

Perception of Real-World Without a Language

Gian Carlo Buoiano ^{C§}, Mario Betti ^{*} and Paolo Bongioanni [§]

[§]*Neuroscience Dpt., University of Pisa;* ^{*}*CESER Center of Mental Health (Lucca), Italy*

^C Corresponding author:

Giancarlo Buoiano
Via del Morello 8 Bargecchia
I-55040 Corsanico (LU)
Italy
e-mail: giancarlo@neurolinguistics.0catch.com

Abstract

The aim of this study is to show how real-world knowledge works without language. Lelio is a 76-year-old man who has been profoundly deaf since birth like his mother and brothers. In the clinical history, Lelio's father was reported as affected by an unspecified "cerebroopathy". Lelio's two brothers had a relatively normal life. Lelio is illiterate like his mother and brothers: therefore Lelio grew up in a rather atypical relational context, developing a pathological affection for his mother and communicating through non-linguistically structured gestures. When his mother died Lelio was 31 and had some bursts of violence. In 1956 he was admitted in a psychiatric hospital with the diagnosis of "phrenastenia due to cerebroopathy, microcephalia, deafness and mutism and probable epileptic crises". During the 35-year hospitalization, there were no attempts to teach him "to read the lips" or use a structured sign language and, consequently, read and write. Since 1997 he has been living with his adoptive family. For these reasons, Lelio is a subject totally deprived of language. Apparently, he is unable to indicate a temporal sequence, but can understand simple gestures for "before" and "after". Simple gestures of this kind are related to his needs and might constitute a primitive form of deictic communication not inserted in a linguistic network of relations: they could be a clue for the existence of an elementary form of temporal communication. Lelio can only produce signs linked to his immediate needs.

We administered him a Comprehensive Test of Non-verbal Intelligence (CTONI)¹ and a color categorization test.

Lelio performed in two of three subtests closely to pre-school and pre-linguistic children who have not yet fully developed their frontal lobes. We found that categorical, contextual and abstract reasoning are highly impaired in the total absence of a structured language. However, a crucial point to clear up is whether his cognitive impairments are mainly due to a reduced brain function or primarily to the total lack of language. One hypothesis is that his deafness and reduced brain function have blocked the development of any form of language, thus severely worsening his cognitive abilities.

Since the present study has been carried out on a single case, it waits for further evidence.

For these reasons, Lelio is a subject totally deprived of language, at least in the conventional sense. At the moment he attends a group of Theatre Therapy. In this group he uses some very simple gestures to communicate with the others. We have video-recorded Lelio and analysed these signs. They are highly iconic and deictic: i.e., he has a sign for “cat” (two raised fingers on the ears) a sign for “umbrella” (the gesture to open an umbrella), a sign for “toilette” (a raised finger). He doesn’t seem capable of indicating a temporal sequence, but he seems to understand simple gestures for “before” and “after”. He does not produce any sign that is not linked to his immediate needs. The cognitive evolution of the subject leaves open an interpretation according to which the passage from the imagistic way of thinking to the alphanumeric way of reasoning is missing. This lack can be seen as the basis that reveal an archaic and primitive thinking, where the objects are always seen in their concrete and functional perspective and Lelio’s way of thinking could precisely be of this kind.

1. Introduction

Perhaps Lelio’s case is very rare if not unique, therein literature on this topic is missing. This study is the first of a series we intend to perform in order to assess with a reasonable precision what can be the residual cognitive abilities in a human being who has not – and has never had – a structured language of any kind. This case is remarkable in the light of neurolinguistic and psycholinguistic theories that strictly link language and thought^{5,25}.

2. Materials and methods

2.1. Subject

A 76-year-old profound deaf subject since birth without any form of structured language.

Therapy: at present the patient is treated daily with 1 mg. of Haloperidol (corresponding to 1 mg. of chlorpromazine) and with 1 mg. of Diazepam.

Present diagnosis: lacking a structured language, the diagnosis cannot go beyond a generic oligophreny (mental retard). The causes of this mental retard must be examined more profoundly.

2.2. Methods

We have administered him a Comprehensive Test of Nonverbal Intelligence (CTONI)¹⁸. This test consents to measure the following faculties: analogical reasoning, categorisation,

elaboration of sequences. Lelio was able to complete the first three items of every subtest relatively to images, so the results can be considered reliable. He could not complete the three subtests with geometric figures, so this part of the test could not be administered. In order to examine more profoundly his faculty of categorisation, we administered a “colors test”. We used pencils of different colors and of different shade. We showed him that, for instance, all the red pencils must be gathered (light red, dark red, etc.), all the blue pencils must be gathered, and so on.

