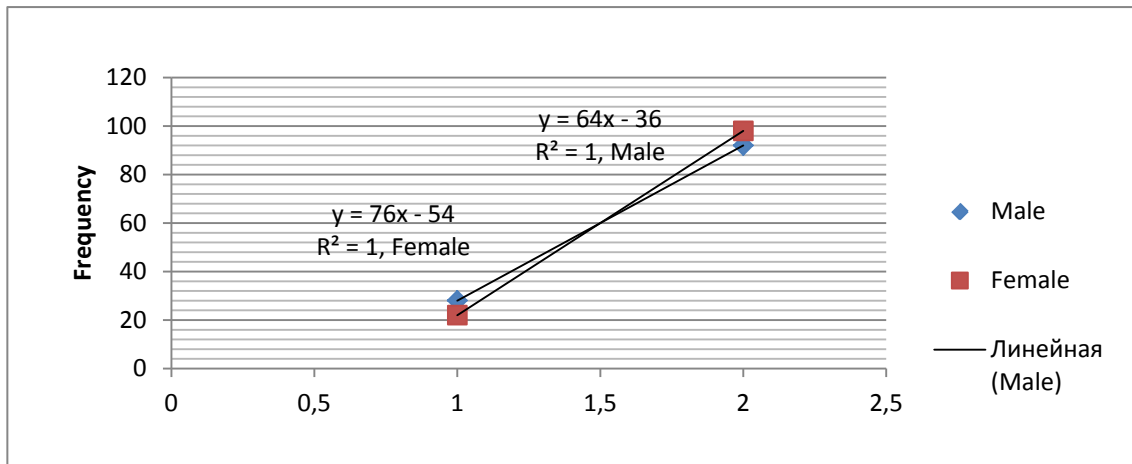


Fig. 6. Scatter Plot of Gender and Task 2

Hypothesis 3b. The third hypothesis nonetheless examined the effect of gender differences in the performance of children on the conservation of substance amount. It was hypothesised that “male children were more likely to perform better in Task 3 than female children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) indicated that this hypothesis was similarly not significant, [$\chi^2_{(1)} = 0.023$, $\rho = 0.876$]. As a result, there is no significant difference in the performance of urban and rural children on the conservation of substance amount. Figure 7 shows a scatter plot of gender and Task 3.

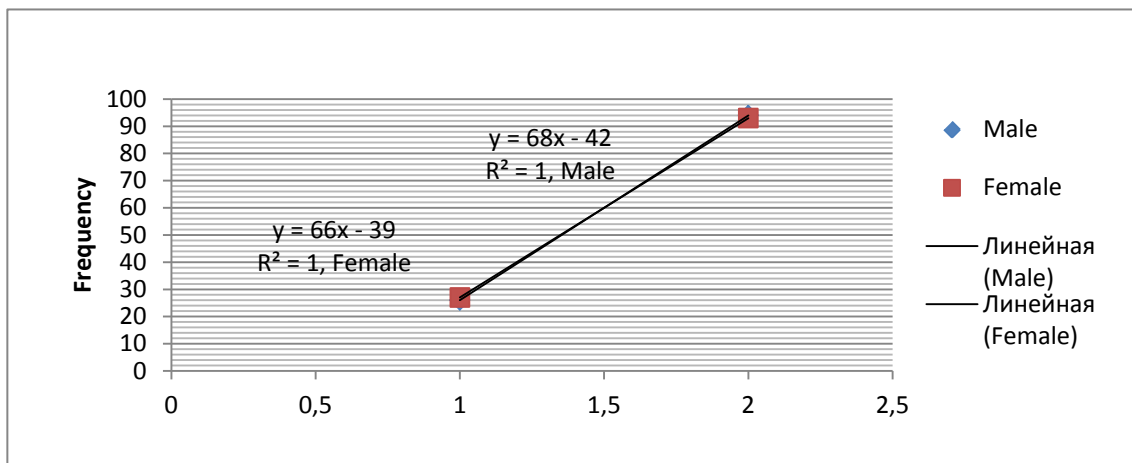


Fig. 7. Scatter Plot of Gender and Task 3

Hypothesis 4b. The fourth hypothesis under this category however examined the effect of gender differences in the performance of children on the conservation of number. It was hypothesised that “male children were more likely to perform better in Task 4 than female children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) revealed that this hypothesis was as well not significant, [$\chi^2_{(1)} = 0.081$, $\rho = 0.766$]. According to the results, there is no significant difference in the performance of male and female children on the performance of the conservation of substance amount. Figure 8 displays a scatter plot of gender and Task 4.

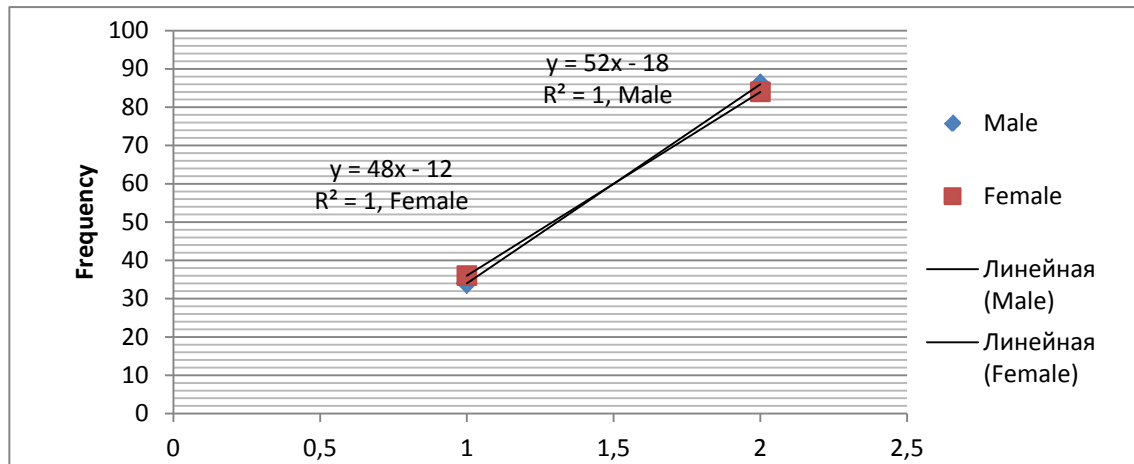


Fig. 8: Scatter Plot of Gender and Task 4

Age and Conservation Tasks Hypotheses

Hypothesis 1c. The aim of the first hypothesis under this subject investigated the effect of age differences in the performance of children on the conservation of liquid in a glass. It was hypothesised that “older children were more likely to perform better in Task 1 than younger children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) showed that this hypothesis was significant, [$\chi^2 (1) = 4.254, p = 0.039^*$]. In effect, older children perform better than younger children on the conservation of liquid in a glass. Figure 9 shows a scatter plot of age and Task 1.

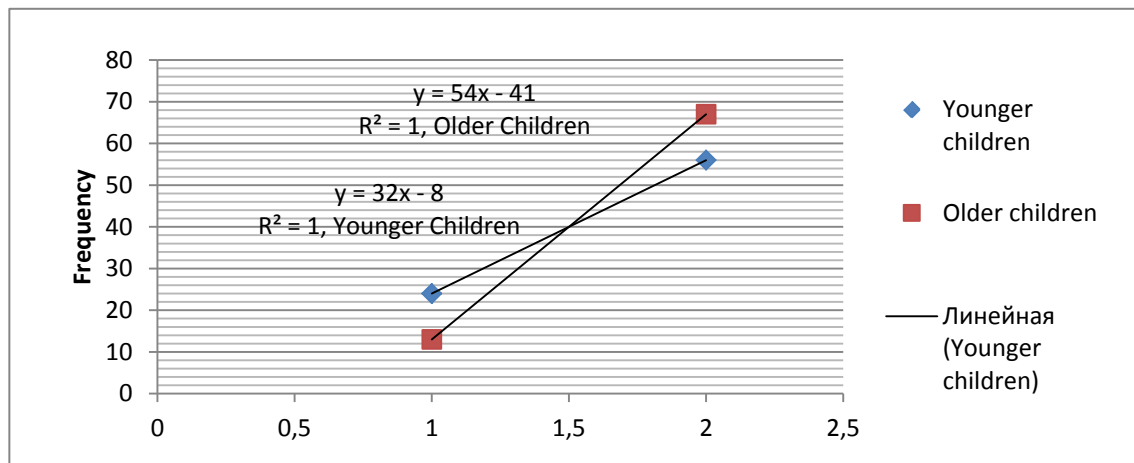


Fig. 9. Scatter Plot of Age and Task 1

Hypothesis 2c. The second hypothesis under this theme also looked at the effect of age differences in the performance of children on the conservation of length. It was hypothesised that “older children were more likely to perform better in Task 2 than younger children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) indicated that this hypothesis was not significant, [$\chi^2 (1) = 3.584, p = 0.058$]. Thus, there is no significant difference in the performance of older and younger children on the conservation of length. Figure 10 illustrates a scatter plot of age and Task 2.

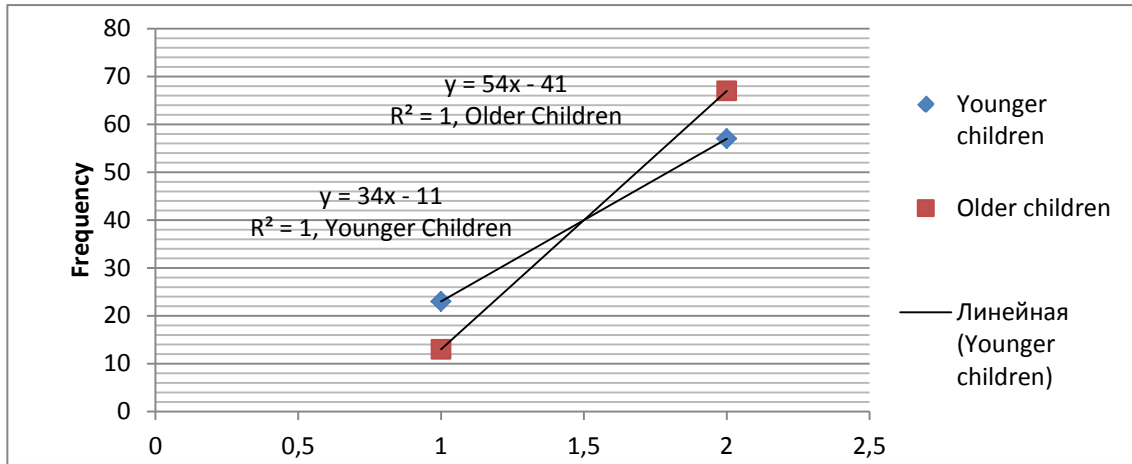


Fig. 10. Scatter Plot of Gender and Task 2

Hypothesis 3c. The third hypothesis under the age theme examined the effect of age differences in the performance of children on the conservation of substance amount. It was also hypothesised that “older children were more likely to perform better in Task 3 than younger children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) indicated that this hypothesis was similarly not significant, [$\chi^2 (1) = 0.573, \rho = 0.449$]. Consequently, there is no significant difference in the performance of older and younger children on the conservation of substance amount. Figure 11 shows a scatter plot of age and Task 3.

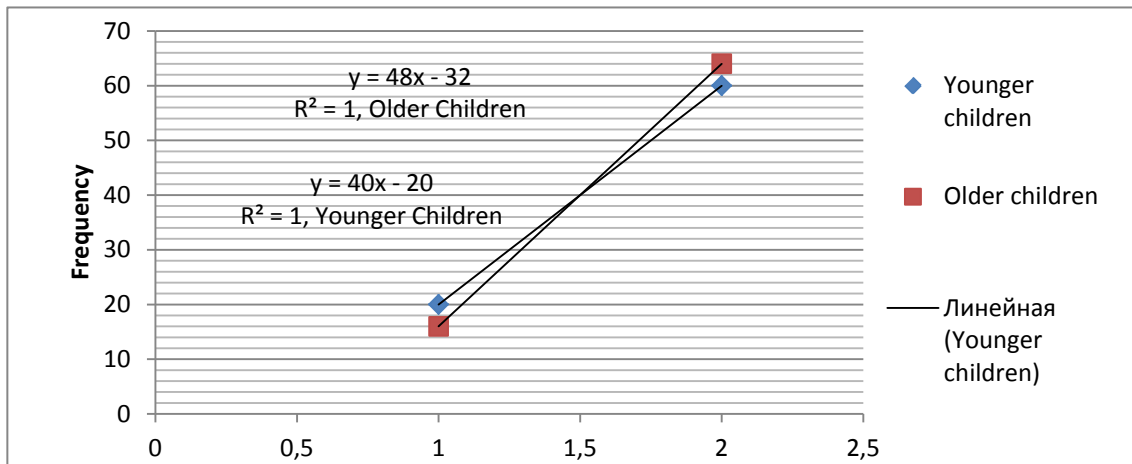


Fig. 11. Scatter Plot of Age and Task 3

Hypothesis 4c. The fourth hypothesis under this category on the other hand examined the effect of age differences in the performance of children on the conservation of number. It was hypothesised that “older children were more likely to perform better in Task 4 than younger children”. A Chi Square Goodness of Fit Test with one degree of freedom (*df*) revealed that this hypothesis was as well not significant, [$\chi^2 (1) = 1.476, \rho = 0.224$]. According to the results, there is no significant difference in the performance of older and younger children on the performance of the conservation of substance amount. Figure 12 shows a scatter plot of age and Task 4.

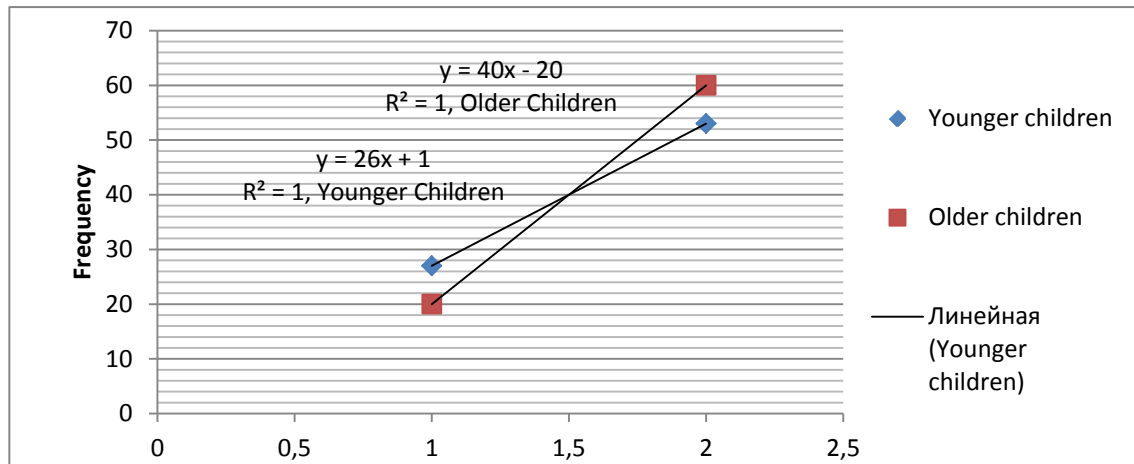


Fig. 12. Scatter Plot of Age and Task 4

A summary of the results reveal that:

- No significant relationships were found between performance of Piagetian conservation tasks and geographical location.
- No significant differences exist between the performance of males and females on Piagetian conservation tasks.
- No significant differences existed between age performances of Piagetian conservation tasks except the conservation of liquid.

Our work has the following novelties:

- For the first time in the performance of Piagetian conservation studies, Ghanaian children have been examined with local and familiar materials.
- We have experimentally analysed how gender, age, and geographical locations consecutively influence children's performance on four conservation tasks.
- We also examined the relationship between choice of answers given by children and their rationale for choosing such options using content analysis.

Discussion

Piaget's term for children's inconsistency in thinking within a developmental stage; explains why, for instance, children do not learn conservation tasks about numbers and volume at the same time. There were no significant differences in the performance of rural and urban children on Piagetian conservation tasks in this current study. This is quite different from the well-known assumption that geographical location during childhood is very extrapolative on consequences like health, cognitive development, and academic achievement (Adler, & Rehkopf, 2008; Merikangas et al., 2010; Shanahan, Copeland, Costello, & Angold).

A possible explanation for this inconsistency could possibly be as a result of the same teaching methods both schools uses under the auspices of the Ghana Education Services. Nonetheless, there was an evident lack of suitable materials and facilities in Nsakina M/A Primary as compared to the University Primary School. Also, the performance of rural and urban children being almost the same could be due to the social learning that precedes development and thus highlight the role of culture, social factors and language on cognitive development (Vygotsky, 1978). Consequently, no single principle for example Piaget's equilibration can justify for holistic cognitive development. There are complex interactions with an individual development framework that cannot be understood without reference to the social and cultural context within which the development is set in (Baucal, & Stepanović, 2006).

There were no significant differences in the performance of male and female children on Piagetian conservation tasks. These findings are consistent with those of Heron and Simonsson (1969) which found no significant difference in the conservation performance between male and

female children. The acquisition of conservation is developmental and as proposed by Piaget, both males and females pass through the same stages of development.

The results also showed no significant difference in the performance of older and younger children on Piagetian conservation tasks except the conservation of liquid in a glass. These findings are consistent with the results of McGarrigle and Donaldson (1974). They found out that children can conserve even at a younger age than that proposed by Piaget. This study suggests that, Piaget's design prevented the children from showing that they can conserve at a younger age than he claimed. However, the older children performed better than younger children in the conservation of liquid in a glass possibly because they might have had more familiarity with the properties of liquids as compared to the younger children.

The results of the content analysis which summarises the reasons participants gave for their choice of answers made clear that, it is highly improbable that children's responses in various conservation situations were channelled by a single generalised mental structure. Relatively, there seems to appear several diverse logical concepts, which come into operation depending on the task characteristics. Superficially, these operations are not so closely connected and integrated into an all-inclusive cognitive structure as Piaget's theory neglects (Baucal, & Stepanović, 2006; Wolfgang, 1974).

Limitations

This study only measured children on quantities rather than perceptual comparisons (Roazzi, & Bryant, 1997). In addition, the study failed to assess whether performance on conservation tasks directly impact on formal academic achievement. Nonetheless, this study has implications for future studies in the area of psychology, pedagogy and developmental researches.

Recommendations

Based on the outcome and limitations of the study, we recommend that both quantities and perceptual comparisons should be employed to explore deeper into cognitive development. Also, an accompanying neuropsychological investigation in conjunction with the study of conservation among Ghanaian children will assist in making valuable contributions. Finally, future studies may explore further into the relationship between children's performance on conservation tasks and formal academic achievement.

Conclusion

The study examined the influence of geographical location, gender and age on the performance of Piagetian Conservation tasks. Notwithstanding the conflicting findings by some previous studies, results from our study indicated that there were no significant relationships between the performance of Piagetian conservation tasks and geographical location. In addition, gender and age differences did not have any significant effect on Piagetian conservation tasks. The only unique case was with the conservation of liquid in a glass as older children performed better than younger children. We also hope that this research will in due course have implications on future studies in Ghana and beyond.

Conflict of Interest Statement

The authors declare that they do not have any conflict of interest.

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