Neurolinguistic Aspects of Bilingual Thalamic Aphasia. A Clinical Case

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ABSTRACT

The case of a right-handed young male (R.P.) with English as L1 and Italian as L2 is reported. At the age of 28 he suffered a stroke which brought about an ischemic lesion to the left thalamus and the splenium. R.P. presented with mutism, reduced strength and right-sided paralysis. The patient slowly recovered language but exhibited bilingual aphasia. After the stroke his IQ was in the normal range. His verbal short-term memory span for disyllabic words was reduced. His verbal long-term memory was greatly impaired and he was severely disoriented in time and space. R.P. showed poor verbal initiative, and in both languages he had severe word-finding difficulties, made many repetitions, some phonemic paraphasias and omissions of bound grammar morphemes. On the Bilingual Aphasia Test the most severely compromised linguistic levels were morphology, semantics and syntax. Furthermore, the patient showed considerable difficulty to translate sentences in both directions.

This case seems to confirm that language functions are represented in the left subcortical structures (thalamus). As R.P. showed parallel recovery of L1 and L2, it may be suggested that the two languages are equally and similarly represented in the left thalamus.

KEY WORDS: subcortical aphasia, bilingualism, memory disorders, left thalamus.

INTRODUCTION

It is now widely believed that neuropsychological functions are not simply localised in specific cortical areas but they are subserved by a mosaic of neuronal structures comprising cortical regions, subcortical structures and their respective reciprocal connections (Damasio, 1994).
Specific thalamic nuclei (the medial dorsal nucleus, the ventral anterior nucleus, the ventral lateral nucleus and the pulvinar) are part of the circuits responsible for language (Crosson, 1992; Alexander, 1994). The following are the best known among them:

- the anterior 'complex' loop (frontal associative cortex - caudate nucleus - globus pallidus - ventral anterior nucleus - frontal associative cortex), which is involved in language planning;
- the anterior 'motor' loop (sensory-motor cortex - putamen - globus pallidus - ventral lateral nucleus - sensory-motor cortex), which is involved in articulation;
- the 'posterior' loop (temporo-parietal cortex - pulvinar-temporo-parietal cortex), which may play a role in auditory comprehension and lexical selection;
- the loop of temporal auditory cortex - caudate nucleus - globus pallidus - ventral anterior nucleus - frontal associative cortex, which is involved in language comprehension;
- the loop of amygdala - temporal neocortex - dorso-median nucleus, subserving speech initiation and production and
- the loop of caudate nucleus - globus pallidus - anterior nuclei - supplementary motor area - anterior cingulum, which is involved in the initiation of speech (Cappa and Vallar, 1992; Metter, 1992; Wallesch, 1997).

Several clinical studies on monolingual patients with left thalamic lesions have shown that disruption of one or some of these circuits may cause language disorders mainly involving the lexical and semantic levels of language. This is a rather typical clinical picture. What has been most frequently observed after such a thalamic lesion is the following clinical syndrome:

- reduction of spontaneous speech with fading voice volume, sometimes also accompanied by mild articulation impairments;
- presence of paraphasias and perseverations;
- mild auditory comprehension deficits;
- preserved repetition and
- writing and reading disorders (Mohr, Wattas & Duncan, 1975; Luria 1977; Fensore, Lazzarino, Nappo & Nicolai, 1988).

In addition, thalamic aphasias are often characterised by a favourable outcome, with nearly normal recovery of functions after three to six months in about 75% of the cases where adequate follow-up data were available in the literature (Cappa and Vallar, 1992; Ibayashi, Tanaka,

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Joanette & Lecours, 1992).

As far as thalamic aphasia in bilinguals is concerned, only four case studies have been described so far (Reynolds, Turner, Harris, Ojemann & Davis, 1979; Fabbro, Peru & Skrap, 1997). The first case reported by Reynolds et al. (1979) described a 40-year-old male patient with Navajo and English as L1 and L2, respectively. He suddenly developed dysphasia following a haemorrhage owing to a left thalamic tumour. The patient was unable to speak in English, but he still could express himself in Navajo, though with several perseverations and non-sense syllables. This clinical picture remained stable for the four months of the follow-up.

