University of Messina

ISSN 2612-4033

Journal of Clinical & Developmental Psychology

Journal homepage: http://cab.unime.it/journals/index.php/JCDP/index

Autobiographical amnesia following Arteriovenous Malformation, case report

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ABSTRACT

Aim: The aim of the current study is the description of an emblematic case of a ruptured left temporal arteriovenous malformation (AVM) causing a large intraparenchymal temporo-parietal left hematoma that resulted in a severe retrograde amnesia.
Methods: The patient underwent neurosurgical evacuation of the hematoma and resection of the AVM. He was also submitted to several pre- and post-operative neuropsychological evaluations and to rehabilitation for different subdomains of both memory and language.
Results: At the end of the rehabilitation course, a new neuropsychological assessment was performer together with a functional cortical mapping Navigated Transcranial Magnetic Stimulation (nTMS) to evaluate the focal damage to and the plastic recovery of language cortical areas.
Discussion: This case report must be ecologically oriented and based on the relationship between the importance and the nature of the cognitive and type of claims of the specific environment of the individual; that a rehabilitative path cannot ignore a holistic approach that considers the effects of the injury on the emotional and psychosocial states of the person and his family members.

Keywords: *Arteriovenous Malformation; Transcranial Magnetic Stimulation (nTMS); Amnesia; Aphasia; Neuropsychological Rehabilitation*

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https://doi.org/10.6092/2612-4033/0110-2103

Introduction

AVMs are vascular malformations composed of a tangle of dysplastic arterial vessels (the nidus), passing through brain parenchyma, and directly converging into usually enlarged discharging veins, without the interposition of the capillaries.

The arterial and venous circle form a high flow - low resistance shunt. This condition of increased blood flow and abnormal pressure is discharged to draining veins, and may sometimes result in the rupture of veins, thereby causing a brain hemorrhage.

AVMs can be managed using different approaches, including observation, microsurgical resection, endovascular embolization, and stereotactic radiosurgery alone or in combination according to the complexity of the malformation.

Regardless of the treatment modality, the rupture of an AVM can have dramatic consequences at a personal (cognitive and emotional), familiar and social level. Following the compromising of the regulatory systems of the cortical and subcortical circuits, the human activity suffers a severe alteration, both on a motory and sensorial level, as well as with cognitive, emotive and affective function (Zettin, La Foresta e Quattropani, 2017). The manifesting of a certain cognitive disorder does not however depend on the damage made to a specific cerebral area, but from the connections and associations that this establishes in the course of the experience: the human brain is infact a complex web of interconnected regions. A specific cognitive function is not attributable to the activity of a single region, but derives from the network as a whole, that is from the “Cerebral Connectome” (Bullmoree & Sporns, 2009; Helmstaedter, Seung, et all. 2013).

A course of rehabilitation cannot therefore disregard a program that implements holistic approaches, focused on the individual, that take into account the various aspects that the disability can take on, such as on a cognitive, neurobehavioral, emotional, affective and social level (Prigatano, 2013).

This case study suggests that the planning and the carrying out of courses of rehabilitation should be ecologically oriented and tailored to the relationship between the importance and nature of the cognitive damage and the type and entity of the specific environment of the individual; that a rehabilitative course cannot disregard a holistic approach that takes into account the effects of the damage on the emotional and psychosocial state of the person and of his familiar relations.

Case Report

Medical history

On the 25-01-2018 the patient G.S., 43 years old, came to the Division of Neurosurgery at the University Hospital of Messina, Italy, with a severe alteration of his speech and a fierce headache. The magnetic resonance scan showed a large left temporal and parietal intraparenchymal hematoma caused by the rupturing of the arteriovenous malformation to the left temporal lobe (Figure 1).

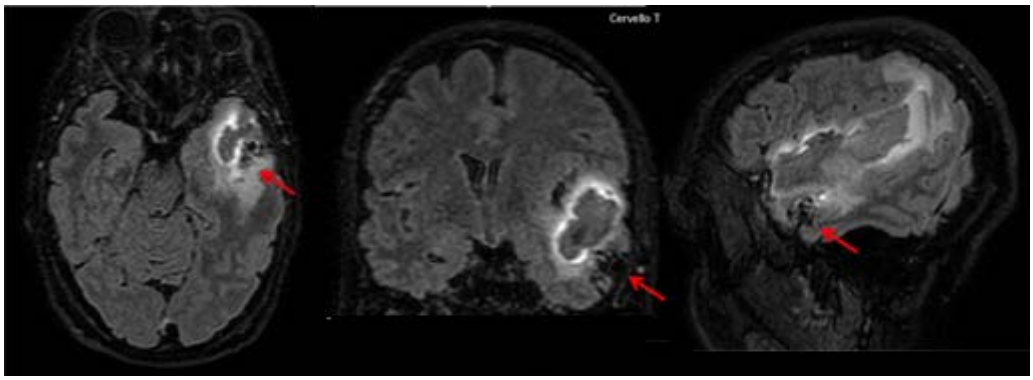


Fig. 1. The magnetic resonance scans.

