

# Cognitive Psychology and Psychopedagogy

## Psicología Cognitiva y Psicopedagogía

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The aim of this article is to describe innovation in psychopedagogy as a consequence of the knowledge provided by cognitive psychology, which have fostered new strategies and psychopedagogical goals. The analysis of this cognitive evolution results from 80 years of research in developmental, clinical and educational psychology, along with research on school learning and learning difficulties. Contributions from cognitive psychology, neuropsychology and neuroimaging have affected this evolution. The key element of this innovation is to promote the development of children's metacognition in order to improve their academic performance and overcome their learning difficulties.

*Keywords:* cognitive psychology, neurosciences, psychopedagogy, metacognition, brain process

En este artículo se describe la innovación de la psicopedagogía como consecuencia de los conocimientos que le ha aportado la psicología cognitiva, que han originado nuevas estrategias y objetivos psicopedagógicos. El análisis de esta evolución cognitiva es resultado de 80 años de investigaciones en psicología infantil, clínica y educacional, acompañado de investigaciones sobre el aprendizaje escolar y las dificultades que presentan algunos niños para aprender. Los aportes de la psicología cognitiva, la neuropsicología y las neuroimágenes han tenido efecto en esta evolución. El elemento clave de esta innovación en la psicopedagogía es estimular en los niños el desarrollo de la metacognición para mejorar su rendimiento y superar sus dificultades para aprender.

*Palabras clave:* psicología cognitiva, neurociencias, psicopedagogía, metacognición, proceso cerebral

### School Psychopedagogy

Psychopedagogy was described by the French psychologist Pièron (1953) as a pedagogy scientifically based on the psychology of the child and Brito Aguilera (1983, p. 148) considers that the term *psychopedagogy* refers to "a convergent specialisation between psychology and pedagogy", whose concrete action consists, mainly, in the application of knowledge derived from both sciences to concrete problems that arise in the field of school learning. In Spain, Coll Salvador (1997) considered that psychopedagogy designates the applied and professional aspects of psychology in education. In Chile it has been defined as "the discipline that studies the nature and processes of human learning, formal and contextualised, and its alterations" (Careaga Medina, 1995, p. 145). This definition highlights as its first objective the study of *formal and contextualised learning* that takes place in schools and also *its alterations* or deficiencies in the *processes that sustain learning*, be they cognitive, affective, social and/or of the educational environment. For Careaga Medina (1995, p. 145) *the psycho-pedagogical fact* would have two fundamental pillars: the "evaluative investigation of the nature of the learning processes and their alterations, and the intervention in this process".

Psychopedagogy is thus considered as an educational discipline that intervenes in school learning processes. Its first objective is the study of the formal and contextualised learning that takes place in schools and also its alterations or deficiencies in the cognitive and verbal processes that sustain learning, considering its affective, social and/or educational environment aspects.

In the United States, a national conference on school learning disabilities in 1988 found that children with difficulties in learning language, reading, writing, reasoning, mathematical computation or social skills were found to have problems independent of their intellectual ability or IQ (Kavanagh & Truss, 1988). That study also ruled out mental retardation or socio-cultural deprivation as a major cause of school learning difficulties. A consequence of this conference was that many researchers focused their work on *learning disabilities* or neuropsychological developmental disorders, which made it difficult for children to learn, and appropriate cognitive methodologies for learning had to be developed.

In Chile they were called children with *specific learning disabilities* (Bravo Valdivieso & Pinto Guevara, 1984), to differentiate them from other schoolchildren with general learning problems. This specificity of the difficulties is characterised by the fact that it goes beyond standard teaching methodologies and requires the teacher to develop specialised psycho-pedagogical strategies to teach or help the pupils.

A contribution of clinical and educational psychology that underpinned the psycho-pedagogical work in Chile were several studies on the large number of children who were failing and repeating grades in basic schooling and their early drop-outs from public schools (Bravo & Morales, 1979-1980). These investigations showed that the origin of grade repetition and early school drop-outs, in most cases, was that children did not learn to read in the first two basic years. These results led to research on difficulties in learning written language and to the linking of psychology and education in the cognitive and verbal processes of school learning. This was later implemented with neuropsychological research.

A rigid behaviourist pedagogical strategy prevailed in primary education, with models of acceptance-rejection of pupils in knowledge tests or promotion-repetition of grades. In psychology, research was initiated to *monitor* pupils with learning difficulties.

