

Vygotsky and Piaget: Scientific concepts

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Jean Piaget's so-called biological perspective is often paired with the viewpoint of Lev Vygotsky when we speak of learning in humans. Both authors acknowledged the active role of children in the construction of knowledge. However, they differ in that, unlike Piaget, Vygotsky believed that the assimilation of new information does not have to wait for an appropriate level of development but must, on the contrary, produce that development through instruction; thus, cooperation between teacher and student promotes the development of higher psychological functions. The present research presents proof that school instruction is instrumental in this process. Samples of adults who had acquired distinct levels of schooling (from illiterates to university students) are differentiated experimentally through the use of four Piagetian cognitive problem-solving tasks created for adolescents and adults. The present research suggests that instructional level is the distinctive factor in the development of those problem-solving capacities that implicate higher psychological functions.

Keywords: Vygotsky, Piaget, learning, development, scientific concepts

Introduction: Basic distinctions

Jean Piaget's perspective is often compared with Lev Vygotsky's because both authors acknowledged the active role of humans in the construction of knowledge. However, they differ in that, unlike Piaget, Vygotsky thought that the assimilation of new information does not have to wait for an appropriate level of development but must, on the contrary, produce that development: "The organization of scientific concepts in children constitutes an important practical problem for schools" (Vygotsky, 1934/2007, p. 222).

Piaget framed his cognitive theory in a biological context, repeatedly referring to his intellectual roots in Immanuel Kant's, C. H. Waddington's, and Henri Bergson's thoughts, as well as focusing on evolutionism and structuralism. He based his orientation and his psychogenetic theory on five principles: reason is rooted in action; it stands on two "a priori" mechanisms, adaptation and organization; reason is "pure" and nontemporal; structuralism is an independent concept.

Piaget seems to have been mostly interested in spontaneous concepts. In his research, he stated that the development of formal reasoning and scientific concepts depends on the experience of cognitive conflict, which promotes imbalance, thus forcing the emergence of successive new assimilations. The reorganization of thought then takes place naturally. This description of the development of higher mental functions has been designated nonhistorical in opposition to Vygotsky's "historical," or cultural, understanding.

Vygotsky's work was strongly influenced by Karl Marx and Friedrich Engels, by Charles Darwin's evolutionism, and by Spinoza's dynamic insights on universal development. Based on the ideas of these philosophers he defined the five distinctive principles that should orient epistemological research: psychology is the science of a historical human being; higher psychological processes originate in social action; there exist three distinct classes of mediators: signs/instruments, individual acts, and interpersonal relationships; specific functions as well as social reality emerge from transformational acts or work; there exists a fundamental unity between body and mind—that is, people are global beings.

According to Vygotsky, spontaneous and scientific conceptual structures both develop through continuous interaction between individual partners in an historical context and don't result from cognitive conflicts between two thought processes. In his view, spontaneous and scientific concepts belong to a dialectical unity and become organized together along opposite paths: spontaneous concepts proceed from the concrete to the abstract; scientific concepts, from the abstract to the concrete.

Spontaneous concepts are primarily inductive, nonsystematic, and based on perceptual attributes; they embody elementary aspects of experienced reality and are imbued with life and dynamics. In turn, scientific concepts, culturally formulated and transmitted, provide structure; they elevate the horizon of consciousness and its ponderings. Scientific concepts grow downward through the involvement of spontaneous concepts; spontaneous concepts grow upward through the use of scientific concepts. In Vygotsky's words:

By forcing its slow upward trajectory, an everyday concept paves the way for a scientific concept and its descendant development. It creates a series of structures necessary for the evolution of the most primitive and elementary aspects of a concept, giving it body and vitality. Scientific concepts, in turn, provide structures for the upward development of spontaneous concepts in relation to consciousness and deliberate use by the child. (1934/2003, pp. 93–94)

Thus, everyday concepts emerge from dealings with concrete situations: these concepts "are ontological, intuitive categories developed by each individual not counting on formal schooling. Consequently, they are nonsystematic, qualified by contextual situations, their associations being affected by concrete analogies or related to isolated generalizations" (Damazio, 2000, p. 54).

