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Does Cognition Continue to Develop Throughout Life?

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ABSTRACT

Piaget's theory of cognitive development defines the successive and universal developmental stages of the cognitive system. The order of the stages is fixed and extends from birth to the end of adolescence. 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 current study examines whether continued biological development (the increase in age) and continued accumulation of life experience, learning and education can develop thinking that contributes to the transition to the stage of formal operational thinking. The sample consisted of 1,000 adults aged between 18 and 76. The main conclusion of these results is that the process of cognitive development is driven primarily by an innate factor. The current study's findings suggest that SPC (Sensorimotor, Preoperational and Concrete) and FPF (Formal and Post Formal) control the development of cognitive thinking and that they need further study at the molecular biology level.

Keywords: Cognitive development, Concrete thinking, Formal thinking, Education, and Mathematical reasoning.

INTRODUCTION:

The development of thinking is the increase in a person's ability to think, consider, understand, draw conclusions and solve problems. It includes the development of cognitive traits. These mental abilities guide the thinking process through which the person articulates his thoughts and interacts with the environment. The current paper is based on the theory of stages by Piaget and Inhelder, (1969) which deals with students' cognitive development in their transition from the concrete operational stage into the formal one (Inhelder & Piaget, 1969). According to Piaget, (1972) the development course is linear and continuous (Piaget, 1972). The stages of cognitive development are universal - shared by children of all cultures with qualitative and interpersonal differences during each stage. Piaget, (2014) also mentions high thinking schemes such as probabilistic thinking, equilibrium, proportion, isolation and control of variables, which develop with the progression of the cognitive level and maturate in the formal operational stage (Piaget & Inhelder, 2014). Hence, the ability of the student to apply those high thinking schemes, as those required for "scientific thinking," depends on the student's age. The theory of cognitive development with its stages is considered a universal theory, valid for the entire population. 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% are students at the concrete level of thinking (Shayer & Adey, 1981; Bonna, 2021).

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 as well as the cognitive ability of students, which can explain the learning difficulties and the low achievements among students in subjects that require abstract thinking. The study used findings related to young learners and high school students as well as the classification of the concrete and formal stages of thinking to develop an intervention plan called "thinking science," which aims to accelerate cognitive development, which in turn will lead to an improvement in the academic achievement in science and other subjects (Adey & Shayer, 2011).

Green's, (1983) study, which includes 3,000 students aged 11-16 in East Midlands, England, showed that most students acquire the formal operational stage at 16 (Green, 1983). Several studies conducted in countries such as Australia, Pakistan and Israel have shown that the recent situation in Israel and the countries mentioned above is similar to that in the past. These studies show that less than 25% of ninth graders are at the formal level of thinking, while the vast majority of them are in the pre-formal stages of thinking (Endler & Bond, 2000; Huppert *et al.,* 2002; Iqbal & Shayer, 2000; Levitt-Dori, 2006). 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 has a universal pattern until the end of the concrete operational stage (Green, 1983; Habib, 2007; Herbst & Brach, 2006; Levitt-Dori, 2006; Shayer & Adey, 1981; Ojose, 2008). In other words, the population goes through all the stages ordinarily until the end of the concrete operational stage at the age of 12. After that, part of the population did not continue with the normative development on the timeline, so the cognitive development stopped at the concrete thinking stage. Only part of the population continues to develop and move to the formal operational stage. At the basis of this research lies the following question: Q. Does the fragment of the population who could only succeed in moving into formal thinking at the age of 17 develops this ability at an older age? If so, 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 life? The present study examined the distribution of cognitive levels among adult populations instead of studies that examined the distribution of cognitive levels among the youth population aged 12-17.

METHODOLOGY:

The sample consisted of 1000 adults from different strata of society. The research population is heterogeneous regarding gender, sector, education, age and occupation. The average age of the sample is 39. 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 three tests developed by "Mathematics and Science Perceptions in High School" at Chelsea College, University of London, between 1973 and 1978 (**Fig. 1**, **Fig. 2** & **Fig. 3**). We received the tests directly from Prof. Shire, with guidance and counseling regarding the transfer and the data processing. These tests were validated and adapted to fit the population's norms in the UK.

