Neuropsychological evaluation of visuo-spatial neglect. Is there a relation between quantitative and qualitative methods?

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Abstract

Visuo-spatial neglect is one of the most frequent neuropsychological disorders after a brain damage. Clinical Neuropsychologists work everyday with persons with this specific attentional syndrome either for assessment and rehabilitation. Scientific literature provides a wide amount of instruments in particular for neuropsychological evaluation and most of them are based upon quantitative methodology, that is they are aimed to provide numerical values in order to assess neglect in terms of impairment. On the other hand, very few instruments lead to an evaluation of neglect in terms of disability. In this work we want to provide a brief description of the most used tests arguing for a relation between quantitative methods, as assessment of impairment, and qualitative methods, as instruments for disability. Finally, we give some suggestions, on the base of our experience, to enforce qualitative methodology in neglect assessment.

Keywords: Neglect; Neuropsychological evaluation; Qualitative methods; Impairment; Disability

1. Introduction

Unilateral spatial neglect is an attentional deficit following a brain lesion. This complex neuropsychological syndrome consists of different signs which have in common the tendency to ignore contralesional space. It is basically

characterized by deficits in exploring, keeping attention either perceive and act in a part of the space (Halligan & Marshall, 1991).

Symptomatology is extremely variable. Firstly it may depends on time from brain damage onset and its severity as well; thus at a bed side examination one could observe a patient with ipsilesional deviation of head and gaze; lack of responses if a speaking person stands on the left; moreover, still in case of presence of two examiners, the patient may provide response only to the examiner which stands on ipsilesional side, even if there is no match between voice and gender of examiner. At a daily life observation patient could eat only in half of the plate; they do not catch objects if put on their contralesional side; they dress only right part of the body; finally it is generally observed that neglect patients show anosognosia, that is a reduced, even absent, awareness of the pathology (Stone et al., 1991).

Secondly, neuropsychological evidences for dissociation between levels of space involved in neglect were found: such as personal, peripersonal, extrapersonal, representational space (Ladavas et al., 1997).

In case of personal neglect a reduced awareness of contralateral half-body is observed and in particular deficits in exploring half part of the body, difficulties in dressing, shaving, washing, making-up, hair-brushing; besides, psychiatric symptoms may occur such as somatoparaphrenia which is an illusional belief concerning left arm, or misoplegia intended as aggressiveness and auto-direct damaging actions on the contralesional arm.

In case of peri-personal neglect, patients show difficulties in detecting stimuli, reaching or perceiving contralateral objects in the space delimited by the width of arm movements. Whilst extra-personal neglect consists in visuo-spatial deficits concerning the surrounding space over the limit of arm movements; in case of extra-personal neglect, severity could be enhanced by the presence of hemianopia.

Thirdly neglect may be space- or object-centred, referring to an egocentric or object-centred reference frame.

Neglect generally occurs after a right brain lesion, involving in particular the temporo-parietal area and the inferior parietal lobule (Vallar, 2001) even thought it is possibile to find neglect signs in left brain damaged patients as well. Different works tried to report an incidence of neglect after right brain lesion and data vary from 10% (Vanier et al., 1990) to 82% (Stone et al., 1993); studies on patients with left brain lesions show an extremely variable of percentage: Beis and coworkers (2004) report an occurrence between 0 and 76%; whilst other studies like those one of Halligan et al. (1993), found an incidence of 15% and other again an occurrence of 65% (Stone et al., 1993). These variations could be caused by different reasons: on one hand it may depends by different sensitivity of tests; on the other hand by

the time between lesion and evaluation (Plummer et al., 2003). Concerning right neglect (that is in presence of a left brain lesion) it may be possible that symptoms are sometimes underestimated because of the task: in many occasion left brain damaged patient could presents aphasia as well and for this reason execution of visuo-spatial test may be affected either for comprehension of instructions and for use of verbal stimuli; the whole of these limits could have indirectly determined a lower percentage of incidence of neglect for left brain demaged patients and a poorer description of specificity of this syndrome (Berndt et al., 2005; Kleinman et al., 2007).

Besides the location of misattention (left vs right) or the specificity of the syndrome, Neglect is described by scientific literature mainly as an *impairment* involving either visuo-spatial attention, arm movements, and gaze exploration in different degree of severity.

Differently, both rehabilitation outcomes and daily life activities recall to the wider concept of *disability*.

In 1980 the World Health Organization, in its *International Classification of Impairment, Disability and Handicap*, states that IMPAIRMENT should be considered as any loss or abnormality of psychological, physiological, or anatomical structure or function in the context of health experience; whilst DISABILITY is any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being.