Three bilingual patients with ischemic or tumoral brain lesions localised in the left thalamus were examined by Fabbro et al. (1997). They all presented with language impairments which included reduced verbal fluency; phonemic, semantic and verbal paraphasias; grammatical errors (e.g. omissions and additions of free grammatical morphemes); greater disruption of comprehension as opposed to repetition and written language disorders. In all patients the most disrupted linguistic levels were morphology and syntax, more in L2 than in L1. One patient also presented with several mixing phenomena and major difficulties in sentence translation.

METHOD

AIMS

The present study on a new case of bilingual thalamic aphasia was aimed at throwing light on the following questions:

- Do bilingual aphasic patients with thalamic lesions show the same pattern of language disorders in both languages?
- May thalamic lesions provoke the so-called "specific symptoms" of bilingual aphasia (e.g. mixing, switching, translation impairments, etc.)?

CASE REPORT

Clinical history

RP is a right-handed young male who was born in Canada where he acquired English as L1. His parents were native Slovenian and spoke English at home. He lived in Canada until he was 17 years old. Then he moved to Italy where he learnt Italian as L2. At the age of 28 a stroke brought about an ischemic lesion to the left thalamus and the splenium. Upon admittance in the hospital he presented with mutism, reduced strength and paralysis of the right side of the body. Slowly he recovered language but showed bilingual aphasia.

RESULTS

NEUROPSYCHOLOGICAL ASSESSMENT

After the stroke RP showed an IQ in the normal range (WAIS: VIQ= 82; PIQ= 90; FIQ=85). His verbal short-term memory span for disyllabic words was reduced (4). His verbal long-term memory was severely compromised (short story = 3, normal values 13.25, SD= 2.65, cf. Spinnler and Tognoni, 1987) and he was severely disoriented in time and space.

NEUROLINGUISTIC ASSESSMENT

With regard to his verbal expression, his voice volume was considerably reduced and on some occasions it became an unintelligible whisper. RP showed poor verbal initiative and in both languages he had severe word-findings difficulties, made many repetitions, some phonemic paraphasias and omissions of bound grammar morphemes. Six months after the stroke he received a Bilingual Aphasia Test in both languages (Paradis, 1987) (see Table 1). The most severely compromised linguistic levels were morphology (L1 = 22% of errors, L2 = 26%), and semantics (L1 = 20%, L2 = 13%). Furthermore the patient showed considerable difficulty in translating sentences in both directions, whereas he had no difficulty with words (see Table 2).

DISCUSSION

This fifth case of bilingual thalamic aphasia first of all contributes to further defining the clinical picture of the language syndrome which is peculiar to thalamic aphasia. The main features of our patient were:

- reduced verbal fluency;
- presence of paraphasias;
- presence of grammatical errors;
- greater disruption of comprehension (about 15.4% of the total number of errors on the BAT) as opposed to repetition (no errors on the BAT) and
- writing impairments (Table 1).

This picture is similar to that described by Fabbro et al. (1997) in three other bilingual patients with lesions to the thalamus. Also in this patient, language disorders are compatible with a picture of transcortical aphasia, which combines characteristics of both transcortical motor aphasia (spontaneous speech impairment and agrammatism) and transcortical sensory aphasia (repetition is better preserved than comprehension, presence of semantic paraphasias and paragrammatism) (Papagno and Guidotti, 1983; Fensore et al., 1988). Reduced verbal fluency and syntactic errors leading to agrammatism in both languages confirm that the thalamus is, along with the basal ganglia, one of the neural "stations" of the so-called "frontal lobe system" involved in language planning and speech production (Fabbro and Paradis, 1995; Aglioti and Fabbro, 1993; Aglioti, Beltramello, Girardi & Fabbro, 1997).

