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MEETING IN THE MIDDLE: LURIA'S APPROACH AND COGNITIVE APPROACH TO SPOKEN LANGUAGE IMPAIRMENT IN APHASIA

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El objetivo de este artículo es comparar y analizar dos enfoques de la afasia: La teoría de localización dinámica sistémica de las funciones mentales superiores desarrollada por A.R. Luria y modelo neurocognitivo de doble ruta. Hasta donde sabemos, nunca antes se había realizado un análisis comparativo de estas dos teorías. Encontramos similitudes entre estas dos teorías, así como diferencias entre ellas. Una de las diferencias clave es que, si bien el enfoque de Luria ve varios síntomas como consecuencias sistémicas de un impedimento primario, el modelo de ruta dual ve estos síntomas como independientes y no relacionados. Esta gran diferencia entre dos enfoques puede explicarse: el enfoque de Luria está en línea con el clásico «análisis del síndrome» de la afasia, al contrario del enfoque cognitivo, que asume que los síndromes clásicos son incapaces de explicar toda la diversidad de síntomas clínicos.
Palabras clave: *Afasia, Luria, Modelo de doble ruta, Habla, Neuropsicología.*

The aim of this paper is to compare and analyze two approaches to aphasia: The systemic dynamic localization of higher mental functions theory developed by A.R. Luria and neurocognitive dual-route model. To our knowledge, comparative analysis of these two theories was never done before. We found similarities between these two theories, as well as differences between them. One of the key differences is that while Luria's approach views various symptoms as systemic consequences of a primary impairment, the dual-route model sees these symptoms as independent and unrelated. This major difference between two approaches can be explained: Luria's approach is in line with classic "syndrome analysis" of aphasia, contrary to the cognitive approach, which assumes that classic syndromes are unable to explain all diversity of clinical symptoms.
Key words: *Aphasia, Luria, Dual-route model, Speech, Neuropsychology.*

Aphasiology is one of the main branches of neuropsychology. It made a significant contribution to our understanding of mental functions. Analysis of aphasic deficits allows to conclude which psychological components are essential for speech processing. Luria's classification of aphasias is one of the most popular approaches of aphasia diagnostics in Russia, but it is also well known and used in the countries of Latin America, Mexico, Australia and others. One of the most common approaches in the European Union and in the United States of America are the spread activation theories, the module approach, as well as the symbol approach. The dual-route model is based on symbol approach and was chosen for the present analysis as one of the most influential models of speech processing in cognitive neuropsychology. It was developed in line with the so-called symbolic approach in cognitive psychology. The dual-route model is related to the classic structuralist approach Wernicke–Lichtheim Model of Aphasia. Luria's theory was based on accomplishments of functionalist approach, which investigated the structure of mental functions (Luria, 1962, 2002).

The aim of this paper is to conduct a comparative analysis between syndromes of aphasia, described by Luria, and elements of spoken speech described in the dual-route model. Such a comparison is possible, since both dual-route model and Luria's neuropsychological approach define speech as a complex process which includes different elements. Thus, investigating the structure of speech processing is one of the main aims of both approaches.

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THE DUAL-ROUTE MODEL

Based on the computer metaphor, the dual-route model defines speech as a complex system, which includes preassigned elements which interact with each other (Coltheart, 2017). Blocks of information processing and storage are one of these elements. All these elements are interrelated, which is why it is possible to describe speech processes in terms of their interactions. Words are the main elements of information, which are processed in the cognitive system. More general speech elements are not examined in this model.

The basic principles of symbolic neurocognitive approach were formulated as (Caramazza, 2006; Coltheart, 2017; Whitworth et al., 2014): 1) universality of cognitive architecture (cognitive system is organized in a similar way among different individuals and includes basic cognitive processes and representations); 2) transparancy (patients with brain lesions have a similar cognitive system, except for some singular impaired elements, which express themselves in the way how patients perform different tasks). If standard components, responsible for a particular speech process, are impaired, the patient is still able to complete the task, relying upon other elements of the cognitive system. This does not signify that a new cognitive structure is developing, to the contrary, it means that other, already existing

speech processing systems are activated. This principle was also formulated by Max Coltheart in 2001 (Coltheart, 2001): damages of a cognitive system can express themselves in impairments of its elements, but not in the development of new elements.