Thus in case of a particular *disease* (e.g. cerebral stroke), the consequent *impairment* could be Neglect and the *disability* the visuo-spatial attentive deficits.

Disability deriving from neglect may generally affect the possibility to find things in the surrounding space, or in addition to other characteristics of patients (e.g. age) it can have significant influences on outcome rehabilitation (Sozzi et al., 2012).

Which measures could provide information on disability deriving from neglect? Is it possibile to find a link between quantitative and qualitative measure of neglect?

The aim of this work is to provide a review of the more frequently used instruments in the assessment procedures to study neglect, give a short description of them and, highlight a possible interaction between different methods of assessment.

2. Assessment methods

Neglect could be assessed and monitored by means of two different types of tools: quantitative and qualitative methods. The first mainly concerns neuropsychological assessment and it is characterized by the use of tasks which can vary in type and difficulties: paper-and-pencil tasks as well as computerized tests. All of them are aimed to highlight impairment and provide a numerical measure by which having information on the specificity of neglect (e.g. peri-personal vs personal one) and at the same time the severity of the syndrome. The second method is based on the clinical observation of the patient in order to have a feedback concerning the disability caused by neglect syndrome.

2.1. Quantitative methods

An example of the most known neuropsychological tests used in neglect assessment includes these instruments:

- Line bisection (e.g. Schenkenberg et al., 1980). There are different versions of the same test which basically consists in asking the patient to bisect a line putting a mark where the exact midpoint is perceived. It is generally found that neglect patients show a rightward bias and consequently mark the midpoint closer to the right extremity.
- Cancellation tasks (Albert, 1973; Gauthier et al., 1989). Line cancellation is a widely use test in neglect assessment; a series of lines with different orientation are distributed on all the space of a paper sheet and the patient is asked to cancel all of them. Patients with a severe neglect generally omit to find the lines put on contralesional extremity. The sensitivity of this test mainly allows detecting severe neglect and this is mainly due because of the possibility to gradually move the focus of attention from right to left in absence of any distractor. Other cancellation tests consider the presence of distractors which determine a higher difficulty of task. With Bell cancellation test, for example, the patient is asked to find all targets (shapes of bells) which are between several other shapes of different objects. In star cancellation patient should be able to find star with the dimension indicated by the examiner; the target are between other stimuli such as stars with different dimensions and letters. In Letter cancellation test patient is asked to find all the H letters; all letters are written on six different lines.
- Drawing test (Spinnler & Tognoni, 1987; Halligan et al., 1991; Agrell et al., 1997). As for the previous tests, it is likely to find different versions of this task: in general, patients are asked to copy geometric figures or com-

plex drawing designs, they may either asked to spontaneously draw different figures (clock, human silhouette, butterfly, etc.).
- Word and Sentence reading. The patient is asked to read word and sentences: the aim of this test is to find the presence of neglect dyslexia and its severity.
- Raven 1947, PCM position preference (Colombo et al., 1976). These authors proposed a different version of the test very frequently used for executive functions and reasoning abilities. Patient is asked to find the "most correct" solution to be put in the uncompleted matrices; at the end of the test a Position Preference Index is calculated as difference between the number of "right" responses (i.e. solutions 3 and 6) and the number of "left" ones (solutions 1 and 4), if the obtained value is higher than 8 one should consider the presence of a position preference related to an attentional bias which is on turn determined by the presence of neglect. It was found to be a sensitive measure of the presence of neglect, either for left and right heminattention (Strauss et al., 2006).
- BIT (Wilson et al., 1987). It is one of the most widely used test battery to assess neglect; the BIT consists of a series of paper-and-pencil like letter and star cancellation, figure copying, line bisection and free drawing. It provides scores that clearly define the severity of neglect basing upon patient's performance.

Apart from these paper-and-pencil tests, it possible to find in addition some computerized procedures aimed to observe more precisely reaction times, accuracy and other variable such as eye-movements in neglect patients. An example is provided by our work (Balconi et al., 2012a; 2012b) in which we administered a modified version of bisection task. Stimuli were horizontal gaps represented by two red spheres and patients were asked to bisect the virtual space between these two endpoints. Segment length and its spatial position were monitored, in order to verify the consistency of rightward bias increasing as a function of left-side dislocation; moreover we monitored eye-movements as indirect measure of attention. We observed, as attended, a rightward bias increasing in function of segment length and spatial position and we additionally confirmed that eye-movement behavior is directly related to visuo-spatial scanning of space.

Another example of computerized assessment comes from Erez et al. (2009) who realized VISSTA (Visual Spatial Search Task). This instrument consists of two kinds of task in which patients are asked to search targets in different conditions: in the *feature search task* the patients have to find the target between distractors which vary only for color, whilst in *conjunction search task* the target is between different distractors which vary either for shape and color. For all of these two types of task different difficulty levels are presents.