Table 1: Cognitive stages in three domains.

Cognitive stage	The Cognitive level	Percent of the total sample Test 1	Percent of the total sample Test 2	Percent of the total sample Test 3
	1B	3%	0.2%	
Early concrete	2A	8%	2.8%	**31.3%**
Mid concrete	2A- 2B	24%	6.8%	
Mature concrete	2B	41%	23.7%	**27.8%**
Concrete generalization	2B*	13%	42.1%	**21.2%**
Early formal	3A	11%	10%	**12.8%**
Mid formal	3A – 3B		7.7%	**4.9%**
Mature formal	3B		6.7%	**2%**
	Total	100%	100%	**100%**

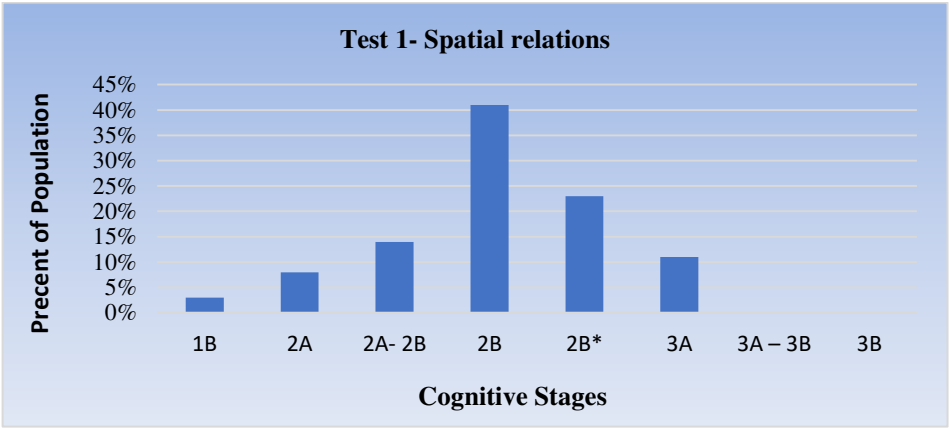

Fig. 1: Distribution of population frequencies by cognitive stages (Test 1).

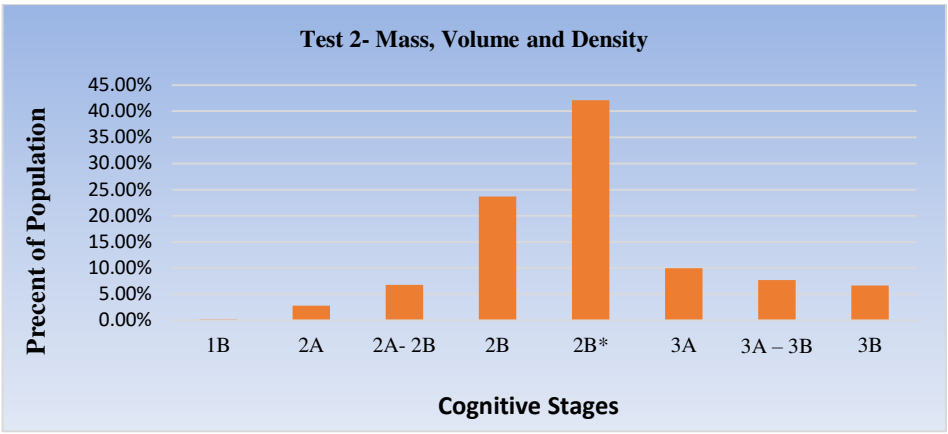

Fig. 2: Distribution of population frequencies by cognitive stages (Test 2).