The first stage of information processing in the dual-route model includes the process of stimulus perception and primary analysis of its physical acoustic characteristics (Block 1 in Figure 1). The second stage includes phonological input buffer (Block 2). This block is a storage of separate phonemes, which are stored as perceptive images. Auditory stimulus which is processed in this block, is compared to different phonematic elements. This allows to transform the primary auditory stimulus in a sequence of phonemes, which represent a system of speech codes. Phonological input buffer also acts as a short-term memory, which keeps a sequence of coded phonemes (Jacquemot et al., 2006). The next stage of processing includes a phonological input lexicon (Block 3), which contains stable auditory images of words: a sequence of phonemes, which is contained in the phonematic input buffer, is compared to a holistic auditory image of words. As a result of this processing, cognitive system concludes whether this auditory stimulus is a sequence of speech sounds or an existing lexeme. Next, a selected auditory image is processed in the block of semantic system (Block 4), which is a storage of meanings. During this stage of processing, a perceived lexeme is compared to a meaning which is associated with it. The process of speech processing terminates.

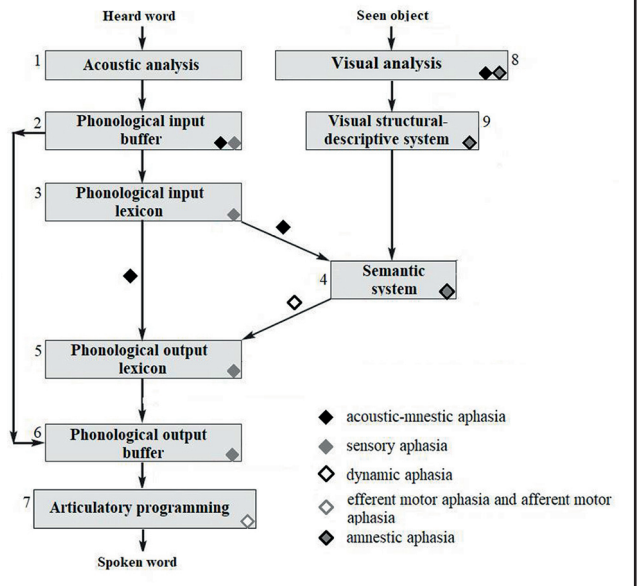
The process of speech production begins in the semantic system (Block 4). The information is processed in a phonological output lexicon, which also stores auditory images of words (Block 5). Similarly to other blocks, this lexicon is called an "output" lexicon, because it takes part in processes of expressive, but not impressive speech. This block is similar to the phonological input lexicon, however it compares activated semantic meanings with lexemes which express them. The next step is the phonological output buffer (Block 6), where a holistic lexeme is once again split up in a sequence of phonemes. Similar to a phonetic input buffer, this buffer also acts as a short-term memory, as it stores a sequence of phonemes. Such a differentiation of a holistic auditory image into separate phonematic elements, while storing their sequence, is essential for the spoken speech processing: we consistently pronounce every phoneme, which constitutes a word as a whole. Finally, prepared sequence of phonemes is processed in the block of articulatory programming (Block 7), which stores articulatory schemes. Every phoneme is connected to a corresponding motor pattern, which allows motor implementation of spoken language. It should be mentioned that some researchers assume that the block of articulatory execution should not be included in the cognitive scheme of the dual-route model. They assume that this process is not cognitive in its nature, but motor (Coltheart et al., 2001).

Describing sequence of processes above, we analyzed the first cognitive pathway: lexical-semantical pathway (Beeson et al., n.d.; Caramazza, 2012; Coltheart et al., 1993). This pathway is related to semantic system and phonological lexicons. Thus, it is responsible for speech perception and spoken language. However, this model also includes a second pathway: non-lexical (Coltheart et al., 1993). It is directly linked to the input (Block 2) and output phonematic buffers (Block 6). This pathway is related to operating speech sounds which do not connect in holistic words. The assumption that this pathway exists is necessary in order to explain such processes as perception and pronunciation of syllables, unknown words and meaningless sequences of speech sounds. Elements of speech which were processed in the system are not further processed in the blocks of phonematic input and output lexicons.

Despite its traditional historic title, the dual-route model includes one more route: lexical non-semantic route (Raymer, 2001; Caramazza, 1991; Coltheart et al., 1993; Patterson, 1986). This route is connected to the input lexicons (phonological and graphemic) with corresponding output lexicons, bypassing the semantic system block. The assumption that this route exists allows to explain the phenomena of repeating a word without understanding its meaning. In this case, each word is perceived as a holistic entity, however, its understanding is impaired, because the connection between input lexicon and semantic system is disrupted. Because of this, patient is unable to detect the meaning of the perceived word, although he or she is able to correctly repeat the word.

