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COGNITIVE DEVELOPMENT - CALL FOR A GENERAL INTELLIGENCE TOOL KIT OR A DOMAIN SPECIFICITY DEPENDENT

Abstract

The present study was designed to test whether knowledge content (domain) affects learning by studying cognitive distribution subjected to three domains: spatial relations, mass, volume and density, and conservation and isolation variables (length, weight, strength). Three different cognitive tests were included in the research method. The study was carried out on 1000 adults. The results show that learning was affected by domain specificity, thus supporting the innateness origins of traits suggested by the modularity theory of Fodor and the core knowledge findings of Spelke & Carey.

Keywords: *cognitive development, content domains, domain specificity, theory of Fodor, Core Knowledge theory*

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Koqnitiv inkişaf − ümumi intellekt alətləri dəsti və ya mövzu sahəsindən asılı olaraq sorğu

Xülasə

Hazırkı tədqiqat bilik məzmununun (domen) öyrənməyə təsir edib-etmədiyini yoxlamaq üçün nəzərdə tutulmuşdur ki, bu üç sahəyə tabe olan koqnitiv paylanmanı öyrənir: məkan əlaqələri, kütlə, həcm və sıxlıq, qorunma və izolyasiya dəyişənləri (uzunluq, çəki, güc). Tədqiqat metoduna üç fərqli koqnitiv test daxil edilmişdir. Tədqiqat 1000 böyüklər üzərində aparılıb. Nəticələr göstərir ki, öyrənmə sahənin spesifikliyindən təsirlənir, beləliklə, Fodorun modulyarlıq nəzəriyyəsi və Spelke & Carey-nin əsas bilik tapıntıları ilə təklif olunan xüsusiyyətlərin anadangəlmə mənşəyini dəstəkləyir.

Açar sözlər: *koqnitiv inkişaf, məzmun domenləri, domen spesifikliyi, Fodor nəzəriyyəsi, Əsas bilik nəzəriyyəsi*

Introduction

There exist controversies regarding the contribution of the content domain to cognition. In other words, is there any general intelligence that serves all content domains, or does intelligence have expertise in specific content domains? Various theories have emphasized the influence of specialized cognitive systems in different content domains. Carey and Spelke's 'Core Knowledge' theory (Carey & Spelke, 1996) and Fodor and Chomsky's 'The Descriptive Modularity' theory (Fodor, 1983) are very well known in this regard.

Core Knowledge Theory believes that children are born with innate cognitive mechanisms. Those mechanisms are seen as learning traits with evolutionary and survival value that help the children acquire valuable information concerning their environment. For example, a toddler has the tools for learning a language. In addition, a newborn toddler has the ability to distinguish between a living creature and a non-living one and also the ability to differentiate between human faces and inanimate objects or animals. These are traits that children are born with, which help them survive. These mechanisms develop and change while interacting with the environment, life experience and contradictory evidence (Gopnik et al., 1999).

Human beings have been given many systems for representing and concluding the different types of entities. Studies indicate at least four core knowledge systems: bodies, agents, numbers and space. For example, knowledge about physical objects applies to the behaviour of materials and bodies. Knowledge of agents applies to the actions of people and animals. Those specific knowledge systems allow babies to solve a series of immediate and urgent problems without examining possible solutions in the larger space. The importance of core knowledge systems stems from the fact that they already exist in infancy, function in the intuitive adults' way of thinking and continue to influence scientists' thinking later on. Relating to the children's perception of knowledge could lead to a conceptual change in the cognitive research of knowledge (Carey & Spelke, 1996). Kinzler & Spelke (2007) add that these four knowledge systems are used to display entities in the real world (inanimate objects) as well as more abstract entities (numbers and geometric shapes) (Kinzler & Spelke, 2007). Moreover, human thought might also be based on a fifth system for representing social partners and classifying the social world. Infants begin their life with a primitive physical theory in regard to inanimate objects. This theory includes the knowledge that the world contains; the physical objects that occupy a place and move continually rather than jumping from one location to another as a response to external forces (Spelke, 2003). Spelke tested the mathematical ability among infants by carrying out a set of tasks. She found that two different systems of Core Knowledge work among babies: the first for representing and determining objects and the second for sets that represent the numeric values. Spelke concludes that the systems of core knowledge are (1) domain-specific (a system for representing objects and a system of representing sets), (2) task-specific (a system for numeration and a system for comparison) and (3) encapsulated (the situations that stimulate each system are different) (Spelke, 2000).