Pozo (2002), quoted by Schroeder (2007, p. 24), defines scientific concepts as distinct from everyday concepts in that three important features appear in their construction: they are part of a system; they are based on internalization of the es-

sence of the concept; and they are based on mental activity promoting awareness while involving a special relationship with the object. Scientific concepts, which are formulated and transmitted culturally, emerge in the context of theories of objects and relational systems that establish associations among themselves—that is, they constitute systems mediating human actions on phenomena.

Vygotsky considered that children operate spontaneously with everyday concepts because attention is always directed toward the object. In turn, scientific concepts involve a mediated attitude of the subject in relation to its object, creating structures for an upward movement of everyday concepts. The formation of a conceptual system based on reciprocal generalizing relations points them out as arbitrary concepts: “Scientific concepts are gates through which awareness penetrates the realm of childhood concepts” (Vygotsky, Luria, & Leontiev, 1944/2001, p. 68). Thus, one may say that, according to Vygotskian reasoning, systematic cooperation between teacher and student provides the development of higher psychological functions and consequent intellectual development.

When applying everyday concepts alone, individuals apprehend only immediate reality. When they acquire the use of scientific concepts, they capture the world, understand the dynamics of human achievement prospectively and retrospectively. In Vygotsky’s words:

Only when a spontaneous concept has reached a certain level can the child absorb a related scientific concept. For example, the historical concepts can begin to develop only when the everyday concepts that the child has of the past are sufficiently differentiated—when their own life and the lives of those who surround it can adapt to the elemental generalization “before and now”; their geographical and sociological concepts must be developed going from the simple format “here and in another place.” (1934/2003, p. 93)

In Vygotsky’s view, the effective learning of a scientific concept then gives people deliberate choices and the ability to justify them; having internalized the concept, they are able to reflect on the rules involved: “The issue lies just there because development consists in this progressive awareness of the concepts and the operations of thought” (1934/2007, p. 279).

Scientific concepts don’t emerge directly from everyday concepts, but as Castorina, Ferreiro, Lerner & de Oliveira (1990, p. 5) underline, teachers introduce them explicitly in schools. Systematic cooperation between teacher and student allows the development of higher psychological functions and consequent intellectual development. Thus, it is my contention that adequate schools are essential mediators of culture, not only as transmitters of information but essentially as the social context in which the dialectical regulation between empirical and scientific concepts becomes shared between students and their teachers in the common ground of learning.

The concept *zone of proximal development* defines the terrain of constant psychosocial transformation. “The modification of the functional structure of consciousness is what constitutes the central and fundamental content of the whole process of psychological development” (Vygotsky, 1934/2007, p. 285).

This concept introduces the role of the teacher in provoking progress in students; progress is not a random happening in educational performance but is to be understood as an area of action exchange with students because, from the beginning, human nature is essentially social: it emerges and evolves through multiple practical interactions.

In summary, in Vygotsky's reasoning, the whole of human development relies on appropriation and enactment of competencies found in this context and is always related to the time and the historical conditions experienced by the social group and by humanity. Consequently, according to him, good teaching places itself one step ahead of spontaneous development, pointing the student toward activities that promote scientific reasoning.

Language occupies a central position in social processes. Appropriating the meanings conveyed by language (and not only the physical instruments built by people throughout history), the individual grasps the available knowledge in a cultural framework and builds on it. Precisely in this double aspect of language—as a tool of thought and of communication—lies its potential for promoting learning processes through exchanges among children, among children and adults, or among adults; these processes are important ingredients in cultural differentiation and social progress.

Method

Experimental procedure

Participants

The present research submitted to four rigorous tests Piaget's psychogenetic theory of the inherent relationship between spontaneous and scientific concepts as compared with Vygotsky's theory of the sociohistorical dynamics of empirical and scientific structures of thought (each test is described briefly for the present purpose). The intention was to be able to discriminate levels of cognitive development in populations with distinct levels of schooling.