It was discovered to be a severe hemorrhagic stroke, such that the patient appeared confused with severe spatial, temporal and personal disorientation. His speech was characterized by the presence of few syllabic fragments and stereotypical expressions without any real informational value (like for example the repetition of numbers and of the date of birth); comprehension was also completely absent; the patient could not manage to decode the meaning of the questions asked to him. For this reason, it was essential to collect his medical history from his family members.

Neuropsychological Assessment

Acute Phase: the first evaluation was carried out on 01.02.2018, with the delivery of the battery *Esame Neuropsicologico Breve-2* (Mondini, Mapelli, Vestri e Bisiacchi, 2011) and *Western Aphasia Battery-revised* (Kertesz, 2006).

The patient, bedridden, showed collaboration even if he didn't seem to understand the meaning of what was asked and showed to have great difficulty even in saying his own name. The cognitive picture appeared to be characterized by the total alteration of all functions. His speech was severely compromised as well as his mnemonic functions.

Specifically, the linguistic aspects differed strongly from the norm: the articulation was slow, stunted, tired; the speech was characterized by meaningless phonemes and few automated phrases, in response to any question. Furthermore, there was a lack of comprehension: the patient could not manage to give meaning to what was asked to him and was unable to decode the syntactic structure.

The general overview of the patient was characterized by an acute cognitive slowing down, the score was null in the single sub-tests, except in the drawing copying test. The performance as a whole was widely below the norm (O.S.: 15; cut-off: 77), invalidated largely by the language disorder. The assessment, through the carrying out of the Western Aphasia Battery revealed a state of global aphasia (table 1).

Esame Neuropsicologico Breve2 (ENB-2)	Scooring	CUT-OFF	Norm
DIGIT SPAN	0	5	ALTERED
IMMEDIATE RECALL PROSE MEMORY	0	8	ALTERED
DELEY RECALL PROSE MEMORY	0	11	ALTERED
INTERFERENCE MEMORY 10SEC	0	6	ALTERED
INTERFERENCE MEMORY 30SEC	0	4	ALTERED
TRAIL MAKING TEST A	123	55	ALTERED
TRAIL MAKING TEST B	259	142	ALTERED
TOKEN TEST	1.5	5	ALTERED
WORD PHONEMIC FLUENCY	0	10	ALTERED
ABSTRACTION	0	4	ALTERED
COGNITIVE ESTIMATION TEST	0	4	ALTERED
INTRICATE FIGURES TEST	0	32	ALTERED
COPY DRAWING	2	2	NORM
DAISY DRAWING	0	2	ALTERED
CLOCK TEST	0	8	ALTERED
APRAXIA TEST	1	6	ALTERED
OVERALL SCORE	**15**	**77**	**ALTERED**
Western Aphasia Battery (WAB-R)	Scooring		
SPONTANEUS SPEECH	1		
AUDITORY VERBAL COMPREHENSION	3.85		
REPETITION	0.2		
OBJECT NAMING	0.6		
APHASIA QUOTIENT	**11.3**		

Table 1. Scooring ENB-2; Scooring WAB-R

Language disorders are generally a consequence of damage to the left cerebrum and may involve different domains. Hickock and Poppel (2000-2004) first suggested the actual modern interpretation of the complex linguistic connectome that is composed of a dorsal stream, largely involved in the phonetics and articulation of language, and of a ventral stream, largely involved in semantics (Poeppel et all., 2012). The *dorsal stream* has a one-sided distribution in the left hemisphere. At the cortical level, it includes the primary auditory cortex, the temporal planum, the area of the posterior parietal, the premotor and prefrontal cortex, while on a subcortical level it mainly involves the superior longitudinal fascicle (SLF) and the arcuate fascicle (AF). The dorsal stream is responsible for the processing of spatial forms of perception, and for this is named the "*where*" pathway, taking on a role of primary importance in the processes of auditory-motory conversion (Pulvermuller et al., 2006). Injury to the dorsal stream is in fact responsible for dysarthria or non-fluent aphasia.

The *ventral stream* instead is bilaterally distributed. At a cortical level, this includes the primary auditory cortex, the front of the anterior superior temporal gyrus and the opercular and triangular part of the frontal lobe- At the subcortical level it primarily involves the inferior fronto-occipital fasciculus (IFOF), the inferior longitudinal fasciculus (ILF), and the uncinate fasciculus (UF). The

ventral stream is named the "*what*" pathway, taking on a role of primary importance in the processes of perceiving and identifying the stimulus for language comprehension. Injury to the subcortical ventral stream are in effect associated with severe language comprehension deficits.

In the present case report, the left temporal-parietal intraparenchymal hematoma has therefore compromised the functioning of the complex language connectome, weakening and eliminating the various connections, causing the patient's speech disorder (Figure 2).