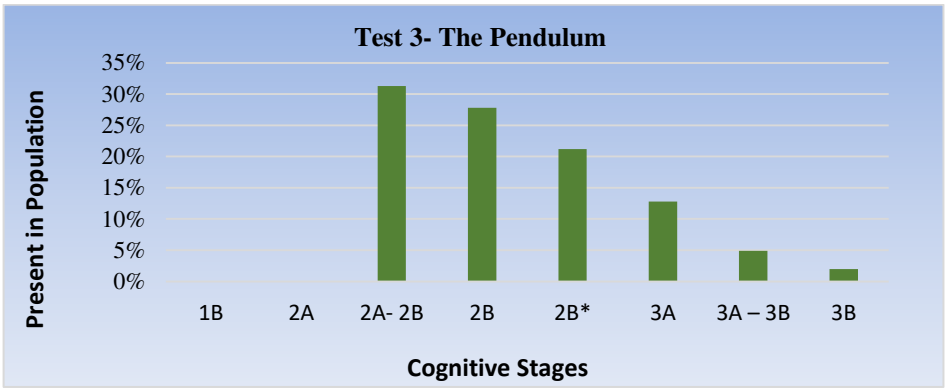

Fig. 3: Distribution of population frequencies by cognitive stages (Test 3).

The distribution of levels of thinking among the adult population is similar to that among junior and high school students, as reported in population studies conducted in Israel and abroad. The distribution remains stable even in adulthood. According to the current study's data, more than 75% of the subjects are at the transition stage and different stages of the concrete operational level in the three content fields. In other words, adding up to 50 years of education and life experience did not lead to further cognitive development processes. It did not promote most of the population toward the formal operational stage. This means the main control over cognitive development is in the individual's hereditary components. It can be concluded that cognitive development is stabilized at the end of junior high school and through high school. Age, life experience, and academic studies contribute little to the formal operational stage transition. This

finding may be an obstacle to achieving the goals of Cognitive Acceleration Projects and Programs. According to our findings, the ability to think did not develop during the school years beyond the concrete stage, and the education system failed to contribute significantly to raising the level of thinking for about two-thirds of the population. The interviewees' data are not involved in determining their level of thinking. This finding reinforces the universal significance of the hereditary factor. The environment, culture, age and sex do not significantly influence the individual's thinking ability. The main difference in cognitive development is interpersonal variance. Formal learning and education can be mediating factors in the learning process. They can significantly contribute to students' coping with the difficulties encountered during learning, yet they cannot develop mechanisms that facilitate the transition into the formal operational stage. The practical conclusion is to consider emphasizing the adaptation of learning environments to the concrete capacity of thinking alongside the attempts to produce cognitive acceleration. The prevailing perception in educational theory is that teaching and learning enable and create cognitive development. Many educational studies are based on this assumption. Many projects were implemented to promote students' general thinking skills to overcome their cognitive disabilities, such as programs for cognitive acceleration and various teaching and learning methods (explicit teaching, inquiry, constructivist learning). Despite all the efforts, the evaluation studies present a hard picture of the distribution of student achievements. The average number of student's entering the Science, Technology, Engineering and Mathematics (STEM) track remains low, and the variance in achievements in all science subjects is very high. However, there is a real possibility that the low number of students in STEM specialization may be related to their level of cognitive development. According to the findings of the current study and previous studies (Shayer & Adey, 1981), cognitive development is held among more than 70% of the population at the concrete operational stage at the age of 12-13, and only a small fraction moves to the formal operational stage. This can explain the difficulty many students experience when dealing with abstract topics. This possibility attributes a significant part of the student's difficulties to the biological-developmental factor, not the environmental one. The findings of the current study are in line with the findings of previous studies conducted in Israel and around the world. Those studies examined the cognitive level in adolescence in which- the percentage of students who existed in the formal operational stage was less than 30% (Habib, 2007; Herbst & Brach, 2006; Levitt-Dori, 2006; Ojose, 2008; Shayer & Adey, 1981). These studies do not fit Piaget's, (1971) theory of cognitive development, which assumes that all of the studied population was supposed to be in the formal operational stage. Many studies provide evidence for goal-oriented attempts to teach people to think. Intervention programs for developing thinking and cognitive acceleration were developed to raise achievements. The motive for these efforts is the widespread recognition that most need to take advantage of their brain potential. However, the idea that people can improve their thinking substantially and in the long term is controversial. There is no evidence that improvements in thinking are constant without interventions to refresh (Perkins & Grotzer, 1997). Jensen, (1983 & 1989) and Hernstein & Murray, (1994) evaluated intervention programs designed to influence IQ and thus improve human cognitive functioning. After conducting several studies, the researchers concluded that interventions usually have an effect of half a standard deviation or less and tend to improve test performance more than overall cognitive efficacy. Moreover, they also found that the effects of the interventions fade away within a few years, the so-called greenhouse effect (Herrnstein & Murray, 1994; Jensen, 1983, 1989). One of the problems in assessing the impact of intelligence instruction is the tendency in formal studies to focus on achievement in understanding the discipline's content and less on the general effect on the thinking process within or across disciplines (Perkins & Grotzer, 1997). The fact that only a small percentage of the population develops to the formal operational stage can explain the difficulties the majority of the student population has when dealing with subjects that require abstract thinking, such as mathematics, physics and chemistry. Although this issue has not been studied, it seems that such a problem exists concerning abstract concepts in the humanities and social sciences. This finding also indicates a discrepancy between