A relevant aspect which was underlined in a previous study and which was also confirmed by our own investigation is that thalamic aphasia mainly impairs the morphosyntactic features of the second language and, to a lesser extent, those of the patient's mother tongue. This may suggest that L2, which had been learned after the age of seven, has a more "thalamic" representation than L1 as far as morphology is concerned. The greater involvement of the thalamus in comprehension and in the correct use of morphology in L2 could be due to the fact that R.P. had learned his second language most probably by means of explicit strategies based on conscious focusing of attention (La Berge and Buchsbaum, 1990), a task that typically involves the thalamus. As the thalamus is a very important relay for consciousness (Jasper, Descarrier, Castellucci, & Rossignol, 1998), it is highly probable that it is more involved in the regulation of linguistic aspects subserved by declarative memory (cf. Paradis, 1994).

TABLE 1. Patient RP's scores on the English (L1) and Italian (L2) Bilingual Aphasia Test

English (L1)								
SCORES BY LINGUISTIC LEVEL AND SKILL								
17/18	30/30	0/0	1/3	1/3	10/10	0/0	Phonology	59/64
0/0	0/0	0/0	18/23	18/23	0/0	0/0	Mrpholgy	36/46
97/117	7/7	9/10	1/3	16/18	20/20	5/5	Syntax	155/180
57/63	30/30	29/30	51/56	1/3	20/20	15/15	Lexicon	203/217
8/11	0/0	10/10	28/33	1/3	4/6	0/0	Smntics	51/63
Compreh	Repetit	Judgmnt	LxclAcc	Proposi	Reading	Writing		
185/209	67/67	48/50	99/118	37/50	54/56	20/20		
Decimal scores:								
0.944	1.000	N/A	0.333	0.333	1.000	N/A	Phonology	0.921
N/A	N/A	N/A	0.782	0.782	N/A	N/A	Mrpholgy	0.782
0.829	1.000	0.900	0.333	0.888	1.000	1.000	Syntax	0.935
0.904	1.000	0.966	0.910	0.333	1.000	1.000	Lexicon	0.861
0.727	N/A	1.000	0.848	0.333	1.000	N/A	Smntics	0.809
Compreh	Repetit	Judgmnt	LxclAcc	Proposi	Reading	Writing		
0.856	1.000	0.960	0.838	0.740	0.964	1.000		
Italian (L2)								
SCORES BY LINGUISTIC LEVEL AND SKILL								
16/18	30/30	0/0	2/3	2/3	10/10	0/0	Phonology	60/64
0/0	0/0	0/0	17/23	17/23	0/0	0/0	Mrpholgy	34/46
102/117	7/7	8/10	2/3	17/18	20/20	5/5	Syntax	161/180
52/63	30/30	29/30	52/56	2/3	18/20	13/15	Lexicon	196/217
9/11	0/0	9/10	29/33	2/3	6/6	0/0	Smntics	55/63
Compreh	Repetit	Judgmnt	LxclAcc	Proposi	Reading	Writing		
179/209	67/67	38/50	102/118	40/50	54/56	18/20		
Decimal scores:								
0.888	1.000	N/A	0.666	0.666	1.000	N/A	Phonology	0.937
N/A	N/A	N/A	0.739	0.739	N/A	N/A	Mrpholgy	0.739
0.871	1.000	0.800	0.666	0.944	1.000	1.000	Syntax	0.894
0.825	1.000	0.966	0.928	0.666	0.900	0.866	Lexicon	0.903
0.818	N/A	0.900	0.878	0.666	1.000	N/A	Smntics	0.873
Compreh	Repetit	Judgmnt	LxclAcc	Proposi	Reading	Writing		
0.856	1.000	0.920	0.864	0.800	0.964	0.900		

Legend:

The Bilingual Aphasia Test consists of 32 subtests (each with its individual score) to test comprehension, production, reading and writing skills in a given language. Once the assessment has been performed, scores are entered into a computerised programme which automatically computes the number of correctly performed tasks as well as the percentage of correctly performed tasks by linguistic level and skill. Language skills are comprehension, repetition, judgement, lexical access, propositionising, reading and writing. Linguistic levels are phonology, morphology, syntax, lexicon and semantics.

For example, on comprehension tasks R.T. correctly scored 185 items out of 209, thus the percentage of correctness on this task is 85.6%. At the phonologic level he correctly scored 59 out of 60 items, thus the percentage of correctness is 92.1%.

