

THEORY AND METHODOLOGY

L.S. Vygotsky in the 21st century

Alfredo Ardila

Department of Communication Sciences and Disorders, Florida International University, Miami, USA

Corresponding author. E-mail: ardilaa@fiu.edu

Although Lev Vygotsky's interpretation of human cognition was proposed almost one century ago, new scientific and technological advances have significantly supported many of his ideas and hypotheses. His cultural-historical theory of psychological processes, and his contributions to educational psychology, have continued growing without interruption. In this paper, three of Vygotsky's hypotheses are examined in light of 21st century scientific developments:

1) The influence of cultural factors on human cognition. A diversity of research studies in different countries has corroborated the crucial impact of culture on cognitive test performance;

2) The role of language in higher psychological processes. According to Vygotsky's cultural-historical approach, cognitive processes ("complex psychological processes") are social in origin, but complex and hierarchical in their structure. Intrinsic to the systemic organization of higher cognitive processes is the engagement of external artifacts (objects, symbols, signs), which have an independent history of development within a culture; and

3) The hypothesis that thought and general complex cognition is associated with certain "inner speech." Some contemporary neuroimaging studies (particularly PET and fMRI) analyzing "inner speech" have been carried out. These studies have attempted to find the areas of the brain involved in "inner speech." These scientific advances significantly support Vygotsky's interpretation of human cognition. It has been found that inner speech depends on activity in Broca's area and related brain network activity in the left hemisphere. Hence, inner speech is closely related to grammar, language production, and executive functions.

Vygotsky's important contribution to the understanding of psychological processes has stimulated, and continues to stimulate, a substantial amount of research in this area.

Keywords: Vygotsky, cultural-historical psychology, literacy, inner speech, cognition

Introduction

Lev Semyonovich Vygotsky is one of the major and most influential authors in psychology and pedagogy in recent history (Haggbloom et al., 2002). Despite his short life (1896-1934), his ideas have solidified, remained, and flourished. Plenty of papers, book chapters, and books analyzing, discussing, and advancing his ideas (Bybee, 2015; Saxe, 2015) continue to be published worldwide.

Despite the fact that Vygotsky's interpretation of human cognition was proposed almost one century ago (Vygotsky, 1929, 1934/1968, 1934/2012; Vygotsky & Wollock, 1997), new scientific and technological advances have significantly supported many of his ideas and hypotheses. His cultural-historical theory of psychological processes, and his contributions to educational psychology, have continued growing without interruption (Gredler, 2012; Roth & Lee, 2007; Wertsch, 1985; Yasnitsky, van der Veer & Ferrari, 2014; Yasnitsky & van der Veer, 2015).

In this paper, three of Vygotsky's hypotheses will be examined at the light of 21st century scientific developments: 1) The influence of cultural factors on human cognition — that is, his cultural-historical approach to psychology; 2) The role of language in higher psychological processes (i.e., language represents the major mediator of human cognition); and finally, 3) The hypothesis that thought and general complex cognition (“complex psychological processes,” according to Vygotsky) are associated with certain “inner speech.” At the conclusion of this paper, some general conclusions will be presented.

The influence of cultural factors on human cognition

One of the major research questions Vygotsky tackled was pinpointing the impact of cultural factors on human cognition. To approach this question, he and A.R. Luria planned two expeditions to Uzbekistan during 1930 and 1931, although only Luria actually travelled there, with some other colleagues. The purpose of this research program was clear: to investigate the influence of culture, and in particular, one of its most important institutions, education, on the development of higher cognitive functions (Luria, 1931, 1933, 1976a).

This research program resulted in several papers, the conclusions of which were controversial. One of the major conclusions was that illiterate people are bound to the concrete situations of real life; Consequently, they have difficulties solving problems that are beyond their personal experience. The obvious conclusion was that the use of abstract reasoning is to a significant degree dependent upon schooling.

This major conclusion is congruent with contemporary research in the area. For instance, Gómez-Pérez and Ostrosky-Solís (2006) studied 521 normal individuals, aged 6 to 85 years. Their educational level ranged from 0 to 22 years. Several memory and executive function tests were administered to each individual. It was found that factors related to memory are sensitive to age, whereas those related to executive functions (that is, “complex psychological processes”) are significantly sensitive to education. Unquestionably, abstracting, problem solving, and similar abilities are associated with the individual's level of education, as Luria and Vygotsky's study in Uzbekistan during the 1930s concluded.