Moreover, the dual-route model describes the process of recognition and naming of objects. This process also begins with the visual analysis of a stimuli via its physical characteristics (Block 8). Next, there is a connection with the block of visual structural-descriptive system (Block 9). This block contains stable visual images of different objects. These images are stable standard images of all objects which were perceived earlier. Initially non-recognized stimuli are compared to these images and identified as familiar objects. Further, visual objects are connecting to particular meanings in the semantic system (Block 4) and thus become meaningful. The next

FIGURE 1
COGNITIVE DUAL-ROUTE MODEL OF SPEAKING PROCESS



stage of information processing can be described in line with already described schemes: via the corresponding structures of spoken language. Object naming can be also executed through the lexical-semantic processing – through the semantic system (Block 4) to the phonological output lexicon (Block 5), phonematic output buffer (Block 6) and, finally, to the articulatory coding block (Block 7).

LURIA'S CLASSIFICATION OF APHASIAS

We will now compare the syndromes of aphasia, described by Luria, with the impairments of different components of speech processing and connections between them in the dual-route model.

Luria's neuropsychological approach defines speech as one of the complex functional systems, which includes many different elements and relies on joint activation of different brain regions. When any of these regions is impaired, the whole speech processing suffers, but every time this impairment is specific: it depends on the function, which was related to this particular impaired brain region, and on the secondary systemic impairments which were induced by this initial impairment, as well as on the functional reconstructions which developed because of it. Such a qualitative structural analysis allows to investigate the mechanism which underlies the impairment, as well as to investigate the mechanism of the normal, unimpaired function (Akhutina, 2014; Luria, 1962, 2002).

Depending on the primary impairment, Luria defines different types of aphasia. Each of these types of aphasia is related to a specific impairment of speech processing. Luria defined the following types of aphasia:

1. Sensory aphasia

The primary impairment in sensory aphasia is the inability to conduct phonematic analysis, which causes inability to understand spoken language, as well as the so-called "word salad" speech impairments (Luria, 2008). Because of the unstable phonematic structure of a word, the patients' speech is incoherent, as well as its grammatical form. The ability to repeat spoken language is severely impaired as well. Because of the disintegration of auditory structure of the word, the connections between this word and the object which it designates interrupts.

According to the dual-route model, the block of phonematic input buffer is responsible for the phonematic hearing. Consequently, in line with the dual-route model, the symptoms of sensory aphasia can be explained as a result of an inability to transform auditory signal into a phoneme, because the storage of phonematic perceptive standards is impaired.

Moreover, in order to explain the impairment of expressive speech in sensory aphasia in line with the dual-route model, it is essential to assume an impairment of the phonological output lexicon, as well as its connection to a phonematic output buffer and semantic system block. This can explain literal and verbal paraphasias develop in spoken language. Literal paraphasias in expressive speech are consequences of the phonological output lexicon impairment, as the latter contains auditory images of words. Impaired auditory images of words essentially cause distortions in pronunciations of different words. In this case, a transition between a holistic auditory image of a word and its phonematic analysis is impaired, which causes the impairment of the word's structure and pronunciation of incorrect syllables. Moreover, literal paraphasias can develop because connection between phonological output lexicon and phonematic output buffer is impaired.

Verbal paraphasias are related to a disruption of the connection between semantic system block and phonological output lexicon. Auditory images of words are intact, as well as their meanings, but the connection between them is impaired. As a result, patient replaces a required word sounding, which corresponds to a particular meaning, with a different word sounding, which is intact in its structure, but is connected to a completely different meaning. Difficulties in naming different objects are explained in a similar way.

Alienation of the word's meaning assumes an impairment of connections between phonological input lexicon and semantic system block, which contains the words meanings. In this case, even using lexical-nonsemantic pathway, it is not possible to avoid difficulties while repeating words. Because, as it was already mentioned above, phonological output lexicon and its connection to phonematic output buffer are impaired.

2. Acoustic-mnestic aphasia

The core impairment of acoustic-mnestic aphasia is related to the auditory-speech memory impairment (Luria, 1962). Because of it, the following symptoms develop: difficulties of spoken language understanding and verbal paraphasias.