### Follow-up Investigations

Research on the follow-up, over several years, of pupils with learning difficulties in reading or mathematics, belonging to schools of different socio-economic levels (SES) and their comparison, showed some determinants of the evolution of their performance and the origin of their failure (Bravo, 1972; Bravo et al., 1991; Orellana Etchevers & Bravo Valdivieso, 2006). In a first four-year longitudinal investigation, the same children were compared twice, two years apart, divided into four subgroups, two with reading delay and two normal readers. The groups were composed of middle SES children and two low SES groups of the same age, who were assessed with the same test (Wechsler Intelligence Scale for Children Revised -WISC-R-). The results showed that the processes that discriminated between children with reading delay and normal readers were different according to SES. Among children with and without reading delay in the middle SES, verbal, vocabulary and arithmetic tests discriminated significantly. In the low SES group, on the other hand, they discriminated between good and poor readers in the visual psychomotor tests of assembling figures, ordering pictures with stories and assembling figures with wooden cubes. These differences suggested that the low SES group of children with reading delay had lower performance in verbal and memory organisation and comprehension, which limited their cognitive ability to make associations between the graphic signs of writing and their meaning (Bravo et al., 1991). These results prompted new psycho-pedagogical teaching methodologies.

Consequently, psychopedagogy evolved as a branch of education that describes and determines pedagogical action on cognitive and verbal processes and took on a neuropsychological approach with pupils who had severe difficulties in their school learning, as was the case with dyslexias or dyscalculias. Over time, the scientific and methodological contributions applied by psycho-pedagogy have contributed to the development of new strategies and methodologies for teaching, assessment and diagnosis of children with learning and/or behavioural disorders at school. Such is the case of slow learners or students with mild intellectual retardation, hearing loss, visual, auditory or psychomotor impairments, language deficits, as well as dyslexia, dysgraphia and dyscalculia (Bravo, 2014, 2018).

The application of new psycho-pedagogical strategies has required work focused on the cognitive, verbal and thinking development of pupils from the perspective of cognitive psychology, psycholinguistics, genetic psychology and neuropsychology.

### Cognitive Neuropsychology and School Psychoeducation

Advances in cognitive neuropsychology provided school psychopedagogy with knowledge of the mental and verbal processes that children need to apply for learning written language and mathematics and their difficulties (Bravo, 2014; Dehaene, 2014; Goswami, 2013; Fletcher, 2009; Maluf & Sargiani 2013; Rumsey, 1996, Shaywitz & Shaywitz, 2008; Simos et al., 2007; Vellutino et al., 2004).

On neuropsychological processes in psychopedagogy, the French neuropsychologist Dehaene (2007/2014) expressed that children's learning of written language is progressively introduced in the brain, in the functional circuits of neurons through the visual and linguistic pathways.

The newborn brain already contains "the appropriate structures", adding that "by the time children enter school, infant brains are ready to recognise letters and words" (p. 198). There is an interface between biological evolution and cultural evolution through a reconversion of children's brain functions as a result of culture and language. In order to bring about this brain reconversion in the school learning of written language, it is necessary that they learn to make the association between visual graphic information and auditory phonological information. The key to this problem is: How do letters become phonemes and written language with meaning?.

Dehaene (2007/2014) investigated and described in detail the neuropsychological processes involved in learning written language and mathematics. Brain activity causes visually perceived words to acquire meaning *when they are pronounced* and establishes a direct relationship between visual orthographic recognition and their phonological expression. The recognition of phonemes and their association with orthographic signs culminates in the meaning of words, which is a metacognitive process. This is fundamental for psycho-pedagogy.

Dehaene (2007/2014) also considers that in the brain the superior region of the temporal lobe, known as the *planum temporale*, "is activated at the sight of a letter". This activation was observed in research carried out with functional magnetic resonance imaging, matching letters and phonemes. He states that when the child hears the sound of a letter he is seeing, "the activity of this region increases" (p. 151).

In other research, which he conducted together with a team of several researchers, he asked the question: Does reading or literacy instruction improve brain function? (Dehaene et al., 2010). To find an answer, they compared the brain activity of French-language illiterate adults with that of former illiterates and normal readers. They found a close correlation between brain architecture and some educational and cultural factors. They concluded that learning to read can modify neural connections and that in learning written language, brain activity supports phonological activity, which enables recognition of words and other languages. One neuropsychological effect of learning in children is the remodelling of some areas of their brain activity, which opens up access to understanding writing. The image of the processes taking place in the brain during this learning is that of a bridge, where words perceived visually acquire a verbal meaning when pronounced. Phonemes establish this bridge between the orthography of writing and spoken language, leading to an understanding of their meaning. This relationship is another fundamental contribution of neuropsychology to psycho-pedagogy.