A diversity of research studies carried out in different countries has corroborated the crucial impact of culture on cognitive test performance (For a review, see Ardila, 2013; Ardila & Keating, 2013). To exemplify this point, three specific questions will be analyzed in this section: a) Cognitive test performance in Amerindian populations, as an example of cognition in non-Western societies; b) The impact of culture on non-verbal abilities; this is in order to emphasize that the effect of culture on cognition is not limited to verbal abilities; 3) The influence of education on cognition. It has been pointed out that schooling can be regarded as a sub-culture itself, which includes certain specific values (e.g., learning is important) as well as an interpretation of the world (a worldview or *Weltanschauung* — frequently but not necessarily, a scientific interpretation of the world).

Cognitive test performance in Amerindian populations

Very few studies have analyzed the performance of Amerindian individuals' cognitive abilities. Pontius (1989) studied 19 healthy adult populations of nomadic Auca Indians of the Ecuadorian Amazon basin, who had never been missionized. The following tests were administered: the four-colored Kohs Block Design, and others measuring spatial-relational, lexical, and body and face shape recognition. The test results revealed a specific group of deficiencies, namely those in: color naming (with preservation of color concept); block design — especially related to representation, and construction of certain intra-pattern spatial relations; and graphic representational skills. The author suggests that these deficiencies have similarities to certain neuropsychological syndromes observed in cases of brain dysfunction.

Ostrosky-Solís, Ramirez and Ardila (2004) analyzed the influence of education and culture on the neuropsychological profile of an indigenous and a nonindigenous population in Mexico. The sample included 27 individuals divided into four groups: a) seven illiterate Mayan indigenous participants; b) six illiterate Pame indigenous participants; c) seven nonindigenous participants with no education; and d) seven Mayan indigenous participants with 1 to 4 years of education. A brief neuropsychological test battery developed and standardized in Mexico was administered to each individual. Results demonstrated differential effects for both variables (cultural group and education). Both groups of indigenous participants (Mayan and Pame) obtained higher scores in visuospatial tasks, while their level of education had significant effects on working and verbal memory tests. No significant differences were found in other cognitive processes (orientation, comprehension, and some executive functions). The authors suggested that both variables (culture and education) affect performance in different neuropsychological tests, but their effect differs depending upon the specific test.

Ardila and Moreno (2001) selected a sample of 20 right-handed Aruaco Indians (12 male, 8 female; age 8–30 years) from the Sierra Nevada de Santa Marta (Colombia). A brief neuropsychological test battery was individually administered. The battery included tests evaluating: visuoconstructive and visuo-perceptual abilities, memory, ideomotor praxis, verbal fluency, spatial abilities, and concept formation. In some neuropsychological tests, performance was virtually perfect (Recognition of Overlapped Figures and Ideomotor Praxis Ability test), whereas in other

tests it was non-existent (e.g., Block Design using a time limit). It was proposed that two types of variables were significantly affecting performance: 1) educational level; and 2) cultural relevance. Some tests appeared significant and meaningful (for example, recognition of overlapped figures) to the participants, whereas others were meaningless and even impossible to understand (e.g., drawing a map).

Everett (2005) analyzed some cultural idiosyncrasies associated with the specific and unusual characteristics of the Pirah language spoken by Pirahã people, an indigenous hunter-gatherer group of the Amazon Rainforest in Brazil. Pirah culture constrains communication to non-abstract subjects, which fall within the immediate experience of the interlocutors. This constraint results in some surprising features of Pirah grammar and culture: the absence of numbers of any kind, or a concept of counting or of any terms for quantification; the absence of terms for different colors, evident when one color is embedded in another; the simplest pronoun inventory known; the absence of relative tenses; the simplest kinship system yet documented; the absence of creating myths or fictional stories; and the absence of any individual or collective memory for more than two generations past; the absence of drawing or other art. This is one of the simplest material cultures ever documented. Furthermore, it is surprising that the Pirah are monolingual after more than 200 years of regular contact with Brazilians and other Indian groups. The author argues that these very unusual characteristics of the Pirah language's perspective, ultimately derive from a single cultural constraint in Pirah culture: namely, *restricting communication to the immediate experience of the interlocutors*. This conclusion clearly suggests that certain cultural practices may significantly affect the idiosyncrasies of spoken language.

