A.R. Luria’s Approach to Neuropsychological Assessment and Rehabilitation

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Abstract

Luria is one of the most influential authors in cognitive neuroscience, and in particular neuropsychology. New scientific achievements and clinical observations have significantly supported many of his suggestions and hypotheses. The article describes the basic concepts of neuropsychological evaluation and rehabilitation, associated with the method of syndrome analysis developed by Luria for diagnosis mental function and focus in the qualitative interpretation of the results neuropsychological diagnosis. Luria is regarded as a pioneer in cognitive rehabilitation. His ideas have maintained relevance and have continued to be developed and analyzed. Luria is presented as one of the major founders of contemporary neuropsychology from the fundamental point of view and the clinical perspective. His influence has continued significantly during the 21st century.

Keywords: Luria; Neuropsychological assessment; Method of syndrome analysis neuropsychological rehabilitation

Introduction

Alexander Romanovich Luria (1902–1977) represents one of the major and most influential authors in cognitive neurosciences, in particular in neuropsychology, during the 20th century (Haggbloom et al., 2002). Indeed, he is frequently regarded as the founder of contemporary neuropsychology (Goldberg, 1990, 2009). His papers, book chapters, and books continue to be published worldwide, analyzing, discussing, and advancing his ideas (Christensen, Goldberg, & Bougakov, 2009; Homskaya, 2001; Vocate, 1987).


Theoretical Foundations

Luria (1962/1980) considers the question about localization of mental functions in a new perspective: each mental function is based on the integrated and integrated functioning of different brain regions united into brain “functional systems”. This interpretation required the development of an appropriate methodologic approach to elucidate the functional involvement of each brain area in the functional system and understand how its contribution could be understood when studying specific cognitive functions. Luria noted that the classic neurological approach evaluated the status of only a limited part of the brain associated with elementary functions but did not provide information about the status of specifically human—secondary and
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Common features in the symptoms of disturbance of different mental functions point to the existence of a common factor that underlies these functions. Luria thought that the search of common features in the symptoms within a syndrome increases the reliability of the results. Therefore “syndrome analysis” should become the main method in the neuropsychological assessment. Each neuropsychological syndrome was considered by Luria as a consistent combination of symptoms of disturbance of different mental functions.

In general, the procedure of syndrome analysis (from revealing symptoms in the neuropsychological assessment up to localizing the brain damage) included several stages: (1) finding out the symptoms of different mental function disorders; (2) qualifying the defect structure by analysis of the psychological symptoms and their specific characteristics; (3) determining the neuropsychological factor associating the symptoms into a specific neuropsychological syndrome; and (4) localizing the brain damage according to the assumed factor.

In his autobiographical book “Making of Mind” Luria wrote that he came to the idea of syndrome analysis after he understood that the logic of clinical work differs from the logic of a regular experimental study. In clinical work, unlike experimental work, “the departing point is not a well-defined problem, but an unknown complex of problems—the patient”. Hypothesis of how to solve the problem starts to emerge at a certain stage of study. “Only when the clinician has found a sufficient number of compatible symptoms that together form a “syndrome” does he/she have the right to believe that his hypothesis about
the patient’s disturbance may be confirmed or rejected. The procedures and reasoning of such investigations seems more like those used by detectives solving a crime than like the problem-solving behavior that prevails among psychologists and physiologists” (Cole, Leventin & Luria, 2006, p. 132).