3. Results

In the subtest of analogical reasoning Lelio totalised a standard score of 11 points, in the subtest relative to the elaboration of categories a standard score of 3 points and in the subtest relative to the elaboration of sequences a standard score of 1 point. In the colors test Lelio gathered together all the items of the same shade (for instance all the dark blue pencils) but he did not gather these items in the category BLUE.

4. Discussion

Evidently we have a meaningful variance between the results of the first subtest and the results of the second and third subtest, while there is not a meaningful variance between the results of the second and third test. His global NVIQ (Non Verbal Intelligence Quotient) is 68, close to the NVIQ obtained by hearing subjects with severe mental retard (64) and rather distant by the NVIQ obtained by deaf subjects who use a sign language (89). The residual ability manifested by Lelio in the first subtest shows a faculty of analogical reasoning very impaired but rather functional for concrete objects (the foot goes in the shoe = the hand goes in the glove). Lelio has difficulties with a more abstract level (big ball and little ball = big square and little square). In sum, Lelio has a residual capacity of analogical reasoning relatively to concrete objects that he has used and/or for objects that he knows very well. Lelio's capacity of categorical reasoning, instead, seems very impaired, like his capacity of contextual and sequential reasoning. The equivalent age for the score of the first subtest is 12 – 12 and 9 months, while for the second and third test is <6. The functional neurocorrelates of the observed cognitive impairments could be related to the following cerebral regions: for the disability to elaborate the context to a reduced functionality of dominant DLPFC (dorsolateral prefrontal cortex). The disability to categorise should be related to a reduced functionality of at least DLPFC and Broca's area but, since the subject is capable of willed imitation (non echopraxic), a residual functionality of mirror neurons system must be hypothesized. For these reasons we hypothesize a diffuse reduced frontal functionality. This hypothesis can be verified with neuroimaging techniques, for instance a fMRI (functional magnetic resonance imaging). A crucial point to clear up is whether his cognitive impairments are due to cerebral Hypo-functionality or to total lack of language. One hypothesis is that his deafness and cerebral Hypo-functionality have blocked the development of any form of language and that this last fact has worsened his cognitive abilities further on.

5. Conclusions

Since this study has been conducted on a single case, we need further evidence. Nevertheless categorical, contextual and abstract reasoning seem to be highly impaired in total absence of a structured language. Typically, Lelio's results in two of three subtests are close to pre-school and pre-linguistic children, who have not yet fully developed their frontal lobes.

References

1. J.H. Aizenstein et al., *Complementary Category Learning Systems Identified Using Event-Related Functional MRI*, in «Journal of Cognitive Neuroscience», 12 (2000), 977-987.
2. T. Bak et al., *Selective impairment of verb processing associated with pathological changes in Brodmann areas 44 and 45 in the motor neurone disease–dementia–aphasia syndrome*, in «Brain», 124 (2001), 103-120.
3. J Barwise and J. Perry, *Situations and Attitudes*, Cambridge, The MIT Press, 1983.
4. N. Bazin et al., *Context-dependent information processing in patients with schizophrenia*, in «Schizophrenia Research», 45 (2000), 93-101.
5. L. Boroditsky, *Does language shape thought? Mandarin and English speakers' conceptions of time*, in «Cognitive Psychology», 43 (2001), 1-22.
6. J. Bradshaw and D. Sheppard, *The Neurodevelopmental Frontostriatal Disorders: Evolutionary Adaptiveness and Anomalous Lateralization*, in «Brain and Language», 73 (2000), 297-320.
7. R. Cabeza and L. Nyberg, *Imaging Cognition II: An Empirical Review of 275 PET and fMRI Studies*, in «Journal of Cognitive Neuroscience», 12 (2000), 1-47.
8. D. Caplan, *Neurolinguistics and Linguistic Aphasiology*, Cambridge University Press, 1987.
9. D. Caplan et al., *Activation of Broca's area by syntactic processing under conditions of suppression and strategy use*, in «Neuropsychologia» 38 (2000), 1292-1304.
10. D. Caplan, *Language-related cortex in deaf individuals: Functional specialization for language or perceptual plasticity?*, in «Proceedings of the National Academy of Sciences of the United States of America», 97 (2000), 13476–13477.
11. D. Carlin et al., *Planning impairments in frontal lobe dementia and frontal lobe lesion patients*, in «Neuropsychologia» 38 (2000), 655-665.
12. J. Cohen and D. Servan-Schreiber, *Context, Cortex, and Dopamine: a Connectionist Approach to Behavior and Biology in Schizophrenia*, in «Psychological Review», 99 (1992), 45-77.
13. D. Embick et al., *A syntactic specialization for Broca's area*, in «Proceedings of the National Academy of Sciences of the United States of America», 97 (2000), 6150–6154.
14. H. Goodglass et al., *Category specific dissociations in naming and recognition by aphasic patients*, in «Cortex», 22 (1986), 87-102.
15. Y. Grodzinsky, *The neurology of syntax: Language use without Broca's area*, in «Behavioral And Brain Sciences», 23 (2000), 1–71.
16. R.E. Gur et al., *Reduced Dorsal and Orbital Prefrontal Gray Matter Volumes in Schizophrenia*, in «Archives of General Psychiatry», 57 (2000), 761-858.
17. K.Y. Haaland et al., *Neural representations of skilled movement*, in «Brain», 123 (2000), 2306-2313.
18. D.D. Hammill, N.A. Person, J.L. Wiederholt, *CTONI (Comprehensive Test Of Nonverbal Intelligence)*, Austin [Texas], PRO-ED, 1997.
19. G. Hickok et al., *The neural organization of language: evidence from sign language aphasia*, in «Trends in Cognitive Sciences», 2 (1998), 129-136.
20. J Hirsch et al., *Interconnected Large-scale systems for Three Fundamental cognitive Tasks Revealed by Functional MRI*, in «Journal of Cognitive Neuroscience» 13 (2001), 389-405.