Today there is no doubt that culture has a significant impact on the pattern of cognitive abilities, as proposed by Vygotsky and demonstrated not only in Amerindian cultures, but also in a diversity of cultural groups around the world (see: Laboratory of Comparative Human Cognition, 1983). As a matter of fact, a new area of neuropsychology has been developed during recent decades, specifically devoted to the analysis of the effect of culture on cognition; this area is usually known as "cross-cultural neuropsychology" (Fletcher-Janzen, Strickland & Reynolds, 2000; Uzzel, Ponton & Ardila, 2013).

The impact of culture on non-verbal abilities

During the Uzbekistan expeditions, Luria and Vygotsky observed that the Uzbeks' perceptual and spatial abilities were quite different than in Western people (Luria, 1976a, 1979), and hence, nonverbal abilities were significantly affected by cultural conditions. For instance, Uzbek people living in non-urban environments are much less prone to visual illusions, such as the Müller-Lyer illusion, than people living in typical Western environments. The famous telegram sent to Vygotsky by Luria from his travel to Middle Asia read: "Uzbeks do not have illusions." This important observation has been confirmed in diverse studies: Culture significantly affects perceptual and spatial abilities.

Regardless of contrary evidence, the idea that non-verbal cognitive tests can be culturally free is frequently found in psychological literature. As a matter of fact, there are diverse intellectual tests that are assumed to be "culture-free," or "culture-

fair,” simply because they include mostly nonverbal items (e.g., Alexander, 1987; Crampton & Jerabek, 2000). This assumption contradicts the evidence of contemporary anthropology and cross-cultural psychology (e.g., Berry, Poortinga, & Segall, 1992; Harris, 1983; Irvine & Berry, 1988; Saxe, 2015; Wilson, 2010).

Culture can significantly affect the development of non-verbal skills (for a review, see Rosselli & Ardila, 2003). Furthermore, ecological conditions and cultural practices are significantly associated with the development of perceptual, spatial, and constructional skills (Cole & Means, 1986). Cross-cultural differences in perceptual and constructional abilities have been extensively studied and analyzed in anthropology and cross-cultural psychology (e.g., Berry, 1971, 1979; Gay & Cole, 1967; Hudson, 1962; Laboratory of Comparative Human Cognition, 1983; Segall, 1986; Smith, Fischer, Vignoles & Bond, 2013). Furthermore, certain non-verbal abilities that are frequently taken for granted, such as drawing a map and copying figures, as measured by current cognitive tests, are not universal skills. They can be meaningless to members of some cultures, such as the Colombian Aruaco Indians (Ardila & Moreno, 2001).

Non-verbal tests currently used in psychology and neuropsychology are not necessarily more appropriate for cross-cultural testing than verbal tests. As mentioned above, Ardila and Moreno (2001) found that the Aruaco Indians' performance was particularly low when they were asked to copy the Rey-Osterrieth Complex Figure (a typical constructional ability test in neuropsychology), and to take a Draw-a-Map test (a spatial orientation test), whereas their verbal fluency test performance was within the normal range. Conversely, Mulenga et al. (2001) found that Zambian children performed better in visuospatial tests (such as design copying) than U.S. children. Indeed, visuoconstructive and visuospatial test scores may be lower or higher in diverse cultural groups, but the important point is that they differ due to cultural factors.

School as a sub-culture: The impact of education

As mentioned above, one of the major conclusions of the Uzbekistan expedition was that illiterate people are bound to concrete real life situations; consequently, they have difficulties solving problems that are beyond their personal experience (Luria, 1931, 1933, 1976a). This conclusion has been extensively supported by a myriad of studies carried out in different countries (see: Scribner, Cole & Cole, 1981; Ardila et al., 2010).

Literacy (i.e., extending spoken language to a symbolic visual representation) plays a major role in mediating cognitive processes. Luria (1931, 1933, 1976a) and Vygotsky (1934/1978) developed the concept of extra-cortical “organization of higher mental functions” to account for the interaction of biological and cultural factors in the development of human cognition (Kotik-Friedgut & Ardila, 2004). Luria (1973) explained that “*It is this principle of construction of functional systems of the human brain that Vygotsky called the principle of extra-cortical organization of complex mental functions, implying by this somewhat unusual term that all types of human conscious activity are always formed with support of external auxiliary tools or aids.*” (page 31) Written language represents a major support for extending oral language, in particular, and human cognition in general.