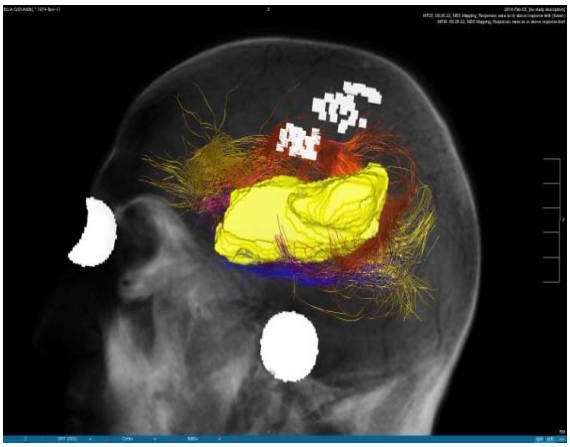


Figure 2 - The nidus is highlighted with the beams adjacent to it: **AF; ILF; IFOF; CST ARM.**

On the 06-02-2018 the patient underwent surgical clipping (Figure 3a) of the afferent arteries to the AVM, resection of the nidus, and drainage of the hematoma (Figure 3b).

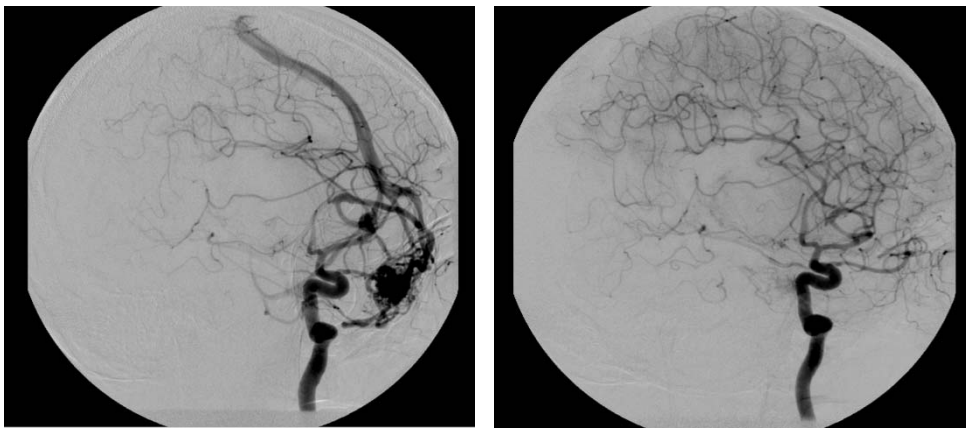


Fig. 3a - Pre-operative angiographic image; 3b - Post-operative angiographic image

Post-Acute Phase: two days after surgery, a second neuropsychological assessment was carried out showing some slight improvements.

The patient, still bed-ridden, collaborated during the interview and in the undertaking of the assessment, even if, as with the pre-operative phase, he didn't seem to fully understand the

importance of what was asked of him. He seemed, *hic et nunc*, aware of his difficulties even although he found it difficult to believe, alternating between moments of disbelief and amazement to moments of severe distress through having a minimal insight to future implications. He didn't remember any of the traumatic event itself, but he managed to recount what was reported back to him by doctors and family. An improvement on the whole was deduced regarding his space-time orientation but no changes about personal orientation was observed. It was immediately evident that the most serious disability was in the severe impairment in the autobiographical, semantic and episodic aspects of long-term memory. The patient reported, albeit in monosyllables, paraphrases and verbal stereotyping, to not remember any event involving himself: he did not know who he was, what he had done in his life. He did not know anything about himself if not his name and date of birth, information frequently reported to him by hospital staff and family.

The difficulty recollecting refers therefore to all autobiographical, episodic and semantic memories preceding the traumatic event, but does not have an effect on the new learning. Patient G.S. learned the names and the duties of hospital staff, remembers the recommendations of doctors and the activities carried out in the pre-operative assessment. There is therefore a disconnection between the learning of new information and the capacity to recall memories. A large portion of the areas injured by the rupturing of the arteriovenous malformation and the consequent hematoma are part of, together with others, an anatomic complex responsible for some mnemonic processes.

As demonstrated by various studies on the medial temporal lobe, the hippocampus and the limbic system constitute essential structures for some forms of memory; by interacting with each other, they support the processes of decoding, retention, consolidating and recovery (Scoville e Milner, 1957).

As of today, despite the large amount of studies being carried out, there is still no agreement on the role of the medial temporal lobe structures on autobiographical memory.

Different authors however assert that a deficit of the autobiographical memory derives from damage to the temporal lobe. (Thaiss e Petrides, 2008; Rayner, Jackson, e Wilson 2015).

The Standard model of Consolidation (Squire and Milner, 1952) supports the idea that the retention of mnesic trace starts in one or more of the polymodal association neocortices (prefrontal cortex, limbic cortex and/ or temporal-parietal-occipital cortex) where incoming information is initially processed. From there it is transferred to the parahippocampal and perirhinal cortices, and therefore to the entorhinal cortex, around the cingulate to the hippocampus, to the subiculum and finally again to the entorhinal cortex. The crucial mechanism of this transfer is in the reactivating, or replay, of the configurations of neuronal activity that involves a short-term consolidation program, for which the information would become transformed in mnesic trace. From the entorhinal cortex

memories are re-sent to the parahippocampal and perirhinal cortex and finally to the areas associated with the neocortex. According to the assumption the role of this memory system should be only temporary, because memories gradually establish themselves in other areas of the brain (Schacter e Tulving, 1994).