students' cognitive abilities and the curriculum requirements. Teachers who instruct their students to acquire research and problem-solving skills must be aware of the distribution of their students' thinking levels. Piaget stressed that the level of conflict or the size of the gap between the child's existing cognitive structure and the new information or the learning task could not be too large. If so, the child cannot cope with the conflict at all, which can only cause frustration and escape (Lavi, 1991). Proposal for a new model of cognitive development assuming that the hereditary factor is the main driving force of cognitive development, we propose the following model of inheritance-cognition relationships as an important component in the cognitive development processes. This model com-bines our findings with the relevant findings of behavioral heredity (Plomin *et al.,* 2008). We propose that two genetic control systems regulate the development of cognitive thinking. One is called the SPC (Sensorimotor, Preoperational and Concrete), a control system responsible for developing cognitive abilities in the first three stages of the individual's development. This system is found among the entire population (universal). The entire research population has reached the concrete thinking stage and acquired the cognitive abilities from previous stages. These features and capabilities appear in a regular order of times, depending on the cognitive level. The second system is called FPF (Formal and Post Formal). This control system is responsible for developing more complex, formal and post-formal thinking abilities. This control system is found in only a quarter of the population. In other words, formal and post-formal cognitive abilities are not universal. This study deals with the development of cognitive abilities called "Traits". Most behavioral features are complex (love, talk, thinking, etc.) and are controlled by a polygenic system (many genes that control one feature). Studies in molecular genetics indicate that there is a group of genes that control properties that are located in unknown chromosomes. This group is called Quantitative Trait Loci (QTL). This variable includes a genetic infor-mation unit without defining a specific gene or its chromosome location. From the findings of the current study and broad population studies, all people undergo three cognitive stages up to the age of 11-12 years (SPC). The stages are universal. Each stage is different from the rest and is controlled by a polygenic control system. According to Piaget, during the first three stages of development, the individual acquires up to 28 cognitive traits. Our theoretical assumption is that QTL1 inherits these traits. Only a quarter of the population develops features of abstract thinking FPF, controlled by a separate control system QTL2. In other words, the QTL2 genetic system is found only in a small part of the population (**Fig. 4**).