Fodor (1983), in The Modularity Theory of Mind, claims that cognition consists of separate components that function independently with interfaces between them or some of them (Fodor, 1983). The philosopher of the Modularity Theory is Fodor, Chomsky's student. According to this perspective, cognition is not a construct of mental processes that result from a cooperative activity of the general recognition mechanisms; rather, it consists of specific independent mechanisms. The argument concerning the existence of specific cognitive components does not mean that we can delimit each of them to a certain area in the brain. Their activities can engage and involve different areas of the brain. The Modularity hypothesis of recognition gained strong support in recent decades. For example, a person can suffer from serious cognitive and developmental disabilities and simultaneously speak and understand different languages without instructions. The human linguistic ability itself is also modular. It is composed of various systems that function independently, still with interfaces among them. Over half a century of research, the modularity of linguistic ability has gained significant confirmation (Smith & Tsimpli, 1995).

According to Fodor, the module is an innate cognitive ability (Coltheart, 1999). It is a mental "organ" that exists in the brain and has the unique expertise to process a particular type of information in a specific processing system. The brain has different modules: language, visualization, mathematics, and spatial perception. When a certain kind of information reaches the brain, it is processed by the module specialized for that type. The information is sent to the central processor that integrates the information. The modules are speedy, separated and intensive. Language, for example, exists in a separate module. Within this module, there are different linguistic modules (syntax, phonology, etc.). A child's thinking processing is based on stimuli from his environment, and the cognitive patterns generated during their development result from this initial processing (Fodor, 1983). Later, Fodor claimed that the modular capabilities answer some of the external concepts; otherwise, the brain has to develop thousands of modules that fit all possible types of content (Massive modularity) (Jerry, 2003). Undoubtedly, the Theory of Modularity gains serious support in Gopnic, Spelke and Carey's findings.

Methodology

The research tool included a series of three tests that examine the cognitive levels beginning from the pre-conceptual level till the late formal thinking level (Shayer & Adey, 1981). The tests deal with the following three domains: (1) spatial relationships (N= 203), (2) conservation of volume, mass and density (N= 1000) and (3) length, weight, strength and isolating of variables (N= 1000). The sample consisted of 1000 adults from different strata of society. The research population is heterogeneous in terms of 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 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. Shire, with guidance and counselling regarding the transfer and data processing. These tests were validated and adapted to fit the population's norms in the U.K.

Findings and Discussion

In the present study, we examined the effect of the content domain on the distribution of cognitive levels in the population studied. **Table 1** and **Fig. 1** depict the distribution of the cognitive levels in the three tests in column charts and continuous diagrams.

Table 1.
Distribution of the cognitive levels in the three domains

Cognitive stage	Cognitive stage	Domain A	Domain B	Domain C
Pre-operational	1B	3%	0.2%	
Early concrete	2A	8%	2.8%	
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	0%	7.7%	4.9%
Mature formal	3B	0%	6.7%	2%
	Total	100%	100%	100%