The Multiple Trace Theory (Moscovitch e Nadel, 1997) would suggest that the structures of the medial temporal lobe would be involved in recovering episodic memories and the hippocampus would be a fundamental structure able to connect new traces to already consolidated memories, while the semantic memory would be independent despite the fact that it would depend on the hippocampus to form (Moscovitch, Nadel, Winocur, Gilboa, e Rosenbaum 2006; Nadel e Hardt, 2011). There is, therefore, a lateralized network within the left hemisphere responsible for past memories. The injury to the temporal lobe is associated to patient G.S.' disorder in recalling facts pre-morbidly acquired and consolidated and the severity of this deficit is directly proportionate to the entity of the focal damage (Reed and Squire, 1998).

The language skills highlighted a slight evolution. Speech appeared less difficult, although still hesitant and little fluent; at a phonological level it was characterized by phonemic paraphasias that made target words hard to recognize; at the semantic-lexical level the difficulty in finding words remained evident, but the patient tried to make up to this issue through *conduites d'approche*; the simple naming of common everyday objects was challenging and showed a degradation of conceptual knowledge and an alteration of word meanings; the morphosyntactic level was characterized by a simplification of the phrasal structure, with omissions of grammatical words and verbs. Also, verbal comprehension skills resulted less compromised than preoperative evaluation.

Heavy difficulties however appeared in the ability to repeat verbal stimuli, which reflected a primitive disorder in phonological processing.

The results, even if way below the norm, returned a small positive decline with some ENB-2 sub-tests, while the WAB scores highlighted the deficit evolution towards a conduction aphasia (table 2).

Esame Neuropsicologico Breve2 (ENB-2)	**Scooring**	**CUT-OFF**	**Norm**
DIGIT SPAN	3	5	ALTERED
IMMEDIATE RECALL PROSE MEMORY	0	8	ALTERED
DELEY RECALL PROSE MEMORY	0	11	ALTERED
INTERFERENCE MEMORY 10SEC	0	6	ALTERED
INTERFERENCE MEMORY 30SEC	0	4	ALTERED
TRAIL MAKING TEST A	44	55	NORM
TRAIL MAKING TEST B	157	142	ALTERED
TOKEN TEST	3	5	ALTERED
WORD PHONEMIC FLUENCY	3	10	ALTERED
ABSTRACTION	0	4	ALTERED
COGNITIVE ESTIMATION TEST	3	4	ALTERED
INTRICATE FIGURES TEST	4	32	ALTERED
COPY DRAWING	2	2	NORM
DAISY DRAWING	2	2	NORM
CLOCK TEST	0	8	ALTERED
APRAXIA TEST	4	6	ALTERED
OVERALL SCORE	**36**	**77**	**ALTERED**
Western Aphasia Battery (WAB-R)	Scooring		
SPONTANEUS SPEECH	11		
AUDITORY VERBALCOMPREHENSION	7.15		
REPETITION	2		
OBJECT NAMING	2.3		
APHASIA QUOTIENT	**44.9**		

Table 2. Scooring ENB-2; Scooring WAB-R

Post-Acute Phase, Re-Test: on 27/03/2018 a new evaluation has been performed, before the patient's dicsharge, to monitor progress (Table 3).

Esame Neuropsicologico Breve2 (ENB-2)	**Scooring**	**CUT-OFF**	**Norm**
DIGIT SPAN	3	5	ALTERED
IMMEDIATE RECALL PROSE MEMORY	0	8	ALTERED
DELEY RECALL PROSE MEMORY	8	11	ALTERED
INTERFERENCE MEMORY 10SEC	6	6	ALTERED
INTERFERENCE MEMORY 30SEC	0	4	ALTERED
TRAIL MAKING TEST A	21	55	NORM
TRAIL MAKING TEST B	157	142	ALTERED
TOKEN TEST	2.5	5	ALTERED
WORD PHONEMIC FLUENCY	4	10	ALTERED
ABSTRACTION	1	4	ALTERED
COGNITIVE ESTIMATION TEST	3	4	ALTERED
INTRICATE FIGURES TEST	29	32	ALTERED
COPY DRAWING	2	2	NORM
DAISY DRAWING	2	2	NORM
CLOCK TEST	3	8	ALTERED
APRAXIA TEST	4	6	ALTERED
OVERALL SCORE	**49**	**77**	**ALTERED**
Western Aphasia Battery (WAB-R)	Scooring		
SPONTANEUS SPEECH	13		
AUDITORY VERBALCOMPREHENSION	8.45		
REPETITION	5		
OBJECT NAMING	6.1		
APHASIA QUOTIENT	**65.1**		

Table 3. Scooring ENB-2; Scooring WAB-R in Post-Acute Phase

New small improvements with language usage were noted, but the clinical picture resulted overall in deficit. The patient reported impairments affecting different cognitive functions: a language disorder remained, especially with words production, in denomination and fluency; relevant was the damage of the mnesic functions, especially of different long-term, episodic, semantic and

autobiographical memory components. A relative saving of the global intellectual functioning, control functions and learning ability was nevertheless appreciated. However, one could note a deflection of the patient's mood, linked to family problems occurring concomitantly with the traumatic event.