Luria noted that in science in general, and in psychology in particular, there is a pronounced tendency to substitute the voluntary and directed activity by mechanical models. Thus, in medicine with the emergence of modern technical tools, traditional forms of medical diagnostics (i.e., the distinction of syndromes based on the description of significant symptoms) is substituted by the analysis of the results of lab tests, or tests done using technical tools. This tendency has led to overlook the clinical reality, and to lose the art of clinical observation and description. The role of technical tools should not be underestimated, but, Luria wrote “I am inclined to strongly reject an approach in which these auxiliary aids become the central method and in which their role as servant to clinical thought is reversed so that clinical reasoning follows instrumental data as a slave follows its master” (Cole et al., 2006, p. 177). The art of observation and description in science, including psychology, stated Luria, should keep its priority. Scientific observation is not just phenomenological description of separate facts. “Its main goal is to view an event from as many perspectives as possible. The eye of science does not probe “a thing” or an event isolated from other things or events. Its real objective is to see and understand the way a thing or event relates to other things or events” (Cole et al., 2006, p. 177). These fears are partly justified in the current state of neuropsychology. For example, they have become apparent in the excessive use of quantitative, psychometric (to the prejudice of qualitative) methods of neuropsychological assessment. This situation is due to the lack of clear understanding of the aims and goals of neuropsychological assessment (Mikadze, 2011, 2012).

Syndrome analysis method, developed by Luria since the 1940s, was first aimed at the local diagnostics of brain pathology, due to the absence at that moment of reliable assessment methods to determine the localization of brain lesions. The priority in assessment was to determine the disturbed components of higher psychological processes and their connection with the localization of the brain damage. Results of such an assessment were presented as concrete syndromes or complexes of syndromes, reflecting the psychological and brain structure of the deficits.

Due to the emergence of the CT scans beginning in the late 1960s, the need for neuropsychological focal diagnosis has significantly decreased. Psychometric methods have become particularly extended. They provide quantitative approach to test data analysis with the assessment of general status of particular mental functions and their dynamics. Emergence of psychometric methods in neuropsychology assessment was related to transfer of a successful experience in psychometric assessment of abilities from general psychology to clinical practice.

This methodology is in a certain way is a return to the ideas of the localizationist: from the brain “map” (brain as an aggregate of “organs” each of which is related to a particular function) to the “map” of psychic (psyche as the aggregate of separate mental functions, states, and features).

Ecologically oriented methods of assessment became popular when the task required to assess quality of life (a notion introduced in the field of rehabilitation during the 1980s), ability to adapt to social and daily situations, and demands in the situation of limitations due to the disease. Quality of life was considered as an integral characteristic estimating the effectiveness of rehabilitation. According to this goal, ecological methods were created to allow for assessment of the mental and emotional state of the subjects using tests and questionnaires which provide quantitative estimation of frequent behaviors (functional status), and predicts possible daily life problems of a patient. Results are presented in the form of data pointing to the disturbance of certain behaviors instrumental for adaptation to social situation, daily life, and independent functioning.

One could say that currently, existing neuropsychological assessment methods allow assessment of at least three different levels of cognitive functioning: level of behavior, level of separate cognitive functions (domains), and level of separate components of cognitive functions. To provide a complete picture and diversity of the disturbances due to brain damage, logic of their connections which Luria wrote about, it is necessary to address all three levels (see Mikadze, 2011, 2012).

For the neuropsychological assessment, the task of diagnostic of local brain pathologies is today less important, but the popularity of general systemic dynamic approach in the neuropsychological assessment has continued growing. Thus, new diagnostic tools were developed based on Lurian approach. After Cristensen’ book (1975) it was Luria-Nebraska Neuropsychological Battery (LNNB) and its downward extension for children 8–12 years of age (LNNB-Children Revision) (Golden, 1987). It was and still is popular (Hynd, Snow & Becker, 1986; Rabin, Barr & Burton, 2005, 2012; Akhutina & Melikyan, 2012). However, it was met with some criticism from American and Russian neuropsychologists (Akhutina & Tsvetkova, 1983 on adult version; Hynd et al., 1986; Stimontana & Hoover, 1988 on the children revision). Following Luria’s pioneer work, Das and colleagues (see e.g., Das, Kar & Parrila, 1996) conceptualized Planning as one of the major cognitive processes in the PASS (Planning, Attention, Simultaneous, and Successive processing) theory of intelligence. More recently, Planning has been subsumed under the umbrella of Executive Functions (EF) along with inhibition and working memory (e.g., Clark, Pritchard, & Woodward, 2010; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003). This aspect became an...
A comprehensive one in cognitive diagnosis of development and building of correction practice for learning disabilities (Das & Georgiou, 2016; Das, 2010).