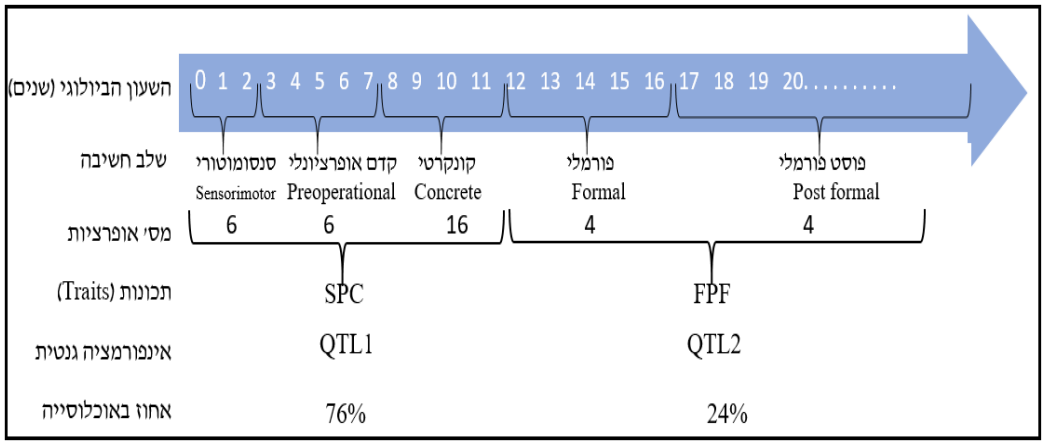

Fig 4: A theoretical model of genetic control over cognitive development.

Anthropologists have found that the beginning of the high culture arose with the invention of alphabetic writing about 600 BC (Goody, 1968; Havelock, 1986; Ong, 1982). The invention of the alphabet script brought formality and the development of science and philosophy, which have challenged the human thinking abilities that require operations. Three thousand years is a short period (Tomasello, 2009) for the classification and distribution of QTL2 (FPF) to the entire population. This is a theoretical hypothesis, but to

establish it, independent research is needed. From a different perspective, a considerable part of the studied population are graduates of higher education institutions. Some are teachers in the education system, and the rest work in various professions. According to the findings, more than 75% of them are at a concrete level of thinking. Their failure to acquire formal operations and their level of thinking did not prevent them from advancing in life and learning. In other words, they have advanced in various areas of life that do not necessarily require abstract thinking.

CONCLUSION:

Many studies attempted to teach people to think, and a series of intervention programs for thinking & cognitive acceleration development have been developed. Yet, the idea that people can significantly improve their thinking capacities in the long term remains controversial. Our research findings conclude that the entire population reaches the stage of concrete development according to Piaget's theory. Only about 25% continue to develop into the formal and post-formal stages. The distribution of thinking levels among the adult population is similar to that among junior and high school students. The contents studied must match the level of cognitive development of the learners. Most students in the education system are in the concrete stage of thinking, which creates learning problems in scientific and mathematical education. The cognitive development process is universal and is barely influenced by culture, age, and gender. The main difference in cognitive development is interpersonal. Programs for cognitive acceleration (thinking development) seem to work but have a small impact on the development of thinking. The main conclusion of these results is that the process of cognitive development is largely driven by an innate factor or, in other words, a hereditary factor. If it were the environmental factor, it would be impossible to explain how most of the population does not continue to develop throughout the life cycle.

Declarations

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Ethical Approval

Not applicable

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CONFLICTS OF INTEREST:

Authors do not have any conflict of interest. Author Contributions The authors have contributed to writing, designing, compiling and editing the final manuscript.

REFERENCES:

1) Adey, P., and Shayer, M. (2011). The effects of cognitive acceleration-and speculation about causes of these effects. AERA Research Conference, socializing intelligence through academic talk and dialogue. Learning, Research & Development Centre, University of Pittsburgh. https://www.letsthinkinenglish.org/wp-content/uploads/2012/06/TheEffectsofCognitiveAcceleration.pdf

2) Bonna S. (2021). The bad effects caused by policy prescription and financial assistance by IMF on developing countries, *Asian J. Soc. Sci. Leg. Stud.*, **3**(5), 172-177. https://doi.org/10.34104/ajssls.021.01720177

3) Endler, L. C., & Bond, T. (2000). Cognitive development in a secondary science setting. *Research in Science Education*, **30**, 403-416. https://link.springer.com/article/10.1007/BF02461559

4) Goody, J. (1968). Restricted literacy in northern Ghana. *Literacy in traditional societies*, 201.