Neuropsychological Rehabilitation

Results Phase: On the first encounter, the patient appeared sufficiently groomed. Speech was poor, interrupted by the presence of anomies and phonological disturbances; it was characterized by simplification strategies, such as the use of direct language, shorter shunters, and by elaboration strategies, such as the use of circumlocutions, use of coordinated sentences in place of subordinate ones, repetitions, self-corrections, comments on one's own language and childish interjections.

Despite the expressive difficulties, Mr. G.S. tried to explain, in more detail, the progress of events according to precise temporal references.

During the report, he appeared agitated and very upset by the separation from his partner, but even more for the inability to see his daughter daily. This event caused a loss of motivation to treatment and a deflection of mood.

Immediately, there was a serious gap with respect to autobiographical, episodic and semantic memory. The state of the patient, from the moment he was discharged, remained essentially the same, except for an improvement in the use of language, although there was still an evident difficulty in the search for words and cannot express the words they want to say.

Mr. G. S. also reported that, in the immediacy of the neurosurgical intervention, he no longer remembered the names of animals and colors, information that at present time, however, was fully recovered. He reported very accurately the dates of birth of all members of his family, but admitted that this information had been taught by his sister after the intervention; this was an indication of his good long-term learning skills. He appeared very motivated to undertake the hopeful rehabilitation work and, due to a lack of insight into the prognosis of his illness, to be able to return to being a security guard, a job that he had always carried out with great dedication.

In light of the data emerging from the assessment process and from the data collected in the cognitive interview, the focus of the rehabilitation project was agreed with the patient. It was decided to favor the recovery of the instrumental functions for daily life activities. The targets of the rehabilitation process were: Production and comprehension; Verbal fluency; Pragmatics of communication; Semantic, episodic and autobiographical memory.

After only 3 months from the start of rehabilitation training, Mr. G.S. has decided to suspend the treatment.

Follow Up

On 30-07-2018 a new control visit was carried out, and the final evaluation recorded an increase in cognitive functions in their entirety and specifically in verbal production and comprehension abilities. Mr. G.S. behaved in an appropriate manner managing to sustain the interview serenely. In several areas of the cognitive domain considerable improvements were appreciated, as reported in table 4.

Some difficulties were highlighted in abstract logical reasoning; even some common knowledge and the ability to estimate appeared to be deficient due to the damage to the semantic warehouse. The contents of thought proved to be adherent to reality, highlighting reduced flexibility and creativity; sometimes the answers to the questions were slightly impulsive with the tendency to trace back on some details considered most important.

Esame Neuropsicologico Breve2 (ENB-2)	**Scooring**	**CUT-OFF**	**Norm**
DIGIT SPAN	3	5	ALTERED
IMMEDIATE RECALL PROSE MEMORY	14	8	NORM
DELEY RECALL PROSE MEMORY	14	11	NORM
INTERFERENCE MEMORY 10SEC	9	6	NORM
INTERFERENCE MEMORY 30SEC	4	4	ALTERED
TRAIL MAKING TEST A	19	55	NORM
TRAIL MAKING TEST B	62	142	NORM
TOKEN TEST	4.5	5	ALTERED
WORD PHONEMIC FLUENCY	7.66	10	ALTERED
ABSTRACTION	0	4	ALTERED
COGNITIVE ESTIMATION TEST	5	4	NORM
INTRICATE FIGURES TEST	27	32	ALTERED
COPY DRAWING	2	2	NORM
DAISY DRAWING	2	2	NORM
CLOCK TEST	5.5	8	ALTERED
APRAXIA TEST	6	6	NORM
OVERALL SCORE	**69**	**77**	**ALTERED**
Western Aphasia Battery (WAB-R)	Scooring		
LINGUAGGIO SPONTANEO	17		
COMPRENSIONE UDITIVO-VERBALE	8.7		
RIPETIZIONE	5.2		
DENOMINAZIONE	7.9		
QUOZIENTE DI AFASIA	77.6		

Table 4. Scooring ENB-2; Scooring WAB-R in Follow-up

The inferred results underline the principles of neuroplasticity (Buonomano, Merzenich. 1998). Mr. G. S.' cerebral cortex, thanks to the rehabilitation program, has been able to dynamically reorganize its connections and answers.

Neuroplasticity has allowed a recruitment of neuronal circuits, different or remote, of the site of the lesion, which determine a compensation, reproducing the injured function in an alternative and sometimes different way.