Method

The following hypotheses were clarified using Piaget's "clinical experimental method":

- H1: The subjects' responses will vary in accordance with their degree of instruction (thus proving the Vygotskian proposition).
- H2: The subjects' responses will *not* vary in accordance with their degree of instruction (thus disproving the Vygotskian proposition).

We chose five distinct groups of adults (ages ranging between 34 and 45 years): 16 illiterate subjects; 16 subjects who had just completed elementary school; 16 subjects registered in 9th-year secondary school; 16 subjects registered in 12th-year secondary school; 16 subjects registered as university students (a "conveniency" sample of 80 subjects). All responses were registered and later submitted to analysis.

Test 1: Class inclusion

A test intending to distinguish class inclusion and hierarchical class was created initially by Piaget and Szeminska (1941) and was described in 1959 by Piaget and Inhelder (1966/1986). The aim was to determine the subject's understanding of class extension and to verify the reversibility of preoperational thought as well as its mobility—in the sense of accepting that, once a certain act is executed, it is always possible to revert to a starting point. To this end, each subject was presented with a bunch of flowers (four roses and two buttercups) and asked whether there were more buttercups, more roses, or the same number of each. This test is based on the original questioning by Piaget (Piaget & Szeminski, 1941), using wooden beads. To verify the degree of (logical) necessity that is attributed by the subjects to their knowledge of what is being inquired about, the experimenter uses counter-suggestion, confronting the subjects with a different point of view and even with other reasoning: “Look, yesterday, another person said to me that the bunch of flowers became bigger. Do you agree with that person?” The intent is to establish whether subjects change their outlook or maintain it even if they are mistaken. Reversibility equally refers to the conservation of all subclasses when the subject is required to compare one subclass to a more extended class: “Let's imagine that two people are standing beside me; this person on this side is going to make a bunch of roses, and that one on that side will make a bunch of buttercups. Which bunch became bigger? The bunch of roses or the bunch of buttercups?”

The criteria for the classification of responses were:

Level 1: Does not seem to grasp the critical question.

Level 2: Does not quantify “inclusion”; not capable of using a scientific concept.

Level 3: Maintains “some” alternating with “all.”

Level 4: Quantifies “inclusion” only in the second part of the test.

Level 5: Responds correctly every time.

The results, presented in Table 1, show that the test differentiates populations according to their level of literacy (although an unexpected exception appears in the Illiterate sample).

Table 1. Results for test of class inclusion

Level	Test 1				
	1	2	3	4	5
Illiterate	1	11	2		2
4th year		5	4	6	1
9th year		1	4	7	4
12th year			1	8	7
University			1	4	11

Test 2: *Transference of elements between wholes*

Piaget classified preoperational intelligence as incapable of constructing the concept of negation, although this characteristic is mentioned in a systematic fashion only in the last phase of his work (Piaget, Meylan, & Bovet, 1974/1977). The task centers on differentiating the format of perception and the subject’s ability to understand the inverse of certain transformations. Putting in front of the subject two equal sets of chips with a barrier separating them, the experimenter asks the subject to give a chip to an observer and to say how many more the observer has now than the subject has and to explain why. If the response is correct, the procedure is repeated without the barrier and a justification is asked for anew, with countersuggestions added.

The criteria for the classification of responses were:

- Level 1: Does not seem to grasp the critical question.
- Level 2: Understands the critical question, but is not capable of constructing negation.
- Level 3: Does not predict at first but ends up doing so by orienting by means of perception.
- Level 4: Predicts specifically through coordinating empirical statements with negation.
- Level 5: Predicts and justifies conclusions adequately.

The results, presented in Table 2, show that the test differentiates distinct populations according to their level of schooling.