As said before, all of these tasks provide a numerical value which gives information on several aspects of neglect, such as its specificity and severity as well. Nevertheless psychometric tests are a part of neuropsychological assessment: these results are in part integrated with clinical interview and clinical observation (which are part or the neuropsychological assessment as well) in order to have a detailed neuropsychological profile (*Table 1*).

2.2. Qualitative methods

In scientific literature only few works concern description of assessment scales based upon qualitative methods. We found two main contributes:

- Semi-structured scale for evaluation of hemi-inattention (Zoccolotti et al., 1991; 2012).
- This is a qualitative assessment based upon the observation of patients during activities; it is composed by a subscale for personal neglect and a scale for extrapersonal neglect. Patient is asked to execute behaviours such as hair-brushing, shaving, making-up or complex activities like serving tea or distribute cards.
- Catherine Bergego Scale (Azouvi et al., 2006). This is a scale based upon qualitative observation of the patient during activities of daily living; it consists in on direct patient observation on real life situation such as grooming, dressing, wheelchair driving etc. The scale provides a score between 0 (no neglect) and 30 (severe neglect). The authors found high correlation of the scores obtained by the scale with neuropsychological tests. These scales constitute a valid and effective integration of psychometric assessment in order to obtain a complete neuropsychological assessment (*Table 1*).

Table 1. Sample of neuropsychological tools for assessment of visuo-spatial neglect

Sample of neuropsychological tools for assessment of visuo-spatial neglect
Quantitative methods (measure of impairment): • Line bisection (e.g. Schenkenberg et al., 1980); • Cancellation tasks (Albert, 1973; Gauthier et al., 1989); • Drawing test (Spinnler & Tognoni, 1987; Halligan et al., 1991; Agrell et al., 1997); • Raven 1947, PCM position preference (Colombo et al., 1976); • BIT (Wilson et al., 1987); • Virtual bisection task (Balconi et al., 2012; 2012b); • VISSTA – Visual Spatial Search Task (Erez et al., 2009).
Qualitative methods (measure of disability): • Semi-structured scale for evaluation of hemi-inattention (Zoccolotti et al., 1991;1992); • Catherine Bergego Scale (Azouvi et al., 2006).

3. Discussion

Scientific literature shows an evident imbalance between quantitative and qualitative methods. At present there is a wide use of quantitative methods (e.g. neuropsychological tests) which are aimed to provide numerical values for a clear description of neglect, conceived as impairment.

Even thought not all the quantitative tests present a high level of validity neither seem to be totally sensitive in finding neglect (for a review see Plummer et al., 2003), they constitute an important tool for neuropsychological assessment. From these values we can obtain a great amount of information concerning either specificity of neglect and its severity. The more complex is the test, the more information they provide: firstly they could concern the level of space involved (e.g. personal; peripersonal or extrapersonal neglect); secondly the attentional bias frame (e.g. object-centred or space-centred neglect); finally all numerical data allow the planning of neuropsychological rehabilitation programs, thus, besides giving useful information, they constitute *per se* a base-line. Actually, after a rehabilitation program it is possible to verify the possible reduction of severity of neglect and, in turn, verify the effectiveness of the specific treatment adopted.

On the other hand it seems that only few instruments permit to have a qualitative assessment of neglect. In other words, there is a lack in assess neglect in term of disability. The scales we found allow the observation of patient during the execution of some activities of daily living. Even thought this could be an indirect measure of neglect consequences in everyday life of the patients, we should obtain some more information on patients' disability.

We then suggest to enforce clinical observation of the patients during daily activities. This procedure provides further information in addition to those obtained by quantitative assessment.

An example of this procedure could be done by patient observation during physiotherapy sessions: neuropsychologist should become a silent observer of the session and keep information firstly on the level of collaboration of the patient. He should observe how the patient behaves with the therapist: firstly in terms of collaboration, secondly if there are some behavior changes with respect to position assumed by the therapist or to physical exercices involving controlesional space. A part of that, the patient should be observed in selected moments of everyday activities during his hospitalization: for example, one should observe if he is able to move by himself in the hospital, and which limits he generally comes across.

All this information are than shared in the multidisciplinary team discussing about the main goals the patient should reach, the achieved targets and the problems and difficulties found by other practitioners in other contexts.

Moreover this qualitative methodology contributes to increase information in order to complete neuropsychological assessment together with psychometric tests and semi-structured scales.

Finally, in our experience this practice allows a more complete assessment of the single patient and, more in general, we argue that this could lead to a wider knowledge of neglect syndrome in terms of disability, concerned as reduction of abilities in patients' own environments.

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