Evidently, without written language, our knowledge of the external world is partially limited by immediate sensory information and concrete environmental conditions. Thus, Reis, Guerreiro and Petersson (2003) found that if in a verbal fluency task (to name objects corresponding to a specific semantic category, for instance, animals, fruits, clothes, etc.), the participants are asked “to name as many different things as possible that one can buy at the supermarket in 1 minute” (a quite concrete context), no educational effect is found, and performance in literate and illiterate participants is similar. However, significant differences between literate and illiterate subjects are found when using a more abstract category (e.g., to name animals); this is because literate people usually know the names of many animals that they have never seen — for example, penguins, dinosaurs, etc. — whereas illiterate people can name only those animals they directly know).

Contemporary research has demonstrated that literacy is significantly associated with virtually all cognitive measures, even though the correlation between education and neuropsychological test scores depends on the specific test (Ardila et al., 2010). For instance, the correlation between years of schooling and test scores was found to be 0.62 for Phonological verbal fluency, 0.49 for Semantic verbal fluency, 0.26 for Language repetition, and only 0.07 for Orientation in space (Ostrosky, Ardila & Rosselli, 1999).

Significant differences in performance have been demonstrated, depending upon the educational level, in at least the following domains:

- Motor Functions (e.g., Bramaio et al., 2007)
- Calculation and Number Processing (e.g., Deloche et al., 1999)
- Language (e.g., Laboratory of Comparative Human Cognition, 1983).
- Metalinguistic Awareness (e.g., Ventura, Kolinsky, Querido, Fernandes, & Morais, 2007).
- Visuo-perceptual and Spatial Abilities (e.g., Ardila, Rosselli, & Rosas, 1989)
- Memory (e.g., Montiel & Matute, 2006)

There is no question but that reading represents an additional instrument to extend human cognition. Contemporary research has corroborated Vygotsky’s and Luria’s initial suggestions about the significant effect of literacy on human cognition.

The role of language in higher psychological processes

According to Vygotsky’s cultural-historical approach (1934/1978), cognitive processes (“complex psychological processes,” as he calls them) are social in origin, but complex and hierarchical in their structure. An intrinsic factor in the systemic organization of higher cognitive processes is the engagement of external artifacts (objects, symbols, signs) which have an independent history of development within the culture. According to the concept of “extra-cortical organization of complex mental functions” (Vygotsky, 1929), the role of external factors in establishing functional connections between various brain systems is, in principle, universal. However, different mediators, means, and strategies, or significantly different details within them (e.g. the direction of writing and degree of letter-sound

correspondence, the orientation by maps, etc.) may have been developed and, in fact, continue to develop in different cultures.

At this point, one could ask the following question: How did complex cognition appear in human history? It could be speculated that some crucial inventions fueled the development of cultural evolution and complex cognition (Vygotsky, 1934/1962). The most important candidate for being held responsible for this crucial invention, however, is language. Language allows the transmission of knowledge, and thus increases the probability of survival. Without language, children can only learn from parents by imitation (vicarious learning), but imitation is limited to elementary activities, such as making a simple stone ax. Language represents a major instrument of internal representation of the world and thinking (Vygotsky, 1934/1978). The evolution of language is a slow process that takes thousands of years. But the most critical element of complex human language is the use of grammar, which likely appeared relatively recently in human history (Ardila, 2015; Bickerton, 2007).

The evolution of human language represents one of the most complex questions in contemporary science. Significantly, it has been pointed out that human languages, regardless of the diversity in their details, present profound structural similarities in all regions of the world — i.e. there is core syntax or Universal Grammar (Chomsky, 1965, 1980). This suggests the existence of an original grammar or basic grammar, or at least, some universal principles and strategies used for expressing ideas. These universal principles used to express ideas, which are found in every language world-wide, would result from the specific idiosyncratic organization of the human brain.

Observations of children's language development corroborate that language initially appears as a lexical/semantic system, and only later is a grammatical language found (Hoff, 2013). Grammar is correlated with the ability to represent and use names for actions names (verbs). Furthermore, while lexicon (vocabulary) indicates how the world is conceptualized (words indicate concepts), grammar requires reasoning and thinking strategies.

The hypothesis of “inner speech”

The idea that there is an inner speech — an individual internal language — has a long history. As a matter of fact, at least since Plato (the *Theaetetus* 189e–190a and the *Sophist* 263e), the idea that thinking means using an inner speech has existed; that is, thinking to a significant extent means to talking to ourselves. This idea has been expressed by different authors throughout the modern and contemporary history. This “mental language,” as it frequently has been called, differs from ordinary language by consisting solely of meanings, i.e. it signifies without signifiers (Wiley, 2006).