5) Green, D. R. (1983). A survey of probability concepts in 3000 pupils aged 11-16 years. *Proceedings of the first international conference on teaching statistics*.

6) Habib, A. (2007). The effect of promoting the probabilistic reasoning scheme on how ninth-graders cope, with questions in genetics that require a probabilistic approach. Unpublished MA Thesis, Tel-Aviv University (in Hebrew).

7) Havelock, E. (1986). The alphabet as the creator of modern culture. Antigonish Review (66-67), 175-193.
8) Herbst, P., & Brach, (2006). Proving and doing proofs in high school geometry classes: What is it that is going on for students? *Cognition and Instruction*, **24**(1), 73-122. https://www.tandfonline.com/doi/abs/10.1207/s1532690xci2401_2
9) Herrnstein, R. J., & Murray, C. (1994). The bell curve. *Library Quarterly*, **66**(1), 89-91. http://pombo.free.fr/herrnsteinmurray1994.pdf
10) Huppert, J., Lomask, S. M., & Lazarowitz, R. (2002). Computer simulations in the high school: Students' cognitive stages, science process skills and academic achievement in microbiology. *International J. of Science Education*, **24**(8), 803-821. https://www.tandfonline.com/doi/abs/10.1080/09500690110049150
11) Inhelder, B., & Piaget, J. (1969). The early growth of logic in the child. Translated from French by Lunzer, EA and Papert, D. *In: New York: WW Norton & Company Inc*. https://doi.org/10.4324/9781315009667
12) Iqbal, H. M., & Shayer, M. (2000). Accelerating the development of formal thinking in Pakistan secondary school students: Achievement effects and professional development issues. *Journal of Research in Science Teaching: The Official J. of the National Association for Research in Science Teaching,* **37**(3), 259-274. https://onlinelibrary.wiley.com/doi/abs/10.1002/(SICI)1098-2736(200003)37:3%3C259::AID-TEA3%3E3.0.CO;2-W
13) Jensen, A. R. (1983). The nonmanipulable and effectively manipulable variables of education. *Education and Society*, **1**(1), 51-62.
14) JENSEN, A. R. (1989). A Review of the Milwaukee Project: Preventing Mental Retardation in Children at Risk. Developmental Review, **9**, 234-258.
15) Lavi, T. (1991). A renewed look at Piaget's theory and its implementation in education. *Planning Studies: A Reade*r, 135-163.
16) Levitt-Dori, T. (2006). The effect of promoting the variable isolation and control reasoning schema on the achievements of students in the teaching of the subject of enzymes in biology. Unpublished MA thesis, Tel-Aviv University (in Hebrew).
17) Ojose, B. (2008). Applying Piaget's theory of cognitive development to mathematics instruction. *The mathematics educator*, **18**(1). https://ojs01.galib.uga.edu/tme/article/view/1923
18) Ong, W. J. (1982). Orality and Literacy: The Technologizing of the Word. *Methuen & Company Limited*. https://monoskop.org/images/d/db/Ong_Walter_J_Orality_and_Literacy_2nd_ed.pdf
19) Perkins, D. N., & Grotzer, T. A. (1997). Teaching intelligence. American psychologist, **52**(10), 1125. https://psycnet.apa.org/doiLanding?doi=10.1037%2F0003-066X.52.10.1125
20) Piaget, J. (1972). The psychology of intelligence *Totowa. NJ: Littlefield, Adams*.
21) Piaget, J., & Inhelder, B. (2014). The origin of the idea of chance in children (psychology revivals). Psychology Press.
22) Plomin, R., DeFries, J. C., & McClearn, G. E. (2008). Behavioral genetics. Macmillan. https://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=16387
23) Shayer, M., & Adey, P. (1981). Towards a science of science teaching: Cognitive development & curriculum demand. *Heinemann Educational Publishers*. https://cir.nii.ac.jp/crid/1130282268952367104
24) Tomasello, M. (2009). The cultural origins of human cognition. *Harvard university press*, 256 pages.

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