In other neuropsychological research, Dehaene et al. (2010) were able to observe in neuroimaging how education had influenced the brain activity of adults, comparing illiterate adults with former illiterates and with normal reading learners. They confirmed that learning to read can modify brain activity and that one effect of the psycho-educational activity is to contribute to a remodelling of children's brains for written language comprehension. In English, Shaywitz et al. (2004) and Shaywitz and Shaywitz (2008) agreed with Dehaene that phonological intervention in reading instruction influences brain organisation in children aged six to nine years.

In addition, empirical evidence showing that phonological processes account for a large proportion of the variance in word decoding ability (Stanovich, 1982) confirms the cognitive phonological importance of learning to decode. Decoding has been defined as "the process of extracting sufficient information from written word units so that they activate the mental lexicon" (Bravo, 2002, p. 167) and acquire meaning.

Other neurocognitive research has confirmed that this psychoeducational work is crucial for children's brain development (Simos et al., 2007). Stern et al. (2005) also state that "the long process of human evolution is not destined for our brains to acquire school knowledge. They have been shaped over the past centuries by social needs and require school teaching methodologies to be in accordance with their genetic programming. In learning processes, the brain selectively activates certain regions, which determine the appropriate connections to more efficiently assimilate the information required in the teaching of written language" (p. 32).

Goswami (2020) considers that the brain uses electrochemical activity to represent knowledge, synchronising the neural activity of a set of cells across different areas, which correspond to cognitive activities, agreeing with Damasio (2010), who considered that to understand how the brain intervenes in learning it is necessary to investigate the synapses and connections between different regions, which undergo changes throughout childhood development. Each learning process, whether at home or at school, modifies the brain's connectivity, which is due to the brain's neuroplasticity.

These modifications came to constitute *an educational objective*, which brought neuropsychological and cognitive sciences closer to psycho-pedagogy. The brain undergoes a transformation with the psycho-pedagogical stimulation of meaningful learning for the child, which leads to new brain modifications as the child progresses in meta-knowledge.

Szűcs and Goswami (2007) defined the paradigm of *educational neuroscience* as "the combination of cognitive neuroscience and psychological methods for investigating the development of mental representations" (p. 114) and McCandliss (2010) stated that educational experiences play a central role in shaping functional brain circuits, which are the source of cognitive skills such as reading or mathematics, and neuroimaging has confirmed that in learning mathematics, modifications in brain development occur at a very early age, showing that children can already perceive quantitative differences from an early age. For this reason, successful learning does not only depend on children's successful application of pedagogical methodologies, but also on the development of implicit neurocognitive processes. School learning is no longer limited to the assimilation of a certain amount of content, but also to its association with previous knowledge and the development of the ability to think.

On the relationship between this learning and brain development, Frith (1988, p. 1011) posed a fundamental question for educational psychology: "Can culture make basic changes in brain anatomy through verbal development? She believes that the teaching of written language has a transformative effect on the mental processes underlying perception and the development of thought. Cognitive neuroscience is not intended to replace the pedagogical action of teaching, but rather to provide the teacher with a better understanding of what is happening in children's brains as they assimilate new knowledge. Fawcett and Nicolson (1994) and Szűcs and Goswami (2007) gave the name *educational neuroscience to the activity of the brain during the learning period*.

For Hruby and Goswami (2011), educational neuroscience opens up the possibility of interdisciplinary brain, cognitive and cultural integration, which is conducive to learning to read by investigating the brain activity of kindergarten children before and after they start learning to read. The same is true for learning mathematics.

It is therefore possible to consider that "neuroscience methods have broadened our understanding of the mind in a way that is highly relevant to educational practice" (Bravo, 2014, p. 18).

### **The Development of Metacognition**

The neural integration and cognitive construction that children achieve during learning with the executive functions of their brain is configured in *metacognition*. Metacognition has been defined as the degree of awareness that people have of their ways of thinking and their ability to control cognitive content and modify it according to their learning goals (Flavell, 1976, 1979). It is an advanced stage of thinking that gives greater breadth to mental processes and also to cultural content, so that as children advance in the school process, with metacognition they enrich their knowledge, increasing their oral and written language and calculation. In learning written language, metacognition involves the association and memorisation of orthographic signs, vocabulary and phonological awareness as ways of accessing meaning. In other words, metacognition is an extension of verbal thinking skills and has been, according to Martínez Velasco (2004), the most recent contribution of cognitive sciences.