For this reason, on 14-09-2018, two months after the interruption of the rehabilitative path, we proceeded to the mapping of the language centers by means of navigated Transcranial Magnetic Stimulation (nTMS) (Krings et al., 1997; Picht, 2013; Forster e Szelényi, 2010; Raffa et al., 2018) (Figure 4).

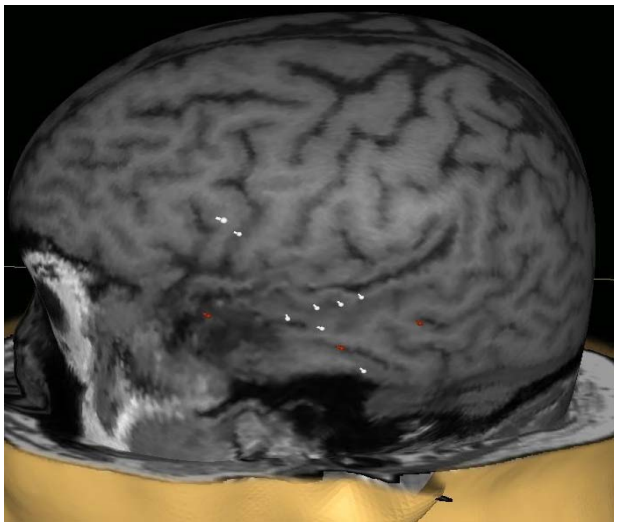


Fig. 4 - Errors in naming task with nTMS

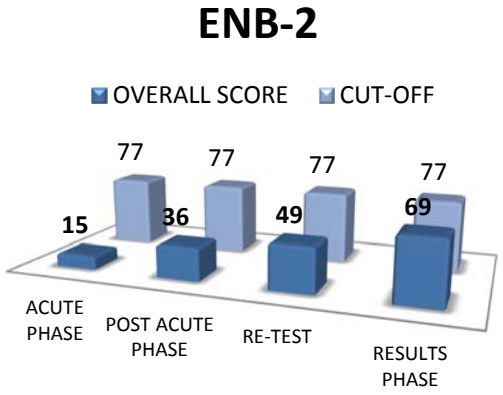
Results and Discussion

The results measured in several steps suggest considerable improvement, despite the rehabilitation intervention has not taken into account the fundamental variables such as awareness and patient motivation.

Following the neurosurgical intervention, it was already possible to appreciate a slight positive trend of the patient's cognitive functioning. The removal of the AVM's nidus and the evacuation of the hematoma alleviated the intensity of the language disorder.

This confirmed the non-invasiveness of the treatment followed by a rapid post-operative course that was not exposed to further complications.

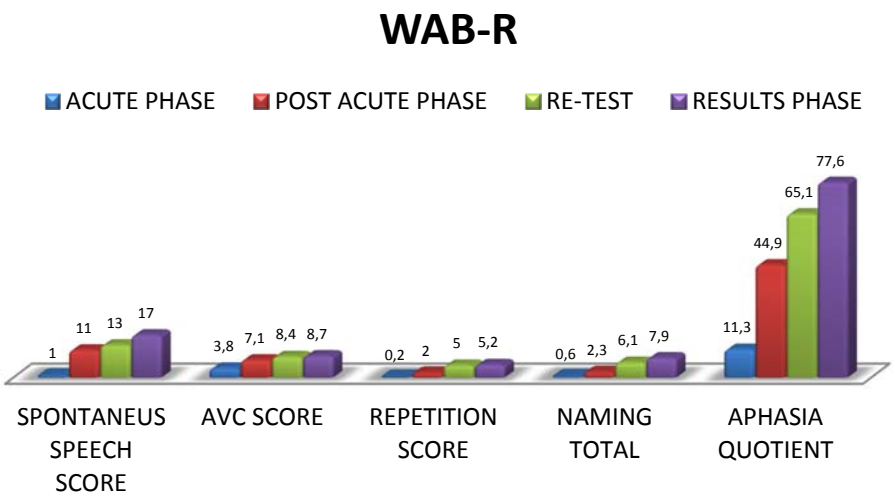
Although the rehabilitative method did not include an integrated intervention with a psychotherapeutic support, appreciable results emerged from a purely cognitive point of view (graphic n.1).



Graphic 1

The linguistic function has shown remarkable improvements, the semantic-lexical system has reported a slight increase in the processing of input stimuli, and a production of output words.

In detail there was a slight positive trend in the performance of naming tasks and semantic verbal fluency. From a morpho-syntactic point of view, sentences were produced according to a gradient of increasing difficulty. The narration is organized in a schematic and concrete way, with the production of mostly complete and pertinent sentences; there are occasional hesitations and paraphasias, with some difficulty in finding words. The analysis of language has highlighted some details that demonstrate an improvement in communicative competence (graphic 2).



Graphic 2

Through nTMS it was possible to evaluate the effectiveness of the rehabilitative method and its indirect effects on the brain language-eloquent areas. The study highlighted a reorganization of the complex linguistic connectoma, but the interruption of the rehabilitative path in such an important recovery phase for the patient meant that this reorganization process did not reach its maturity.