Vygotsky (1934/2012) systematized the concept of inner speech when he referred to three different types of speech: “external speech” (or “social speech” — that is, the speech used in social interactions), “egocentric speech” (or “private speech” — that is, speech to ourselves), and “inner speech” (internalized social speech). It is important to note that there is a process of “internalization” in which the first (external or social speech) is transformed into the second (egocentric

or private speech), and finally into the third (inner speech). As a matter of fact, private speech represents a kind of halfway station between “external” and “inner” speech, but with very distinctive properties. Therefore, Vygotsky’s egocentric (private) speech is the link between social (external) speech and organized inner speech. Furthermore, social speech represents the overt, external speech addressed to others (words, sentences) for the purpose of social interaction and communication; whereas inner speech is subvocalized speech directed and adapted to oneself. Private speech, as a midway point between external and inner speech, is vocalized speech addressed and adapted to one’s self. Thus, private speech is neither social communication nor silent thought, but rather vocalized thought (Ehrich, 2006; Jones, 2009; Vygotsky (1934/2012)).

Following Vygotsky, some have proposed that inner speech has four distinguishing features: a) silence — that is, it is not overtly produced; b) syntactical ellipses or short-cuts (i.e., words may be omitted that are understood in context); c) semantic embeddedness (i.e. highly condensed word meanings); and d) egocentricity or highly personal word meanings (Johnson 1994; Jones, 2009). Vygotsky (1929, 1934/1968, 1934/2012) argued that thought (and so-called “complex psychological processes”) is associated with some “inner speech.”

In addition, attempts have been made to find the neurological substrate of inner speech. Some contemporary neuroimaging studies (particularly PET and fMRI) analyzing “inner speech” have been carried out. These studies have attempted to find the brain areas involved in “inner speech.”

McGuire et al. (1996) analyzed the neural correlates of inner speech and auditory verbal imagery in a sample of normal subjects. Positron Emission Tomography was used to measure brain activity. Single words were presented, and subjects were required to generate short sentences without speaking. Inner speech was associated with increased activity in the left inferior frontal gyrus (Broca’s area). Results demonstrated that silent articulation involves increased activity in an area specializing in speech generation — that is, Broca’s area (left inferior frontal gyrus).

Geva et al. (2011) studied 17 patients with chronic post-stroke aphasia; participants performed two different types of tasks: a) inner speech tasks (rhyme and homophone judgments), and b) overt speech tasks (reading aloud). The relationship between brain structure and language ability was examined using voxel-based lesion–symptom mapping. It was found that inner speech abilities were affected by lesions in the left *pars opercularis* of the inferior frontal gyrus (Broca’s area) and to the white matter adjacent to the left supramarginal gyrus.

Morin and Michaud (2007) analyzed a hypothesis about inner speech’s participation in self-referential activity. They reviewed 59 studies measuring brain activity during the processing of self-awareness in several domains relating to the self. The left inferior frontal gyrus (Broca’s area) was shown to sustain inner speech use. Moreover, the left inferior frontal gyrus was more frequently recruited into action during conceptual tasks than during perceptual tasks. These results support the view of some degree of involvement of inner speech in self-reflexive processes.

Damage in Broca’s area (Brodmann areas 44 and 45, *pars opercularis* and *pars triangularis* of the left inferior frontal gyrus) in the left hemisphere, results in so-called Broca’s aphasia. This aphasia is characterized by limitations in, or absence of, grammar, and difficulties in organizing the sequence of articulatory movements

(apraxia of speech), as well as disturbances in executive functions (e.g., Benson & Ardila, 1996; Kertesz, 1979; Luria, 1976b). Considering that this brain area is the crucial area for inner speech, it is easy to conclude that inner speech is associated with grammar and executive functions (complex cognition).

In summary: Inner speech depends on Broca's area activity and related brain network activity in the left hemisphere. *Hence, inner speech is closely related to grammar, language production, and executive functions ("higher psychological processes"). Exactly as proposed by Vygotsky.*

Conclusion

New scientific advances significantly support many of the Vygotsky's ideas about human cognition. It is not surprising that many papers, books, courses, and conferences are devoted to analyzing and discussing Vygotsky's ideas.

Vygotsky represents the origin of (or a specific step in) the development of these ideas and hypotheses, but they are obviously not the final answer. In science, each author makes a particular contribution that will be further developed by other scholars. During the approximately seven decades since Vygotsky's death, diverse studies have extended and frequently re-oriented the original ideas about human cognition presented by Vygotsky. His contribution to understanding psychological processes was enormous, and his ideas have stimulated a significant amount of research in the area.