Knowledge of neuropsychology and its association with cognitive psychology makes it possible to broaden psycho-pedagogical activity and orient it towards the relationships between brain activity, thinking and learning with the socio-cultural determinants of education (Bravo, 2014).

Neuroimaging of children observed in their first days of life has led to a better understanding of the variations in their brain activity as a result of environmental stimulation. Martínez Velasco (2004) expressed that, as a result, a "new cognitive architecture has originated based on the knowledge of how human brains can function" (p. 102). He considers that a contribution of cognitive neurosciences has been to investigate the way in which the basic processing units of brain neurons operate, which is modified as a result of development and the experience that mental learning produces. This progressive modification of brain activity as a consequence of learning and social experiences resulting from language acquisition is key to cognitive development (Vygotsky, 1995). Cognitive neuroscience studies on brain changes in written language learning are thought to help understand the specialisation of some cortical areas (Bravo, 2016).

Research on the changes that occur in brain regions during the orthographic and phonological processing of written words and the connections between them has led to a better understanding of the neural basis of word recognition. For this reason, it is desirable to integrate knowledge from neuroscience and cognitive psychology in order to carry out a psycho-pedagogical programme such as teaching written language or mathematics. Learning and reading experience contribute to changes in the organisation of the brain's functional structure (Shlaggar & McCandliss, 2007). This neuropsychological modification coincides with the transformations proposed by Dehaene (2007/2014).

Szűcs and Goswami (2007) express that neuroscience, by integrating the study of the nervous system with the processes of education, seeks to discover the optimal pathways for shaping the individual cognitive system with school learning and "for a successful achievement of educational neuroscience we need to connect neural variables with educational performance. Neural variables can generate new insights that affect *psychological theories* and can influence the course of educational research" (Szűcs & Goswami, 2007, p. 115). Cognitive psychology appears as a necessary intermediary between neuroscience and education and is described as the study of mental representations.

The current paradigm of educational psychology shows that school learning is the result of a process of cognitive and emotional neuropsychological development carried out within a linguistic and socio-cultural context of schooling. Therefore, psycho-pedagogical strategies must take into consideration both the socio-cultural and emotional characteristics of children and the cognitive and verbal neuropsychological characteristics of their development. Knowledge of neuroscience has provided a stronger foundation for educational psychologists to understand how learning occurs and thus to intervene strategically in the mental development of children, especially those with learning difficulties (Fletcher, 2009; Shaywitz et al., 2004; Torgesen et al., 2001; Vellutino et al., 2004).

Concerning the relationship between written language learning and children's age, follow-up studies show that learning is greater and longer lasting if the psychoeducational intervention is carried out at an early age (Cuadro, 2010; Torgesen et al., 2001). Early psychoeducational interventions produce more stable modifications in brain synapses, which facilitates the understanding of the structure of written language (Fletcher et al., 1992; Shaywitz et al., 2004; Simos et al., 2007). Also Szűcs and Goswami (2007) expressed that in order to achieve successful teaching "we need to connect neural variables with educational performance" (p. 115). Consequently, as psycho-pedagogy did, teaching written language and writing is not limited to children perceiving and discriminating words visually and phonetically or learning their spelling, but learning with them to develop metacognition of the text.

Labus and Romero Galván (2012) consider that pedagogical methodologies should evolve from a behavioural model of conditioning to a cognitive psychological model, in which teaching aims to develop *mental strategies* that motivate and help children to search for the meaning of content, with metacognition of learning.

Metacognition, in terms of people's awareness of their ways of thinking, of their ability to control cognitive content and to modify it according to learning objectives or behaviour, is an advanced stage of thinking that gives greater scope to active mental processes and also to cultural and school content, so that, as children advance in the school process, they enrich their knowledge, with an increase in oral and written language and numeracy (Flavell, 1979).

A key goal for psychoeducation involves assimilating the awareness of ways of thinking, the control of thinking and the retention in memory of cognitive content in children. Nazarieh (2016, p. 62) expresses that "the metacognitive experience during the work of learning, which comprises the different adaptive processes that a person carries out, determines the strategies he or she uses to learn" and agrees with Osses and Jaramillo (2008), who described metacognition as a way of learning in an autonomous and regulated way, which facilitates children to have meaningful learning. Martínez Velasco (2004) considers metacognition as a mental strategy for learning.

Flavell (1976, 1979) identified the cognitive areas in which children develop and establish the context of their knowledge, become aware of information received and retain it in memory. They learn to search systematically for new knowledge, based on personal strategies. Flavell (1976) states that metacognition refers to "the knowledge one has about one's own cognitive processes and products or any other related matters, e.g., the properties of information relevant to learning" (p. 232).