The interruption of the rehabilitation process also did not allow the process of generalization of learning to take place. The performance at the naming task has undergone a slight inflection characterized by anomie and semantic errors.

Neuropsychological rehabilitation has made some physical-morphological changes because the mechanisms underlying the learning processes encourage the process of functional reorganization. The rehabilitation activity therefore entails an increase in neuro-plasticity.

The stabilization of new connections is a long path that requires continuous stimulation, especially in the case of acute focal damage (Agliotti, 1998). Functional recovery and physical-morphological changes go hand in hand. “The ability of the cortex to change is determined by the ecology that the brain finds during its existence” (Kolb, 1999).

After the rehabilitative interventions, the working memory and the memory dedicated to new learning appear in strong recovery: one appreciates a re-learning of the semantic knowledge that were present in the pre-morbid era, although there is still a serious gap. Furthermore, the patient is able to recount current news with no hesitation, in fact its long term retaining of new knowledge is deemed sufficient.

The autobiographical, episodic and semantic component of long-term memory remains strongly deficient. Mr. G.S. is not able to report autobiographical events (even emotionally salient), anecdotes happened by chance, or learning acquired over time.

The memory for remote and recent events has therefore not reported any improvement. Due to family problems that occurred concurrently with the hemorrhagic event, the recovery of these memories was not encouraged because despite the purely cognitive level, the patient seemed unable to hook the memory up, and there was a hyperactivation from an emotional-affective point of view that destabilized the patient's serenity.

Mr G.S. has therefore suffered a disintegration of his own self, intended both as knowledge about himself, and as a failure to compare the pre-morbid self and the current self. This disruption has led to a loss of self-determination and motivation, affecting the quality of life with profound emotional, social, and behavioral repercussions, that affected also the rehabilitation process with consequent interruption.

It is primarily for reasons like these that a rehabilitation intervention should take charge not only of the patient’s deficiencies, but of his whole person. There cannot be a rehabilitative path if it is not based on the development of processes of awareness and understanding of the current self.

In Mr. G.S. we have been able to appreciate the achievement of an adequate level of knowledge and understanding of the nature of his disorders and how they can interfere in the daily and in the future. This, however, took place only in an intermediate phase of the path and involved, on the one hand, the patient’s need to successfully compensate for his difficulties and on the other a sudden lowering of too high future prospects. This, together with issues of emotional-affective nature, has resulted in a deflection of the mood.

Conclusions

Cerebral damage strikes, fundamentally, the identity of the individual. Therefore, the challenge of neuropsychological rehabilitation is to attempt to rediscover every patient as a person, to treat him on a cognitive, behavioral, emotional and relational level, with the hope of improving his sense of self, the quality of his life and the familiar support around him (Ownsworth, Haslam, 2016).

Efficient neuropsychological rehabilitation treating patients with cerebral dysfunction should essentially focus on recovering a sense of self, not only on the changes brought on them. That becomes even more important in the moment that the person, reached a stable level of functioning recovery, starts to feel a sense of denial towards his own self with the onset of a series of emotional disorders.

For this reason, the rehabilitative paths cannot be separated from integrated interventions, which entail, in addition to the rehabilitation of a given function, also the rehabilitation of the person as such.

Brain injuries do not upset the cognitive sphere alone, but also personal identity. The damage is both organic and psychological, causing a violent emotion that tears the life of the person and his family.

References

Agliotti, S.M., Corvino, M.P. (1998). Plasticità post-ontogenetica e basi nervose della riabilitazione. *Riabilitazione Oggi*, *2*, 15–18.

Bullmore, E., & Sporns, O. (2009). Complex brain networks: graph theoretical analysis of structural and functional systems. *Nature Reviews Neuroscience*, 10(3), 186–198. https://doi.org/10.1038/nrn2575

Buonomano, D.V., & Merzenich, M.M. (1998). Cortical Plasticity: from synapses to maps. *Annual Review of Neuroscience, 21*, 149–186. https://doi.org/10.1146/annurev.neuro.21.1.149

Forster, M.T., & Szelényi, A. (2010) Integration neuronavigierter transkranieller Magnetstimulation in die Resektionsplanung zentral gelegener Tumore. *Tagung der Sektion Neurophysiologie der Deutschen Gesellschaft für Neurochirurgie*. 19.

Helmstaedter, M., Briggman, K.L., Turaga, S.C., Jain, V., Seung, H.S., & Denk W. (2013). Connectomic reconstruction of the inner plexiform layer in the mouse retina. *Nature, 500* (7461), 168–174. https://doi.org/10.1038/nature12346

Hickok, G., & Poeppel, D. (2000). Towards a functional neuroanatomy of speech perception. *Trends in cognitive sciences*, *4*, 131–138. https://doi.org/10.1016/S1364-6613(00)01463-7

Hickok, G., & Poeppel, D. (2004). Dorsal and ventral streams: a framework for understanding aspects of the functional anatomy of language. *Cognition*, *92*, 67–99. https://doi.org/10.1016/j.cognition.2003.10.011

Kolb, B. (1999). Towards an ecology of cortical organization: experience and the changing brain In: Grafman, F., Christen, Y. *Neural Plasticity: building a bridge from the laboratori to the clinic*. Springer-Verlag Berlin.