References

- Alexander, W. P. (1987). *Apreciación de la inteligencia practica y libre de influencia cultural* [Appraisal of practical and culture-free intelligence]. Madrid: Tea Ediciones.
- Ardila, A. (2013). The impact of culture on neuropsychological test performance. In: Uzzell, B., Ponton, B., & Ardila, A. (Eds.), *International Handbook of Cross-Cultural Neuropsychology*. Erlbaum, Mahwah, NJ.
- Ardila, A. (2015). A Proposed Neurological Interpretation of Language Evolution. *Behavioral Neurology*, 2015, Article ID 872487. doi: 10.1155/2015/872487
- Ardila, A., Bertolucci, P. H., Braga, L. W., Castro-Caldas, A., Judd, T., Kosmidis, M. H., ... & Rosselli, M. (2010). Illiteracy: the neuropsychology of cognition without reading. *Archives of Clinical Neuropsychology*, 25(8), 689–712. doi: 10.1093/arclin/acq079
- Ardila, A., & Keating, K. (2013). Cognitive abilities in different cultural contexts. In: Uzzell, B., Ponton, B., & Ardila, A. (Eds.), *International Handbook of Cross-Cultural Neuropsychology*. Erlbaum, Mahwah, NJ.
- Ardila, A. & Moreno, S. (2001). Neuropsychological evaluation in Aruaco Indians: An exploratory study. *Journal of the International Neuropsychological Society*, 7, 510–515. doi: 10.1017/S1355617701004076
- Ardila, A., Rosselli, M., & Rosas, P. (1989). Neuropsychological assessment in illiterates: Visuospatial and memory abilities. *Brain and Cognition*, 11, 147–166. doi: 10.1016/0278-2626(89)90015-8
- Benson, D. F. & Ardila, A. (1996). *Aphasia: a clinical perspective*. New York: Academic Press.
- Berry, J. W. (1971). Ecological and cultural factors in spatial perceptual development. *Canadian Journal of Behavioral Sciences*, 3, 324–336. doi: 10.1037/h0082275

- Berry, J. W. (1979). Culture and cognition style. In A. J. Marsella, R. G. Tharp, & T. J. Ciborowski (Eds.), *Perspectives in cross-cultural psychology* (pp. 117–135). New York: Academic Press.
- Berry, J. W., Poortinga, Y. P., & Segall, M. G. H. (1992). *Cross-cultural psychology*. Cambridge: Cambridge University Press.
- Bickerton, D. (2007). Language evolution: A brief guide for linguists. *Lingua*, 117, 510–526. doi: 10.1016/j.lingua.2005.02.006
- Boivin, M. J., & Giordani, B. (2009). Neuropsychological assessment of African children: evidence for a universal brain/behavior omnibus within a co-constructivist paradigm. *Progress in Brain Research*, 178, 113–135. doi: 10.1016/S0079-6123(09)17808-1
- Bramao, I., Mendonca, A., Faisca, L., Ingvar, M., Petersson, K. M., & Reis, A. (2007). The impact of reading and writing on visuo-motor integration task: A comparison between illiterate and literate subjects. *Journal of the International Neuropsychological Society*, 13, 359–364. doi: 10.1017/s1355617707070440
- Bybee, R. (2015). Scientific literacy. *Encyclopedia of Science Education*, 944–947. doi: 10.1007/978-94-007-2150-0_178
- Chomsky, N. (1965). *Aspects of the theory of syntax*. Cambridge, MA: MIT Press.
- Chomsky, N. (1980). *Rules and Representations*. Oxford: Blackwell.
- Cole, M., & Means, B. (1986). *Comparative studies of how people think*. San Diego, CA: University of California Press.
- Crampton, A., & Jerabek, I. (2000). *Culture-Fair IQ Test*. Montréal, Canada: Plumeus Inc.
- Deloche, G., Souza, L., Braga, L. W., & Dellatolas, G. (1999). A calculation and number processing battery for clinical application in illiterates and semiliterates. *Cortex*, 35, 503–521. doi: 10.1016/S0010-9452(08)70815-3
- Everett, D. (2005). Cultural constraints on grammar and cognition in Pirahã. *Current Anthropology*, 46(4), 621–646. doi: 10.1086/431525
- Fletcher-Janzen, E., Strickland, T. L., & Reynolds, C. (2000). *Handbook of Cross-Cultural Neuropsychology*. New York: Springer Science & Business Media. doi: 10.1007/978-1-4615-4219-3
- Gay, J., & Cole, M. (1967). *The new mathematics and an old culture*. New York: Holt, Rinehart & Winston.
- Geva, S., Jones, P. S., Crinion, J. T., Price, C. J., Baron, J. C., & Warburton, E. A. (2011). The neural correlates of inner speech defined by voxel-based lesion–symptom mapping. *Brain*, 134(10), 3071–3082. doi: 10.1093/brain/awr232
- Gómez-Pérez, E., & Ostrosky-Solís, F. (2006). Attention and memory evaluation across the life span: Heterogeneous effects of age and education. *Journal of Clinical and Experimental Neuropsychology*, 28(4), 477–494. doi: 10.1080/13803390590949296
- Gredler, M.E. (2012). *Understanding Vygotsky for the classroom: Is it too late?* *Educational Psychology Review*, 24(1), 113–131. doi: 10.1007/s10648-011-9183-6
- Haggbloom, S. J., Warnick, J. E., Jones, V. K., Yarbrough, G. L., Russell, T. M., Borecky, C. M., McGahhey, R. et al. (2002). The 100 most eminent psychologists of the 20th century. *Review of General Psychology*, 6(2), 139–152. doi: 10.1037/1089-2680.6.2.139
- Harris, M. (1983). *Culture, people, nature: An introduction to general anthropology* (3rd ed.). New York: Harper and Row.
- Hoff, E. (2013). *Language development*. Belmont, CA: Cengage Learning.
- Hudson, W. (1962). Cultural problems in pictorial perception. *South African Journal of Sciences*, 58, 189–195.
- Irvine, S. H., & Berry, J. W. (Eds.). (1988). *Human abilities in cultural context*. New York: Cambridge University Press. doi: 10.1017/CBO9780511574603