The second mechanism, which underlies acoustic-mnestic aphasia, is related to the impairment of images and representations of the objects. This impairment causes inability to activate a correct word which corresponds to these objects, and results in the nominative difficulties described above.

In line with the dual-route model, the first mechanism of acoustic-mnestic aphasia is related to phonematic input buffer. As mentioned above, this block is responsible not only for perception and storage of phonemes, but acts as a short-term memory. The second mechanism which underlies acoustic-mnestic aphasia is related to the impairment of the visual descriptive system (Block 9). Degradation of images and representations of the objects in this case is the reason of the verbal paraphasias described above.

Disruption of the connection between phonological input lexicon and semantic system block explains the "alienation of the meaning of the word", which develops although the ability to repeat the word is intact. However, patient can still rely on lexical-nonsemantic pathway: a direct transition from phonological input lexicon to the output, bypassing the semantic system. Thus, patient is able to perceive and correctly repeat the word, but unable to define its meaning. It still cannot be concluded that connection between two lexicons is fully intact, because these patients have difficulties repeating sequences of words.

3. Amnestic aphasia

The main cause of amnestic aphasia, according to A.R. Luria, is the impairment of internal semantic web of notions (Luria, 1962, 2008). Difficulties in object naming are the leading symptom, which develops

as a result of the parietal-occipital lesions in the left hemisphere. However, a hint (e.g., the first syllable of the forgotten word) is sufficient to help the patient with amnestic aphasia to name the object correctly, which is not the case for patients with acoustic-mnestic aphasia. Impairment of nominative function of speech causes verbal paraphasias. In line with the dual-route model, such a disruption in the web of the meanings probably corresponds to the disruption of the semantic system, which is the storage of all word meanings and their interconnections.

The second mechanism which might underly the amnestic aphasia, according to A.R. Luria, corresponds to the one already described for the acoustic-mnestic aphasia (Luria, 1962, 2008). Trying to explain the difficulties of object naming, the author refers to the impairment of internal images-representations of these objects. Unable to rely on the image-representation of the object, the patient is unable to detect the key characteristics of the object and, subsequently, to detect the meaning which corresponds to it. In line with the dual-model route, a similar mechanism can be observed in the block of visual structural-descriptive system: the holistic image of the object is developing as a result of synthesis of visual impressions. In this case, amnestic aphasia can be defined as an impairment of this block, which causes the disruptions of images-representations of the objects. Thus, patient it unable to rely on them in order to switch to the next block of semantic system.

4, 5. Efferent motor aphasia and afferent motor aphasia

According to A.R. Luria, efferent motor aphasia and afferent motor aphasia are both related to the motor type of aphasia. However, the primary impairment of these two aphasias is different: kinetic analysis and synthesis and kinetic organization of subtle speech processes aphasia (Luria, 1962, 2008).

Afferent motor aphasia causes inability to articulate appropriate sounds of speech. Speech of these patients is characterized by literal paraphasias and mixing speech sounds, which have different acoustic traits, but have similar articulation.

Efferent motor aphasia causes difficulties in switching from one articulated speech sound to another, which disrupts pronunciation of words. At the same time, pronunciation of isolated speech sounds can be intact. However, previously automatically executed sequences of efferent operations, which switch smoothly and result in a correctly articulated scheme of the word, are impaired (Akhutina, 2014; Luria, 1962).

Such a distinction between two types of motor aphasias is impossible in line with the dual-route model. As we already mentioned above, some researchers consider that motor component should not be included in the structure of the cognitive system (Coltheart et al., 2001), because it is not cognitive, but motor in its nature. However, other researchers consider the block of articulatory coding (Coltheart, 2006; Whitworth et al., 2014; Wilshire, 2008), which is situated after the phonematic output buffer and before the process of spoken speech production. Accordingly, the mechanism of motor aphasic impairments in line with the dual-route model is related to the deterioration of articulatory schemes, which are stored in the articulatory coding block. Luria considered that earlier theories did not differentiate these two mechanisms of motor aphasia as two distinct mechanisms, which is also the case of the dual-route model (Luria, 1962).

6,7. Dynamic aphasia and semantic aphasia

According to A.R. Luria, dynamic aphasia is related to the impairment of speech coding which causes difficulties of active spoken language development (Luria, 1962, 2008). In line with the dual-route model, a similar mechanism impairs the connection between semantic system block and phonological output lexicon. Patients with dynamic aphasia have intact speech elements, however the active dynamic speech production process is impaired. Thus, speaking (e.g., repeating) is available for these patients, but not as an active productive process.