Another diagnostic battery, NEPSY (Korkman, Kirk, & Kemp, 1998), which has been translated or adapted into a number of languages, was also originated in the Lurian approach to assessment and is widely used internationally in developmental neuropsychological assessment (Rosenqvist, Lahti-Nuuttila, Cosimo, Urgesi, & Holdnack, 2017). In Spanish, the test battery Programa Integrado de Exploración Neuropsicológica – Test Barcelona (Integrated Program of Neuropsychological Assessment–Barcelona Test) (Peña-Casanova, 2005) is directly based in Luria’s ideas about neuropsychological assessment.

In Russia, Luria’s pupils developed screening methods (Mikadze & Korsakova, 1994; Simernitskaya & Matyugin, 1991) and complete batteries of neuropsychological evaluation of children (Akhutina, Polonskaia & Pylaeva, 2008, 2016; Glozman, Potanina & Soboleva, 2006; Glozman, 2013). The authors of the “Methods of neuropsychological evaluation of children 6–9 years” (Akhutina et al., 2008, 2016) proceeded from the assumption that the battery should be not too large but comprehensive. For example, Nepsy does not have tests to compose sentences and stories about pictures, which makes it difficult to assess not only the state of the vocabulary, grammar, and discourse of children, but also the semantic completeness and adequacy of their texts. In order to assess the state and dynamics of the children’s higher mental functions, the battery should allow for a qualitative analysis of the responses, separation of primary and secondary symptoms and their quantitative evaluation. Its tests should be specific, if possible directed at one factor, it should not contain such tests, errors in which can be equally probable due to many different of factors. An example of such a “universal” test can be a test in a Nepsy battery, where children should repeat five times a pair of the pseudowords: split-splat, grinch-grauchi, etc. Errors in it can be caused by deficiencies in phonemic hearing, kinesthetic analysis, or inhibition. The set of tests, some of which were developed by Luria himself, and others developed by other Moscow authors, is presented in Table 1.

This test battery was adapted for 6–9 year-old children. The norms of the battery on a contingent of first grade students in Moscow (n= 296 children) are presented in Akhutina et al.’s assessment book (2016). To show the scatter in the results of

<table>
<thead>
<tr>
<th>Table 1. Tests battery for the assessment of children 6- to 9-year-old (based on Luria’s neuropsychological tests)</th>
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<tbody>
<tr>
<td>Serial organization of movements and speech</td>
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<tr>
<td>Palm-First-Edge Test;</td>
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<tr>
<td>Reciprocal Coordination;</td>
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<td>Graphomotor Sequences Test;</td>
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<tr>
<td>Reproduction of Rhythms (after instruction);</td>
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<td>Sentence Completion;</td>
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<tr>
<td>Creating a Story based on the series of pictures</td>
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<td>Programming and control voluntary actions (executive functions)</td>
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<td>Counting;</td>
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<td>Problem Solving;</td>
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<tr>
<td>Vocal Fluency Tests;</td>
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<td>“Odd one out”;</td>
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<tr>
<td>Arranging series of pictures</td>
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<tr>
<td>Processing of kinesthetic</td>
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<td>Finger Position Test;</td>
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<td>information</td>
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<tr>
<td>Oral Praxis</td>
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<td>Processing of auditory information</td>
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<tr>
<td>Rhythm Reproduction and Evaluation;</td>
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<tr>
<td>Understanding of Similar Sounding Words;</td>
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<tr>
<td>Understanding of Words Similar in Meaning;</td>
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<td>Verbal Memory Test</td>
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<tr>
<td>Processing of visual information</td>
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<tr>
<td>Perception of Superimposed, Crossed out, and Unfinished Images;</td>
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<tr>
<td>Design Fluency Tests (free drawings, drawings of plants)</td>
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<tr>
<td>Processing of visual-spatial information</td>
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<tr>
<td>Head’s Test (reproduction of hand position);</td>
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<td>Construction Test (mental rotation);</td>
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<td>Three-Dimensional Drawings;</td>
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<td>Block Design Test;</td>
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<tr>
<td>Visual Spatial Memory;</td>
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<td>Understanding of Logical Grammatical</td>
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</table>