21. C. Hooker and S. Park, *Trajectory Estimation in Schizophrenia*, in «Schizophrenia Research», 45 (2000), 83-92.
22. E. Howanitz et al., *Verbal fluency and psychiatric symptoms in geriatric schizophrenia*, in «Schizophrenia Research», 42 (2000), 167-169.
23. P. Indefrey et al., *A neural correlate of syntactic encoding during speech production*, in «Proceedings of the National Academy of Sciences of the United States of America», 98 (2001), 5933-5936.
24. G. Lakoff, *Women, Fire, and Dangerous Things*, Chicago, The University of Chicago Press, 1987.
25. S.M. Lamb, *Pathways of the Brain – The Neurocognitive Basis of Language*, Amsterdam-Philadelphia, Benjamins, 1999.
26. A.R. Luria, *The Frontal Syndrome*, in *Handbook of Clinical Neurology*, a cura di P.J. Vinken and G.W. Bruyn Amsterdam, North Holland Publishing Company, 1969.
27. A.R. Luria, *The Working Brain*, Penguin, 1973.
28. J. McGrath, *Ordering thoughts on thought disorder*, in «British Journal of Psychiatry», 158 (1991), 307-16.
29. D. Neary et al., *Cognitive change in motor neurone disease /amyotrophic lateral sclerosis (MND/ALS)*, in «Journal of the Neurological Sciences», 180 (2000), 15– 20.
30. W. Ni et al., *An Event-related Neuroimaging Study Distinguishing Form and Content in Sentence Processing*, in «**Journal of Cognitive Neuroscience**», 12 (2000), 120-133.
31. N. Nishitani and R. Hari, *Temporal dynamics of cortical representation for action*, in «Proceedings of the National Academy of Sciences of the United States of America» 97 (2000), 913–918.
32. C. Pantelis et al., *Frontal-striatal cognitive deficits in patients with chronic schizophrenia*, in «Brain» 120 (1997), 1823-1843.
33. L.A. Petitto et al., *Speech-like cerebral activity in profoundly deaf people processing signed languages: Implications for the neural basis of human language*, in «Proceedings of the National Academy of Sciences of the United States of America», 97 (2000), 13961–13966.
34. G. Rizzolatti and M.A. Arbib, *Language within our grasp*, in «Trends Neuroscience» 21 (1998), 188–194.
35. E. Rosch et al., *Basic objects in natural categories*, in «Cognitive Psychology», 8 (1976), 382-439.
36. S.M. Silverstein et al., *Perceptual organization, the disorganization syndrome, and context processing in chronic schizophrenia*, in «Schizophrenia Research», 43 (2000), 11-20.
37. K. Stromswold et al., *Localization of Syntactic comprehension by Positron Emission Topography*, in «Brain and Language», 52 (1996), 452-43.
38. R.J. van den Bosch, *Context and cognition in schizophrenia*, in *Advances in the neurobiology of schizophrenia*, a cura di Boer, J.A. den, Westenberg, H.G.M. e Praag, H.M. van, Chichester, Wiley, 1994.
39. G.I. Zubicaray de et al., *Cerebral regions associated with verbal response initiation, suppression and strategy use*, in «Neuropsychologia» 38 (2000), 1292-1304.
40. G.I. Zubicaray de et al., *Motor response suppression and the prepotent tendency to respond: a fMRI study*, in «Neuropsychologia», 38 (2000), 1280-1291.