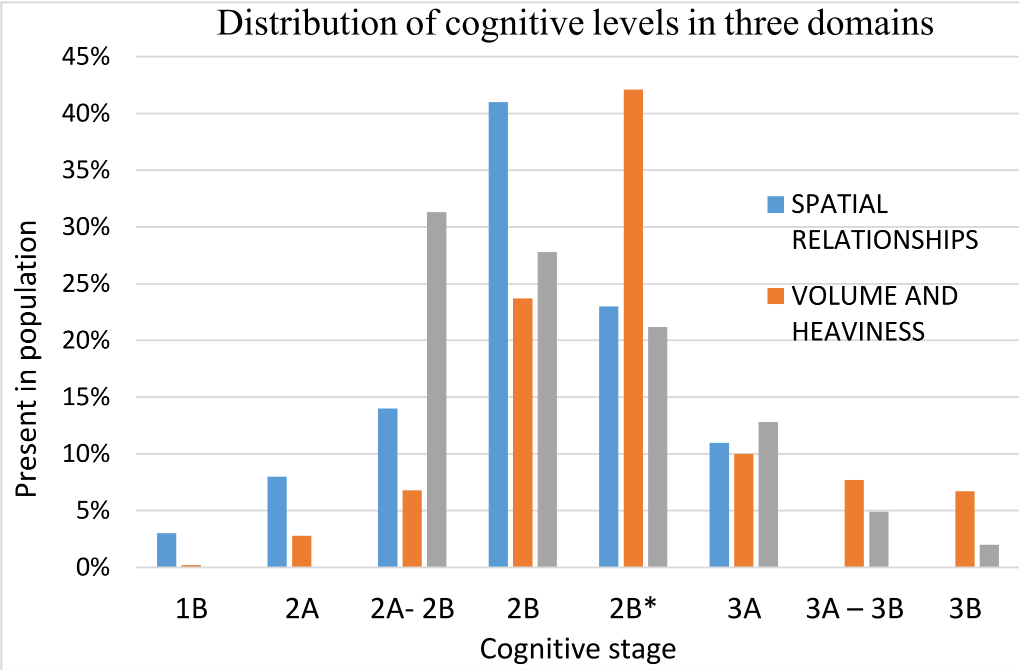

Fig. 1. Distribution of the cognitive levels in the three domains

It can be seen that most of the population piles up within the late concrete thinking stage and the transition stage; a small percentage (< 25 %) reaches formal thinking in the three tests. All three tests have shown a similar pattern of cognitive distribution, yet there was a gap and differences in achievements among the tests. The content area affected the functioning of the examinees and their achievements in the test. The participants solved the test that dealt with volume retention better than the tests that dealt with "spatial perception" and "pendulum." In all three tests, a large percentage of the population was at the end of the late concrete thinking stage and the transition phase to formal thinking. 44 % of the participants in Test 1 are at the late concrete thinking stage and in transition to the formal thinking stage. 66 % of the participants in Test 2 are at the late concrete thinking stage and in transition to the formal thinking stage. 49 % of the participants in Test 3 are at the late concrete thinking stage and transitioning to the formal thinking stage. Namely, many participants are at the end of the late concrete thinking stage and transitioning to the formal thinking stage. A small percentage of the participants, 11% in Test 1, 24 % in Test 2, and 19 % in Test 3, acquired formal operations and moved to formal thinking. The percentage of the participants who managed to transfer to formal thinking, in the three tests is 18%.

The answer to the research question is unequivocal: the content domain (Domain Specificity) contributes to the variance in the distribution of the cognitive levels of the participant population.

Zohar (1996) argues that instruction designed to develop thinking primarily teaches how to think and not what to think (Zohar, 1996). The research findings suggest that teaching content and levels of thinking are interrelated. The difference in the distribution of the cognitive levels among the three content domains and the gap in achievement and grades in all three tests indicate that the content domain and the learned subject influence the ability to think. That is, content has a major role in determining the distribution of cognitive levels.

The findings of the current research second the 'Modularity of the Mind' theory. This theory claims that cognition consists of separate components that function independently. Fodor argues that 'module' is the innate cognitive ability with the unique expertise to process a particular data type within a specific processing system (Fodor, 1983). According to this approach, cognition is not constructed of mental processes which are the result of a joint operation of the general recognition mechanisms, but rather it is constructed of specific independent mechanisms. The findings of the research indicate a significant variance in the distribution of the levels of thinking among the three content domains. Namely, the thinking ability of the participants depends on the content. According to the 'Modularity Theory,' while performing the test, the participants activated different internal modules depending on the content of the task. Although the second and the third tests dealt with a content domain that relates to science in two different subjects, there were gaps in the results and the achievements of the participants in both tests.

These findings negate the concept of one general intelligence factor that serves all content domains. This view argues that a positive relationship exists between all the intelligence tests a person carries and that one cognitive factor underlies the process of solving many problems.

Already Thurstone (1941) argues that intelligence is not a single, general capability but a series of independent primary abilities (Thurstone & Thurstone, 1941). A person can be more intelligent in a particular domain than in another. This argument supports the research findings when showing that the function of the subjects was not uniform in performing all tasks.

Core Knowledge is another theory that emphasizes the existence of basic knowledge systems that specialize in different domains. This theory believes that children are born with innate cognitive mechanisms which help them survive. Human beings have been awarded many systems for representing and reasoning (Carey & Spelke, 1996; Spelke, 2003).

Spelke (2000) claims that babies have at least four separate core systems, so each one is specialized in performing tasks in a specific domain (Spelke, 2000). These knowledge systems start in infancy and develop into intuitive thinking during childhood and adolescence (Carey & Spelke, 1996). Apparently, they affect the individual's behaviour and cognitive ability in older age. In the current research, the subjects' cognitive function was related to the task content. Kinzler & Spelke (2007) add that the four core knowledge systems present entities from both the concrete as well as abstract worlds (Kinzler & Spelke, 2007). Core knowledge systems seem to respond according to the content domain (Domain Specific) when people grow up, not only among infants. This study showed the importance of task content on the functioning of the subjects.

Conclusion

The modularity of the brain is an innate hereditary system. The surrounding cannot affect it, nor can we change it. It exists within the cognitive structures of the individual. There is an approach that strengthens the metaphor of the current study: there is a toolbox in the brain (operations), which is used to solve different problems. Up to the concrete stage, 36 toolboxes or operations were developed, which are responsible for solving problems such as classification, retention, ordering, connection, etc. At the formal reasoning stage, a group of operations called INRC is added to the toolbox, enabling abstract logical thinking and making combinations of operations for solving infinite problems.

'Modularity Theory,' the core knowledge and the metaphor of the "toolbox," indicates the effect of the learned content domain on the participants' way of performance and, later on, the distribution of the thinking levels within the population. A fact that exists within the scientific community is that scientists at the level of formal and post-formal stage level lead and specialize in specific content domains and not in all domains of knowledge. Nobel Prize is awarded according to the domain of expertise: physics, chemistry, physiology, medicine and literature. In other words, even those who reach higher levels of thinking have a special ability in a defined content domain and not all the domains.

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