Metacognition occurs when one becomes aware of the difficulty of learning a subject or when one realises that one must verify a phenomenon before accepting it as fact or when one thinks that one must examine each and every alternative in a multiple choice before making a choice.

Flavell, in 1979, expanded his view of metacognition into a range of applications involving oral and written language learning, memory, attention, social interactions and self-instruction. For Flavell metacognitive experience is like a stream of consciousness, in which it is possible to seek the solution of some cognitive problems (Flavell, 1979).

For Campanario and Otero (2000) metacognition in science learning involves two basic components: knowledge about their own cognitive abilities and their self-regulation, and Carretero (2001) also refers to metacognition as the knowledge that people construct regarding their own mental functioning, and assimilates metacognition to operations related to the processes of monitoring and regulating their own cognitive activity when faced with a task and having to evaluate the result obtained.

Because of the above, cognitive psychoeducation can provide knowledge and strategies for a progressive construction of children's minds. For this process, neuropsychological research has pointed out the importance of the "*executive functions*" of the brain for successful learning (Luria, 1973, p. 55). The concept of executive functions of the brain is highly relevant for psycho-pedagogy. They are involved in the development of children's attention to learning content and memory and are a basis for metacognition (Santa-Cruz & Rosas, 2017).

Executive brain functions are considered regulators of human behaviour and begin to develop in the first year of life in the prefrontal cortex. They are modulators of behaviour, activating strategies for learning, such as planning, memory, attention, inner language and complex problem solving. The success of this process depends on the connections that are established in child development between different brain areas.

A strategic psycho-pedagogical consequence of the concepts and knowledge derived from neurosciences and cognitive psychology for school teaching methodologies is that it has made it easier to overcome the behaviourist model of teaching based on stimulus-response and also the psychometric models of quantitative and statistical performance, carried out by means of structured psychometric tests and examinations. Cognitive psycho-pedagogy aims to teach children to develop metacognition, based on the association of different school contents, and to find meaning in them.

This is a cognitive and verbal process of mental and child brain development. Stern et al. (2005) state that the brain is mainly shaped by the development of language, which involves neural recycling. In verbal learning, the central nervous system selectively activates certain brain regions. In reading, it establishes appropriate connections between the visual perception of orthographic signs and the phonological awareness of their pronunciation, which helps to attribute semantic meaning to them within a psycholinguistic context.

Thus, an innovation of psycho-pedagogical methodologies has been to assume as its own objective the neurocognitive and mental development of children and to stimulate new brain activities that activate the interconnections between the different regions of the brain for the development of thought and metacognition, through language.

In the case of written language learning, metacognition requires the association and memorisation of orthographic signs, vocabulary and phonological awareness as a way to access meaning. In other words, metacognition is an extension of thinking capacity that depends on the executive functions of the brain. According to Martínez Velasco (2004), it is a more recent contribution to the study of cognitive science.

Knowledge in neuropsychology has made it possible to broaden psycho-pedagogical activity, working on the relationships between the brain's neuronal activity and thought, and to associate learning and biological conditioning factors with socio-cultural determinants (Bravo & Orellana, 1994). This is an epistemological process that seeks convergences of different mental processes with brain functioning. The golden pathway of this connection is in language.

## Conclusion

In conclusion, school learning is an active process of the mind, which builds new cognitive structures or modifies existing ones, based on mental activity stimulated by psycho-pedagogical methods (Nazarieh, 2016). It is a cognitive neuropsychological process that takes place in a socio-cultural and linguistic context.

Psychopedagogy has autonomised itself from school and genetic psychology and established its own scientific basis for its work. First, it did so with the research of Piaget (1971), who taught a better understanding of the different stages of cognitive and verbal development, relating them to the age of children and established an epistemological thought model of mental development, and of Vigostski (1995), who integrated inner language with new school knowledge on the neuronal functioning of the brain, its organisation and adaptability. Also the neuropsychological research of Luria (1966) had an impact on a better understanding of the development of the child's mind, which is decisive for psycho-pedagogy.

These scientific advances have given rise to the pedagogical neurosciences or neurosciences of education, which can be considered a paradigm that investigates the development of the cognitive processes of school learning and the brain activity involved. Psychopedagogy contributes to a better mental and verbal neuropsychological development of children, when it takes into consideration their socio-cultural, emotional and intellectual characteristics, associating them with cognitive, verbal and neurocerebral processes.

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