Unit I. Energy Unit and Subcortical-Brainstem Structures

The functions of this unit can be assessed in the process of completing the whole test battery, in particular movement trials and Schulte’s tables. The fluctuations of attention, exhaustion, micro- and macrography, muscle hypo- and hypertension, speed, and pauses are considered.
first-graders from different Moscow districts and types of schools, the book presents both the averaged data for the whole sample and the data from individual schools. Russian neuropsychologists continue to work on optimization of this battery and other methods of examining so children as adults.

Rehabilitation Issues

The systemic approach to the problem of localization higher psychological functions defines the basic principles for rehabilitation. In general, the rehabilitation of functional deficits, caused by damage of central nervous system, is associated with the restructuring of the higher psychological functions and the brain functional systems. The methodological basis of the possibility of such adjustments is the notion of “systemic organization of mental functions” (Mikadze, 2014).

In his monograph “Restoration of function after brain injury” (1948/1963), Luria describes two types of consequences of brain injury. The first one is associated with the destruction of the brain tissue and is irreversible. The second one refers to those abilities that can be partially recovered. In this second case, a restructuring of the lost function is required. The brain organization of the function will radically change its psychophysiological structure and will begin to use a new “brain system” (Luria, 1948/1963, p. 35). Luria identifies that the main forms of such reconstructions are associated with both, intra and inter-system reorganization. Intra-system restructuring provided by internal reserves of each functional system relocates the components or changes the level of organization of the injured functions. Inter-system restructuring is associated with the involvement of new components, which were not previous used in this system. From the anatomical point of view, for restoring a mental function, there are two potential strategies. One involves the transfer of the function from the damaged area to another related intact area. The second one is associated with the transfer of the functions from the damaged area to symmetric area of the contralateral hemisphere.

Luria strongly emphasized the importance of motivation and self-activity of the subject in the rehabilitation training.

Application of Lurian Neuropsychological Principles to Cognitive Rehabilitation

Theoretical foundations of cognitive rehabilitation were laid after the Second World War in his books “Traumatic aphasia” (1947/1970) and “Restoration of functions after brain injury” (1948/1963). In these books Luria described two main strategies of higher mental functions rehabilitation: disinhibition of inhibited functional components, and reorganization of the affected functional systems.

When applying disinhibition strategy, it is important to demonstrate the patient’s capability to overcome the inhibited condition. This condition can be changed only if the inhibited system is partially incorporated into a conscious functional system. For example, if patient with severe motor aphasia, who cannot speak, is involved in singing a well-known song, he/she may at first be able to convey only a melody without words, and only later contours of words that finish up the lines may appear. Realization of own success is a good motivation for further work.

In the second strategy of higher psychological processes restoration, which is the main way of rehabilitation work, the damaged functional system is reorganized using inter- and intra-system functional restructuring. Let us consider prerequisites and principles of the second restoration strategy in more detail. Vygotsky and Luria’s experiments on gait rehabilitation in patients with Parkinson’s disease, conducted at the end of the 1920s and the beginning of the 1930s, have demonstrated transfer of the activity to a different, consciously controlled level, using a mediation (for example, cards laid on the floor). This strategy allows to effectively rebuild the functional system of gait. Based on the results of these experiments, and on understanding of development as a process of internalization, Vygotsky wrote “Initially all these functions (higher forms of speech, cognition, and action) operate in intimate connections with external activity and only later on change into the inner activity. Research into compensatory functions which develop in these disorders also shows that objectification of a disturbed function, i.e. bringing it outside and changing it into external activity, is one of the basic roads in the compensation of disorders” (Vygotsky, 1997, p. 143).

