

## Doing and reporting a neuropsychological assessment<sup>1</sup>

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**ABSTRACT.** The process of neuropsychological assessment involves several stages. Having identified the objectives and analysed the characteristics of the participants to be tested the task is then to select appropriate tests and to administer, score and interpret them. The final stage involves writing the clinical or scientific report. The present paper begins with a brief overview of the history of neuropsychology and considers approaches to assessment and the main reference books on assessment. The most prestigious journals in the field are also listed. This is followed by a discussion of the most important aspects to be considered in each stage of clinical assessment or research, complemented by guidelines regarding the publication of neuropsychological assessments; mainly in relation to method - participants, assessment, statistical analysis - and results. This information is also presented in the form of a table in which a distinction is made between those aspects which are considered essential to include when writing a paper about neuropsychological assessment and those which are recommended.

**KEYWORDS.** Neuropsychological assessment. Neuropsychological tests. Administration. Interpretation. Theoretical study.

**RESUMEN.** El proceso de la evaluación neuropsicológica implica varios estadios. Primero se identifican los objetivos y se analizan las características de los participantes que van a ser evaluados y después se seleccionan las pruebas, se administran, corrigen

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e interpretan. El último paso es la redacción de un informe clínico o científico. El presente trabajo comienza con una breve reseña de la historia de la neuropsicología, considera los enfoques de la evaluación y los principales manuales de referencia en evaluación. También se listan las mejores revistas de la especialidad. Continúa con un apartado en el que se explican los aspectos más relevantes para las distintas fases de la evaluación clínica o de investigación y finaliza exponiendo unas pautas sobre aspectos específicos de la publicación de evaluaciones neuropsicológicas, principalmente en relación a los apartados de método – participantes, evaluación, análisis estadístico- y resultados. Esta información se puede consultar en una tabla anexa en la que se diferencia entre la información que consideramos necesaria para publicar sobre evaluación neuropsicológica y aquella aconsejable aunque no imprescindible.

**PALABRAS CLAVE.** Evaluación neuropsicológica. Tests neuropsicológicos. Administración. Interpretación. Estudio teórico.

The term *neuropsychology* was first used in 1913, and by the 1940s it had already acquired a specific meaning. This led in 1967 to the creation of the International Neuropsychological Society, which currently has over 4,500 members, mostly clinical neuropsychologists but also researchers and associated professionals. In 1980 the American Psychological Association (APA) established the Division of Clinical Neuropsychology (Division 40), which was followed in 1987 by the definition of the specialty and its competencies. The Houston Conference of 1988 saw a redefinition of the specialty, its competencies, the basic training required and the accreditation procedures, and produced the following description: «A clinical neuropsychologist is a professional psychologist trained in the science of brain-behaviour relationships. The clinical neuropsychologist specializes in the application of assessment and intervention principles based on the scientific study of human behaviour across the life span as it relates to normal and abnormal functioning of the human central nervous system» (Executive Committee of Division 40 of the APA, 1989).

In the North America clinical neuropsychological assessment emerged out of the field of psychology and its interest in following standardized procedures. At the same time, however, a school of neuropsychology was developed in Russia by Alexander Romanovich Luria, who had been trained in neurology and psychoanalysis. Consequently, neuropsychological assessment as performed by the Russian school placed greater emphasis on close observation and case studies than on the development of standardized tests. Indeed, the Russian approach was based on generalization and the testing of hypotheses that guided the clinical examination, diagnosis and treatment. Both these traditions are reflected in the current approach to neuropsychological assessment, which includes both qualitative and quantitative aspects, *i.e.* both clinical observations and standardized test scores are seen as necessary to assess a patient.

A milestone in the history of neuropsychological assessment was the publication in 1985 of Muriel Lezak's *Neuropsychological Assessment*, a book that ended up on the shelves of neuropsychologists across the world due to it being the first compendium

not only of neuropsychological tests but also of guidelines for choosing, scoring and interpreting them. The fourth and latest edition of the book was published in 2004 (Lezak, Howieson, and Loring, 2004), and although there are now other handbooks of interest Lezak's book continues to be an irreplaceable reference. The book is organized into two thematic parts: 'Theory and Practice of Neuropsychological Assessment' and 'A Compendium of Tests and Assessment Techniques'. Part 1 reviews key aspects such as the practice of assessment, basic concepts of brain damage and cognitive function, the behavioural geography of the brain, the rationale of deficit management, procedures used in neuropsychological examination and how to interpret the results, neuropathology for neuropsychologists, and, finally, neurobehavioural variables and diagnostic issues. Part 2 is organized according to functions: orientation and attention, perception, memory, verbal functions, construction, concept formation and reasoning, executive functions and motor performance, test batteries, observational methods, rating scales and inventories, tests of personal adjustment and emotional functioning, and testing for response bias and incomplete effort. It can be seen that the book is much more than a simple list or manual of neuropsychological tests, and in fact it considers each stage of the process of neuropsychological assessment, describing the knowledge required, the questions that remain to be answered and the problems faced. It also pays special attention to published neuropsychological findings, as well as to the different tasks, tests, batteries and scales that are used. In sum, the book constitutes an invaluable resource for any clinical neuropsychologist.

Possibly, the second most widely used handbook is that of Spreen and Strauss, originally published in 1991 and whose most recent edition, *A Compendium of Neuropsychological Tests*, appeared in 2006 (Strauss, Sherman, and Spreen, 2006). This book reviews tests of general cognitive functioning, neuropsychological batteries, the assessment of premorbid intelligence, various tests (of achievement, attention, memory, executive functions, language, visual perception, somatosensory and olfactory function, body orientation, motor function), the evaluation of adaptive functions, of mood and personality, and response bias and suboptimal performance. It adds to Lezak's book by including more detailed discussion of the psychometric properties of tests, as well as more data about norms, test versions in other languages, and the commercial availability of tests.

A more specific text is Mitrushina, Boone, Razani and D'Elia's *Handbook of Normative Data for Neuropsychological Assessment*, the second edition of which was published in 2005 (Mitrushina, Boone, Razani, and D'Elia, 2005). