THE DEVELOPMENT OF FORMAL THINKING

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Abstract

In the current study we have investigated the development of logical and mathematical reasoning among mature population, following Piaget's theory of cognitive development. The purpose of the present study is examining if continued biological development and/or continued accumulation of life experience, learning and education can develop into formal operation. The findings indicate that, only about 25% of the population moves to the formal operational stage, and this is before the age of 20. Furthermore, learning was affected by domain specificity. Our findings show that about one fifth of illiterate population have the ability of performing formal thinking. This percentage is close to that of literate population thus suggesting that development of formal operation is regulated innately.

Keywords: *Cognitive development, concrete thinking, formal thinking, education, mathematical reasoning.*

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1. Introduction and Aims

The present paper is based on the theory of stages by Piaget and Inhaler (Inhaler & Piaget, 1969; Piaget, 1972) which deal with the cognitive development of students in their transition from the concrete operational stage into the formal one. According to Piaget, the course of development is linear and continuous. The stages of the cognitive development are universal.

Shayer & Adey's (1981) study of the cognitive levels, which included 12,000 students from junior and high schools in England, found that only about 30% of students are in the formal operational stage, while 70% of students are at the concrete level of thinking. These findings show that not all junior and high school students reach the formal level of thinking as expected by Piaget's developmental theory.

The research also found a gap between the requirements of the curriculum and the level of development, which can explain the learning difficulties and the low achievements among students in subjects that require abstract thinking.

While Piaget focused on the cognitive development of the individual, a series of extensive studies, which were conducted around the world and examined the distribution of the cognitive levels within a population of junior and high school students, found that cognitive development attains a universal pattern until the end of the concrete operational stage at the age 12. After that, a section of the population does not continue with the normative development with the timeline and so the cognitive development stopped at the concrete stage. (Alon, 2003; Herbst, 2006; Iqbal and Shyer, 2000, Green, 1983; Shaye & Adey, 1981; Engler and Bond, 2001).

At the basis of this research lies the following question: does the section of the population who could not reach the formal thinking until the age of 17 develops this ability at in older age? If so, then this means postponing the cognitive maturation to a later age. If the answer is no, then what is the role of all the learning and the experience acquired during the entire life?

In the current study we have investigated the development of logical and mathematical reasoning among a mature sample following Piaget's theory of cognitive development. The purpose of the present study is examining if continued biological development (the increase in age) and/or continued accumulation of life experience, learning and education can develop thinking that contributes to the transition to the stage of formal operational thinking.

Our research tested the following questions:

1. Does cognitive development continuous during adult life?
2. Is Cognition driven by general intelligence or by modularity of the mind (Domain's specificity)?
3. What drive cognitive development – schooling, genetics or both?
4. Does illiteracy prevent transformation to formal thinking?

2. Method

The present research is based on two populations: The first consists of one thousand literate subjects, aged between 18-76 (M= 39). The sample is heterogeneous in terms of culture, gender, education and age. the second consists of one hundred and three illiterate adults.

For data collection purposes, we used a quantitative-correlative layout to examine the cognitive level according to Piaget's cognitive theory and to understand the functional relationships between the cognitive level and other background variables.

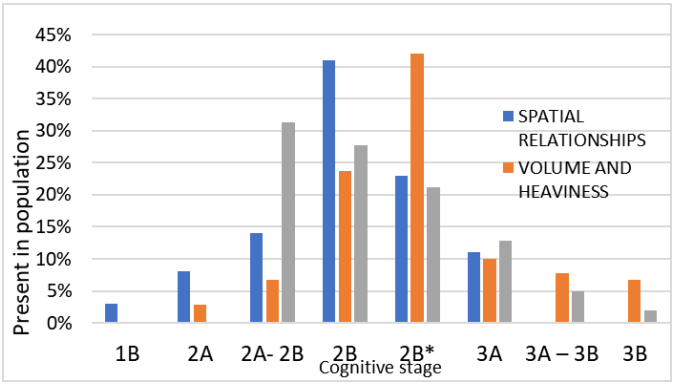
We used a series of three tests developed by "Mathematics and Science Perceptions in High School" at Chelsea College, University of London, between 1973 and 1978. We received the tests directly from Prof. Shayer, with guidance and counseling in regard to the processing of the data. These tests were validated and adapted to fit the norms of the population in the U.K.

3. Findings and discussion

Our findings show that during the long period of adult life (20-70 y) there was no further cognitive development. Only about 25% of the population moves to the formal operational stage, and this is before the age of 20. Culture, sex, and age had no significant effect on the distribution of cognitive levels within the population studied. The very nature of the distribution of cognitive development within the literate population indicate a polygenic model of control.

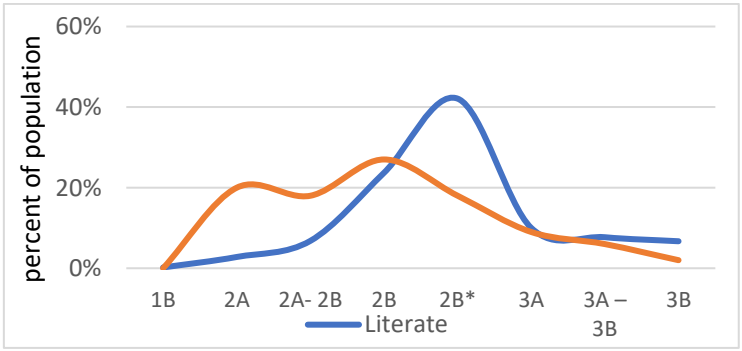
On the other hand, Domain specificity did change the distribution of cognitive functioning, both in the literate and the illiteracy populations. This finding support Fodor's modularity model and the Core knowledge model of Spelke and Carey rather than the kovas – Plomin general intelligence model of information processing.

Figure 1. The distribution of cognitive levels in three domains.



The findings show that about one fifth of illiterate population have the ability of performing formal thinking. This percentage is close to that of literate population. This finding presumably affirms the dominance of the genetic factor in cognitive development and refutes the assumption that illiteracy means ignorance. It can be argued that people, who attain the formal stage through the mediation of the school, have the inherited basis and the cognitive tools necessary for the development of formal operations. However, we also found that school contributes significantly to transferring most of the students to the end of the concrete stage, but not beyond it.

Figure 2. The distribution of cognitive levels in of both the literate and illiterate groups.



We therefore suggest distinguishing between cognitive development and cognitive growth. The cognitive development is universally regulated intrinsically by the genome (Innately) and thus cannot be "accelerated". Cognitive growth, however, is the product of learning and is continues in time. It is the kind of knowledge acquired that is constrained by the developmental stage and the specific modules that were differentiated.

On the basis of our findings, we suggest a working model of the genetic regulation of cognitive development. In this model the first three stages from sensorimotor to concrete, are under the control of a single QTL, as all the population complete its maturation of this development phase. The third and fourth stages (FPF) are under a separate QTL present only in a third of the population.

This model is subject to further research.

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