A previous study showed that lesions to the left side of the thalamus also provoked a reduction in translation abilities (Fabbro et al., 1997). In particular, after surgical removal of a tumor located in the thalamic posterior nuclei, a patient (PB) could translate only words, but not entire sentences. The same disorder was shown by our patient. RP could translate words but not sentences (cf. Table 2). This could be due both to deficits in sentence production and to a more specific inhibition of the subsystems accounting for translation (Paradis, Goldblum, & Abidi, 1982; Fabbro, 1999), or still to verbal memory deficits which may impair storing of verbal material before and during translation (Graff-Radford, Tranel, Van Hoesen, & Brandt, 1992; Peru and Fabbro, 1997).

CONCLUSIONS

If we go back to the two fundamental questions of this study, we can state that our patient presented the same pattern of language disorders both in English (L1) and

TABLE 2. Patient RP's scores on the Bilingual Aphasia Test, Part C* for English-Italian (L1=A-L2=B)

SCORES BY SECTION			
Word Recognition A-B	5/5	1.000	
Word Recognition B-A	5/5	1.000	
Translation of Concrete Words A-B	5/5	1.000	
Translation of Abstract Words A-B	4/5	0.800	
Translation of Concrete Words B-A	4/5	0.800	
Translation of Abstract Words B-A	3/5	0.600	
Translation of Sentences A-B	0/6	0.000	
Translation of Sentences B-A	0/6	0.000	
Grammaticality Judgments A	4/12	0.250	
Grammaticality Judgments B	5/11	0.312	

SCORES BY LINGUISTIC LEVEL AND SKILL: A-B			
0/6	4/12	Morph/Syntax	4/22
14/15	0/0	Lexicon	14/15
Translation	Gram.Judg.		
14/21	4/16		
Decimal scores:			
0.000	0.250	Morph/Syntax	0.181
0.933	N/A	Lexicon	0.933
Translation	Gram.Judg.		
0.666	0.250		
SCORES BY LINGUISTIC LEVEL AND SKILL: B-A			
0/6	6/16	Morph/Syntax	5/22
12/15	0/0	Lexicon	12/15
Translation	Gram.Judg.		
12/21	5/16		
Decimal scores:			
0.000	0.312	Morph/Syntax	0.227
0.800	N/A	Lexicon	0.800
Translation	Gram.Judg.		
0.571	0.312		

**Part C is specific to a given pair of languages.*
Total scores are computed on the number of correctly performed items and the percentage of correctness.

Italian (L2) with a greater impairment of L2 morphology, and a "specific symptom" of bilingual aphasia, that is a disruption in sentence translation in both directions. This case, therefore, supports the hypothesis of a representation of language functions in the left subcortical structures (thalamus). Since the lesion brought about aphasia with parallel recovery of the two languages (same linguistic disorders and severity), it is reasonable to hypothesize the same mode and extent of representation for L1 and L2 (learnt after the age of 17) in the left thalamus.

REFERENCES

Aglioti, S. & Fabbro, F. (1993). Paradoxical recovery in a bilingual aphasic following subcortical lesions. *Neuroreport, 4* 1359-1362.

Aglioti, S., Beltramello, A., Girardi, F. & Fabbro, F. (1997). Neurolinguistic and follow-up study of an unusual pattern of recovery from bilingual subcortical aphasia. *Brain, 119* 1551-1564.

Alexander, G.E. (1994). Basal ganglia-thalamocortical circuits: Their role in control of movements. *J Clin. Neurophysiol., 11* 420-431.

Cappa, S.F. & Vallar, G. (1992). Neuropsychological disorders after subcortical lesions: Implications for neural models of language and spatial attention. In G. Vallar, S.F. Cappa & C.-W. Wallesch (Eds.), *Neuropsychological Disorders Associated with Subcortical Lesions*. Oxford: Oxford University Press.

Crosson, B. (1992). *Subcortical Functions in Language and Memory*. New York: Guildford Press.