Table 2. Results for test for transferring elements between wholes

Level	Test 2				
	1	2	3	4	5
Illiterate	3	7	4	1	1
4th year		10	4	1	1
9th year		5	2	4	5
12th year		3	6	3	4
University		1	1	5	9

Test 3: *Pendulum task*

The pendulum task emerges in Inhelder’s and Piaget’s (1958) research between 1955 and 1958. They intended to clarify adolescents’ formal-operational thought and aimed at evaluating subjects’ competence in determining and isolating factors conditioning the frequency of the oscillation of a pendulum. To that end, the experimenters, taking into consideration the various alternatives, hypothetical pos-

sibilities, and logical deductions leading back from manipulations of the material, evaluated formal operations as executed by the subjects.

Each subject was shown how to construct a pendulum (a small object hanging from a string) and then was asked whether changing the length of the string or changing the weight of the object would make the pendulum oscillate faster. The subject was given time to experiment and was supported with questions of the type: "What are you trying to understand now?" "In what way can it oscillate faster?" "What did you discover about the weight?"

In the replication of this experiment in the present research, the criteria for the classification of responses were:

- Level 1: Does not seem to grasp the critical question.
- Level 2: Is unreflective when intending a rational understanding or explanation.
- Level 3: Searches for practical laws but cannot find them; justifies this failure or gives practical examples from perceptual experience. Does not provide any verification.
- Level 4: Searches for practical laws and criticizes experience; is still unable to dissociate factors and thus is unable to find a systematic procedure for discovering the solution.
- Level 5: Constructs experimental techniques, working through all the factors; scrutinizes facts a posteriori, seemingly intending to find proof for reasoning.

The results, presented in Table 3, show that the test differentiates distinct populations according to their level of schooling.

Table 3. Results of pendulum task

Level	Test 3				
	1	2	3	4	5
Illiterate		5	11		
4th year		6	7	3	
9th year		1	4	11	
12th year			1	14	1
University			1	14	1

Test 4: *The possible and the necessary*

Starting from Piaget's (1981) original task relating to the "possible lines of travel of a car" when trying to understand a subject's concrete operational evaluation of the real, the possible, and the necessary, this test aims at understanding whether the

concept of the possible is an extension of the perception of reality or if it originates in a mix of conceived virtualities in which the seen and otherwise apprehended are but one of its possible forms.

Subjects are asked to indicate how many routes can be taken to arrive at a lake. The experimenter is trying to establish whether the subjects initially consider several possibilities at the same time or whether they proceed by successive trial and error and only afterward try to analyze those trials. The experimenter also tries to determine whether the subjects rapidly arrive at an indefinite number of co-possible solutions or whether they reduce the trials to a modest number. To make this analysis easier, concrete objects are used, like a small figure to represent the subject and a miniature to represent the lake. At all times, justification of procedures is required of the subjects.

The criteria for the classification of responses were:

- Level 1: Does not seem to grasp the critical question.
- Level 2: Gives responses extending from 1 to 100 possibilities.
- Level 3: Gives responses extending from 100 to 10,000 possibilities.
- Level 4: Gives responses extending from 10,000 to infinite possibilities.
- Level 5: Gives an immediate response and justifies infinite extension.

The results, presented in Table 4, show that the test differentiates distinct populations according to their level of schooling.

Table 4. Results of test of the possible and the necessary

Level	Test 4				
	1	2	3	4	5
Illiterate		15		1	
4th year		12		3	1
9th year		4	5	4	3
12th year		4	1	6	5
University			2	7	7

Results

Summarizing results, one can see that the selected tests confirm the hypothesis that subjects' levels of cognitive responses vary in accordance with their degree of instruction—that is, on the whole, one may observe a gradual increase in efficacy accompanying increasing levels of schooling. As the complexity of the tasks increases, the difference between the results presented by groups that received more rather than fewer schooling opportunities become larger.