Kertesz, A. (2006). *Western Aphasia Battery-revised*. PsychCorp.

Krings, T., Buchbinder, B.R., Butler, W.E., Chiappa, K.H., Jiang, H.J., Rosen, B.R., et al. (1997). Stereotactic transcranial magnetic stimulation: correlation with di- rect electrical cortical stimulation. *Neurosurgery Journal*, *41*, 1319–1326.

Mondini, S., Mapelli, D., Vestri, A., Arcara, G., & Bisiacchi, P.S. (2011). *Esame Neuropsicologico Breve-2*. Raffaello Cortina Editore.

Moscovitch, M., Nadel, L., Winocur, G., Gilboa, A., & Rosenbaum, S.R. (2006). The cognitive neuroscience of remote episodic, semantic and spatial memory. *Current Opinion in Neurobiology*, *16*(2), 179–190. https://doi.org/10.1016/j.conb.2006.03.013

Nadel, L., & Hardt, O. (2011). Update on memory systems and processes. *Neuropsychopharmacology*, *36*(*1*), 251–273. https://doi.org/10.1038/npp.2010.169

Nadel, L., & Moscovitch, M. (1997). Memory consolidation, retrograde amnesia and the hippocampal complex. *Current Opinion in Neurobiology*, 7, 217-227. https://doi.org/10.1016/S0959-4388(97)80010-4

Picht, T., Krieg, S.M., Sollmann, N., Rösler, J., Niraula, B., & Neuvonen, T. (2013). A comparison of language mapping by preoperative navigated transcranial magnetic stimulation and direct cortical stimulation during awake surgery. *Neurosurgery*, *72*, 808–819. https://doi.org/10.1227/NEU.0b013e3182889e01

Poeppel, D., Emmorey, K., Hickok, G., & Pylkkänen, L. (2012). Towards a new neurobiology of language. *Journal of Neuroscience*, *32*, 14125–14131. https://doi.org/10.1523/JNEUROSCI.3244-12.2012

Prigatano, G.P. (2013). Challenges and opportunities facing holistic approaches to neuropsychological rehabilitation. *Neurorehabilitation*, *32*(4), 751–59. https://doi.org/10.3233/NRE-130899

Pulvermuller, F., Huss, M., Kherif, F., Moscoso del Prado Martin, F., Hauk, O., & Shtyrov, Y. (2006) Motor cortex maps articulatory features of speech sounds. *Proceeding of the National Academy of Sciences of the USA*, *103*, 7865–7870. https://doi.org/10.1073/pnas.0509989103

Raffa, G., Quattropani, M.C., Scibilia, A., Conti, A., Angileri, F.F., Esposito, F. et al. (2018). Surgery of language-eloquent tumors in patients not eligible for awake surgery: the impact of a protocol based on navigated transcranial magnetic stimulation on presurgical planning and language outcome, with evidence of tumor-induced intra-hemispheric plasticity. *Clinical Neurology and Neurosurgery*, *168*, 127–139. https://doi.org/10.1016/j.clineuro.2018.03.009

Rayner, G., Jackson, G.D., & Wilson, S.J. (2015). Behavioral profiles in frontal lobe epilepsy: Autobiographical memory versus mood impairment. *Epilepsia*, *56*(2), 225–233. https://doi.org/10.1111/epi.12902

Reed, J.M., & Squire, L.R. (1998). Retrograde amnesia for facts and events: findings from four new cases. *Journal of Neuroscience*, *18*(*10*), 3943-3954

Scoville, W.B., & Milner, B. (1957). Loss of recent memory after bilateral hippocampal lesions. *Journal of Neuropsychiatry and Clinical Neurosciences*, *20*(1), 11–21. https://doi.org/10.1136/jnnp.20.1.11

Sporns, O., Tononi, G., & Kötter, R. (2005). *The human connectome: A structural description of the human brain*. *PLoS* Computational Biology, 1 (4), e42. https://doi.org/10.1371/journal.pcbi.0010042

Svoboda, E., McKinnon, M.C., & Levine, B. (2006). The functional neuroanatomy of autobiographical memory: a meta-analysis. *Neuropsychologia*, 44(12) 2189–2208. https://doi.org/10.1016/j.neuropsychologia.2006.05.023

Thaiss, L., & Petrides M. (2008). Autobiographical memory of the recent past following frontal cortex or temporal lobe excisions. *European Journal of Neurosciences*, 28, 829–840. https://doi.org/10.1111/j.1460-9568.2008.06381.x

Zettin, M., La Foresta, S., & Quattropani, M.C. (2017). *L'Intervento neuropsicologico olistico nelle cerebrolesioni acquisite*. Alpes-Roma.