Damasio, A.R. (1994). *Descartes' Error. Emotion, Reason, and the Human Brain*. New York: Putnan.

Fabbro, F. (1999). *The Neurolinguistics of Bilingualism*. Hove: Psychology Press.

Fabbro, F. & Paradis, M. (1995). Differential impairments in four multilingual patients with subcortical lesions. In M. Paradis (Ed.), *Aspects of Bilingual Aphasia*. London: Pergamon.

Fabbro, F., Peru, A. & Skrap, M. (1997). Language disorders in bilingual patients after thalamic lesions. *Journal of Neurolinguistics, 10,* 347-367.

Fensore, C., Lazzarino, L.G., Nappo, A. & Nicolai, A. (1988). Language and memory disturbances from mesencephalothalamic infarcts. *Eur. Neurol., 28,* 51-56.

Graff-Radford, N.R., Tranel, D., Van Hoesen, G.W. & Brandt, J.P. (1992). Diencephalic amnesia. In G. Vallar, S.F. Cappa & C.-W. Wallesch (Eds.), 143 - 168. *Neuropsychological Disorders Associated with Subcortical Lesions*. Oxford: Oxford University Press.

Ibayashi, K., Tanaka, R. Joanette, Y. & Lecours, A.L. (1992). Neuropsychological study in patients with thalamic and putaminal hemorrhage. *Journal of Neurolinguistics, 7,* 217-240.

H.H. Jasper, L. Descarrier, V.F. Castellucci, & S. Rossignol, (Eds.) (1998). *Consciousness at the Frontiers of Neuroscience: Advances in Neurology, vol. 77*. New York: Lippincott Williams and Wilkins.

Kennedy, M. & Murdoch, B.E. (1993). Chronic aphasia subsequent to striato-capsular and thalamic lesions in the left hemisphere. *Brain and Language, 44,* 284-295.

La Berge, D. & Buchsbaum, M.S. (1990). Positron emission tomography measurements of pulvinar activity during an attentional task. *J Neurosci., 10,* 613-619.

Luria, A.R. (1977). On quasi-aphasia speech disturbances in lesions of the deep structures of the brain. *Brain Lang., 4,* 432-459.

Metter, J.E. (1992). Role of subcortical structures in aphasia: Evidence from studies of resting cerebral glucose metabolism. In G. Vallar, S.F. Cappa & C.-W. Wallesch (Eds.), *Neuropsychological Disorders Associated with Subcortical Lesions*. Oxford: Oxford University Press.

Mohr, J.P., Wattas, W.C. & Duncan, G.W. (1975). Thalamic haemorrhage and aphasia. *Brain Lang., 2,* 3-17.

Papagno, C. & Guidotti, M. (1983). A case of aphasia following left thalamic haemorrhage. *Eur. Neurol. 22,* 93-95.

Paradis, M. (1994). Neurolinguistic aspects of implicit and explicit memory: Implications for bilingualism and second language acquisition. In N. Ellis (Ed.), *Implicit and Explicit Learning of Languages*. London: Academic Press.

Paradis, M. (1987). *The Assessment of Bilingual Aphasia*. Hillsdale (NJ): Lawrence Earlbaum Associates.

Paradis, M., Goldblum, M.C. & Abidi, R. (1982). Alternate antagonism with paradoxical translation behavior in two bilingual aphasic patients. *Brain Lang., 15,* 55-69.

Peru, A. & Fabbro, F. (1997). Thalamic Amnesia following venous infarction. Evidence from a single case study. *Brain Cogn., 33* 278-294.

Reynolds, A.F., Turner, P.T., Harris, A.B., Ojemann, G.A. & Davis, L.E. (1979). Left thalamic haemorrhage with dysphasia: A report of five cases. *Brain Lang., 7,* 62-73.

Spinnler, H. & Tognoni, G. (1987). Standardizzazione e taratura italiana di test neuropsicologici. *Ital. J Neurol. Sci.*, Suppl. 8.

Wallesch, C.-W. (1997). Symptomatology of subcortical aphasia. *Journal of Neurolinguistics, 10,* 267-276.