Syndrome of dynamic aphasia is characterized by a phenomenon of agrammatism(Akhutina, 2014, 2002). However, such an impairment of grammatical aspect of speech cannot be explained in line with the dual-route model. As mentioned above, the dual-route model attempts to explain speech processing on the level of words and phonemes. Thus, agrammatical impairments, which are related to different levels of speech processing, cannot be explained on the level of words and phonemes. To explain these impairments, other approaches can be used. For example, N. Chomsky's conception of generative grammar (Caplan & Marshall, 1976; Garraffa & Fyndanis, 2020).

The same applies to the syndrome of semantic aphasia: according to Luria, speech is impaired at the syntagms level. Thus, this aphasia cannot be explained in line with the dual-route model. Patients with semantic aphasia do not have difficulties with articulation or phonematic hearing. Understanding of distinct words and simple phrases is intact as well. Considerable impairments appear in more complex processes of speech: logical grammatical constructions, which express spatial and other complex relations (for example, comparative or attributive relations).

CONCLUSION

We compared syndromes of aphasia according to Luria and the dual-route model. It is possible to compare these two models, because both of them define speech as a complex process. At the same time, there is an important distinction between those two models: various symptoms of speech impairment are described by Luria as systematic consequences of one primary impairment, they are thus included in one particular syndrome of aphasia. The same symptoms can be viewed as distinct impairments of speech in line with the dual-route model.

This distinction between two models can be explained. Luria's model was developed in the middle of XX century, when syndrome analysis principle (initially developed in medicine) was one of the major principles of aphasiology. In line with this principle, various symptoms were explained as a result of one primary impairment. As a result of this approach, the well-known aphasic syndromes were described: the Wernicke–Lichtheim's syndromes, Goodglass's syndromes, Head's syndromes, etc. Luria's approach to aphasia was made in a similar way.

However, as time passed by, many case studies described patients which had a dissociation of symptoms, which were earlier considered as related to one syndrome. This fact stimulated cognitive approach in neuropsychology to detail our understanding of speech processes. As a result, syndromes described by Luria and other researchers were considered as a set of symptoms, which are not necessarily connected to one singular primary impairment. This fact can explain the differences between the Luria's approach and the dual-route model, described in this paper.

Finally, we can conclude that the dual-route model does not reject the classic syndromes of aphasia, but details them. The double-route model analyzes the same aphasic syndromes as the Luria's model does. However, it considers different mechanisms of impairment. The advantage of the dual-route model is a more detailed investigation of the impairments which underly the symptoms, as well as mode detailed description of impairments and dissociations. For example, according to the dual-route model, various impaired speech mechanisms underly the sensory aphasia. While in line with Luria's model, one single factor's impairment underlies sensory aphasia. At the same time, Luria includes the feedback component in his analysis of the mechanisms of speech impairments, which is lacking in the dual-route model. We attempted to reveal these and other differences between two approaches which attempt to explain the same types of aphasia: Luria's approach and the dual-model route.

The mutual enrichment of both models by achievements of each of them is one of the main results of this paper. Comparing these two models contributes to clarifying and identifying the mechanisms which underly speech impairments. Moreover, it contributes to our understanding of these impairments and allows to identify the advantages and disadvantages of both approaches. In its turn, clarification and investigation of mechanisms which underly the impairments will contribute to our understanding of rehabilitation processes. In line with Luria's syndrome approach, the primary and secondary symptoms are identified, which allows to develop an adequate rehabilitation program in line with human centered approach. Compared to the dual-route model of aphasias, Luria's approach also allows to overcome its limitations, related to its applicability uniquely on the level of words. Luria's classification of aphasias explains the speech impairments on the level of words, but also on the level of sentences and texts – more general speech units. The dual-route model, in its turn, identified detailed speech mechanisms which can more flexibly explain symptoms and dissociations, which are rarely explained in line with Luria's syndrome approach. At the same time, the dual-route model did not develop the idea of the interplay between the impairments. In line with the dual-route model, all effects of impairments pointed in one direction, while in line with Luria's model all effects have different directions (according to his mechanism of feedback). Consequently, comparing these two approaches may enlarge psychological discussion, dedicated to our understanding of the structure of speech processing. Moreover, it builds the bridge between two neuropsychological schools, overcoming theoretical disconnection and leading to collaboration.

CONFLICT OF INTERESTS

There is no conflict of interests

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