- Kertesz, A. (1979). *Aphasia and associated disorders: Taxonomy, localization, and recovery*. Austin, TX: Holt Rinehart & Winston.
- Kotik-Friedgut, B. & Ardila, A. (2004). Systemic-Dynamic Lurian Theory and Contemporary Cross-Cultural Neuropsychology. In: Akhutina, T., Moskovich, L. & Dorothy, T. (Eds), *A.R. Luria and Contemporary Psychology*. New York: Nova.
- Kotik-Friedgut, B. & Ardila, A. (2014). Cultural historical theory and Cultural Neuropsychology Today. In: Yasnitsky, A., van der Veer, A. R. & Ferrari, M. (eds). *Handbook of Cultural-Historical Theory*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9781139028097.021
- Laboratory of Comparative Human Cognition (1983). Culture and cognitive development. In: P. Mussen (Ed.), *Handbook of child psychology: History, theory and methods* (Vol. 1, pp. 342–397). New York: Wiley.
- Luria, A. R. (1931). Psychological expedition to central Asia. *Science*, 74, 383–384. doi: 10.1126/science.74.1920.383
- Luria, A. R. (1933). The second psychological expedition to central Asia. *Science*, 78, 191–192. doi: 10.1126/science.78.2018.191-a
- Luria, A. R. (1973). *The working brain*. London: Penguin Books.
- Luria, A. R. (1976a). *Cognitive development: Its cultural and social foundations*. Cambridge, MA: Harvard University Press.
- Luria, A. R. (1976b). *Basic problems of neurolinguistics*. New York: Walter de Gruyter. doi: 10.1515/9783110800159
- Luria, A. R. (1979). *The making of mind*. Cambridge, MA: Harvard University Press.
- McGuire, P. K., Silbersweig, D. A., Murray, R. M., David, A. S., Frackowiak, R. S. J., & Frith, C. D. (1996). Functional anatomy of inner speech and auditory verbal imagery. *Psychological Medicine*, 26(01), 29–38. doi: 10.1017/S0033291700033699
- Montiel, T., & Matute, E. (2006). La relación entre alfabetización y la escolarización con el desempeño en tareas verbales. In E. Matute (Ed.), *Lectura y diversidad cultural*. Guadalajara, México: Universidad de Guadalajara.
- Morin, A., & Michaud, J. (2007). Self-awareness and the left inferior frontal gyrus: inner speech use during self-related processing. *Brain Research Bulletin*, 74(6), 387–396. doi: 10.1016/j.brainresbull.2007.06.013
- Mulenga, K., Ahonen, T., & Aro, M. (2001). Performance of Zambian children on the NEPSY: A pilot study. *Developmental Neuropsychology*, 20, 375–384. doi: 10.1207/S15326942DN2001_4
- Ostrosky-Solís, F., Ardila, A., & Rosselli, M. (1999). NEUROPSI: A brief neuropsychological test battery in Spanish with norms by age and educational level. *Journal of the International Neuropsychological Society*, 5(05), 413–433. doi: 10.1017/S1355617799555045
- Ostrosky-Solís, F., Ramírez, M., Lozano, A., Picasso, H., & Vélez, A. (2004). Culture or education? Neuropsychological test performance of a Maya indigenous population. *International Journal of Psychology*, 39(1), 36–46. doi: 10.1080/00207590344000277
- Ostrosky-Solís, F., Ramírez, M., & Ardila, A. (2004). Effects of culture and education on neuropsychological testing: A preliminary study with indigenous and nonindigenous population. *Applied Neuropsychology*, 11(4), 186–193. doi: 10.1207/s15324826an1104_3
- Pontius, A. A. (1989). Color and spatial error in block design in stone-age Auca Indians: Ecological underuse of occipital-parietal system in men and of frontal lobes in women. *Brain and Cognition*, 10(1), 54–75. doi: 10.1016/0278-2626(89)90075-4
- Reis, A., Guerreiro, M., & Petersson, K. M. (2003). A sociodemographic and neuropsychological characterization of an illiterate population. *Applied Neuropsychology*, 10(4), 191–204. doi: 10.1207/s15324826an1004_1