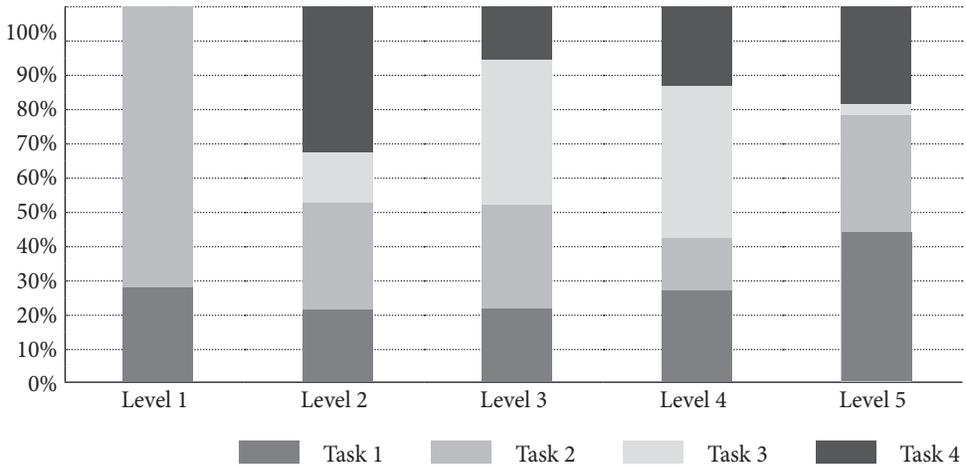


Figure 1. Variation in the levels of cognitive responses

Isolated contradictory results found in several groups may be attributed to ignorance of the empirical matter or even to impulsivity.

Conclusion

The research here presented does not attempt to point out all possible matches and mismatches between Piaget and Vygotsky in respect to developmental processes and learning. It rather intends to show that the two authors developed fundamentally divergent readings of some of these phenomena. According to Piaget's theory, the development of intelligence is at first essentially sensorimotor and individual; it advances slowly and is gradually formalized. The constitution of forms of thought (psychogenesis) is independent of historical transformations or contextual variations.

Although Piaget considered the ceaseless activity of the subject as the dynamics of intelligence, Vygotsky saw the relationship between practical action and the symbolic thought of the child as the key to understanding the genesis of higher psychological functions as they occur in ongoing development. Devoted entirely to the subject and concerned with the construction of logical reasoning, Piaget did not deepen the discussions about the human and social world with which the child interacts and on which the child depends. According to Piaget, because they possess a self-regulatory mechanism, cognitive structures ensure auto maintenance and hence the cognitive system. Thus, mental development is oriented toward ensuring the proper maintenance of cognitive structures. This orientation emphasizes a secondary aspect attributed to historical context by Piaget: cognitive structure tends to preserve itself, whatever the context in which it is found.

Vygotsky was interested mainly in demonstrating that the development of higher mental functions is related mainly not to biological laws but to social laws, and therefore is historical. The whole development of people, with their typical capabilities, depended (and depends) on their appropriations and objectifications, which are always related to the time and the conditions experienced in sociohis-

torical circumstances by the social group and by humanity. It is understood that human nature is, from the beginning, essentially social in as much as it emerges and develops from work and from human beings.

According to Vygotsky, development and learning condition each other: people are constructed and evolve as they interact socially, appropriating and re-creating the culture developed by earlier generations. People and society make up a whole, and dialectical movement produces learning and development. It is a unity in which the two poles complement and influence each other through social and historical interactions among people and between them and nature.

When studying the results of the performance of the five different sample groups on Piagetian problem-solving tasks and confirming that their responses seemed to vary according to levels of schooling, I was centered on making more visible the synthesis, or dialectic unity, between learning and development as found in consciousness.

The results of the experimental study and its interpretation point us to the genetic law of cultural development: the construction of consciousness, the highest reflection of reality, is entirely subordinated to the law of double development. This general law of psychology, proposed by Vygotsky (1929/2000), states that every psychological function appears twice in human experience: first in an interpsychological dimension and then in an intrapsychological format. In the interim, he defines higher psychological functions in their relations with lower psychological functions as being genetically, structurally, and functionally different.

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