An example of transfer of internal actions into external activity can be the following technique suggested by Luria to overcome difficulties in building inner programs of utterances in patients with dynamic aphasia. He illustrates the procedure with a specific example. When a particular patient with dynamic aphasia was already able to construct separate phrases, but is still unable to develop the plan for narrating a story, Luria explained such method for rehabilitation in the following way: “In order to help him overcome this defect, the therapist shows him how to break down the formulation of the plan into two steps. The first step consisted of writing down all the component statements in the story without regard to their order; the second was to organize the externalized components into a single plan. It was hoped that in this way he might create external conditions whereby the order of thought could be restored. A rather long story was read to him and he was asked to write down on
separate cards all of the events in the order he recalled them. Having recovered the individual episodes he was allowed to rearrange the cards in correct sequence. Once this was accomplished he had no difficulty in relating the content of a story by referring to the cards on the table before him” (Luria, Naydin, Tsvetkova & Vinarskaya, 1969, p. 455).

Later the topic of cognitive rehabilitation was being developed by Luria together with his colleague Tsvetkova and her coworkers of Laboratory of Neuropsychology that she directed. At the same time, two other Luria’s students, V.M. Shklovsky and E.P. Kok, were concurrently developing an interdisciplinary approach to neurorehabilitation. Initially, Tsvetkova’s group worked on cognitive rehabilitation of mental functions (especially speech) in adults with brain pathology. As a result, system of qualitative and quantitative assessment of different types of aphasia and rehabilitation techniques specific for each type of aphasia were developed; they are currently widely used when working with such patients (Tsvetkova, 1972b; Tsvetkova, Akhutina, & Pylaeva, 1981).

The basis of these systems of methods consists of the principles of restorative teaching that were developed by Tsvetkova. They include: (1) Uncovering of the primary defect underlying the speech problems and setting goals for the restorative teaching. (2) Utilization of intact components of functional systems. (3) Use of intact levels of activity realization (e.g., if writing is disturbed, the patient still may be able to use highly automatized writing skills: own signature, writing mathematical calculations, etc.). (4) Restoration of the function as an integral activity, i.e. restoration in active self regulating rather than passive form. Specifically, this principle assumes first of all restoration of communicative function of speech, rather than its separate aspects (such as naming, repetition, and so on). (5) Programming (or external guidance) of damaged functions restoration (Tsvetkova, 1972b, p. 23–24).

Luria’s approach to cognitive rehabilitation represents the basis for the further development of neuropsychological rehabilitation and correction of learning disabilities (Akhutina & Pylaeva, 2012). Indeed, Luria can be regarded as the pioneer of neuropsychological rehabilitation. The innovative work of Ben-Yishay and Diller in USA is directly based in Luria’s ideas, strategies, and theoretical interpretations (e.g., Ben-Yishay & Diller, 1981; Ben-Yishay, Gerstman, Diller, & Haas, 1970; Diller & Gordon, 1981). During the following years, and particularly during the 21st century, neuropsychological rehabilitation has become one of the major areas in neuropsychology professional activity (e.g., Evans, Gast, Perdices, & Manolov, 2014; Sohliberg & Mateer, 2017).

In her book, dedicated to Alexander Romanovich Luria, Barbara Arrowsmith Young describes how her reading of “The man with the shattered world”, (which she discovered in 1977 just after Luria’s death), changed her life. Zasetsky’s symptoms, caused by brain damage as a result of war wounds, were very similar to her own learning disabilities. Believing in the plasticity of the human brain (Doidge, 2007), she used Luria’s approach to rehabilitation of Zasetsky to correct her own problematic cognitive functions. Inspired by her own success, she developed a system of treatment exercises. Since 1984 she has directed a school in Toronto, Canada and several branches in other English-speaking countries which follow her approach with creative complementary tests and exercises (Arrowsmith-Young, 2012; Eaton, 2011).

Conclusion

Luria’s ideas developed specially during the mid 20th century have significantly impacted the further development of neuropsychology. New neuropsychological assessment procedures and cognitive rehabilitation techniques have been developed during the late 20th and early 21st century based in his conceptual interpretations about the brain organization of cognition and their disturbances in cases of brain pathology.

Conflict of interest

None declared.

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