- Rosselli, M., & Ardila, A. (2003). The impact of culture and education on non-verbal neuropsychological measurements: A critical review. *Brain and Cognition*, 52(3), 326–333. doi: 10.1016/S0278-2626(03)00170-2
- Roth, W. M., & Lee, Y. J. (2007). Vygotsky's neglected legacy: Cultural-historical activity theory. *Review of Educational Research*, 77(2), 186–232. doi: 10.3102/0034654306298273
- Saxe, G. B. (2015). *Culture and cognitive development: Studies in mathematical understanding*. Psychology Press.
- Scribner, S., Cole, M., & Cole, M. (1981). *The psychology of literacy* (Vol. 198, No. 1). Cambridge, MA: Harvard University Press. doi: 10.4159/harvard.9780674433014
- Segall, M. H. (1986). Culture and behavior: Psychology in global perspective. *Annual Review of Psychology*, 37, 523–564. doi: 10.1146/annurev.ps.37.020186.002515
- Smith, P. B., Fischer, R., Vignoles, V. L., & Bond, M. H. (2013). *Understanding social psychology across cultures: Engaging with others in a changing world*. London: Sage.
- Uzzell, B. P., Ponton, M., & Ardila, A. (Eds.). (2013). *International handbook of cross-cultural neuropsychology*. Psychology Press.
- Ventura, P., Kolinsky, R., Querido, J. L., Fernandes, S., & Morais, J. (2007). Is phonological encoding in naming influenced by literacy? *Journal of Psycholinguistic Research*, 36(5), 341–360. doi: 10.1007/s10936-006-9048-1
- Vygotsky, L. S., & Wollock, J. (1997). *The collected works of L.S. Vygotsky*. New York: Springer Science & Business Media.
- Vygotsky, L.S. (1929). The problem of the cultural development of the child II, *The Journal of Genetic Psychology*, 36, 415–432. doi: 10.1080/08856559.1929.10532201
- Vygotsky, L.S. (1968). *Mind in society*. Cambridge, MA: Harvard University Press. (Original work published 1934)
- Vygotsky, L. S. (2012). *Thought and language*. Cambridge, MA: MIT Press. (Original work published 1934)
- Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press. (Original work published 1934)
- Wertsch, J. V. (1985). *Vygotsky and the social formation of mind*. Cambridge, MA: Harvard University Press.
- Wilson, M. (2010). The re-tooled mind: how culture re-engineers cognition. *Social Cognitive and Affective Neurosciences*, 5(2–3), 180–187. doi: 10.1093/scan/nsp054
- Yasnitsky, A., van der Veer, A. R. & Ferrari, M. (Eds.). (2014). *Handbook of cultural-historical theory*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9781139028097
- Yasnitsky, A. & van der Veer, R. (Eds.) (2015). *Revisionist Revolution in Vygotsky Studies*. London, New York: Routledge.

Original manuscript received July 29, 2016

Revised manuscript accepted September 21, 2016

First published online December 01, 2016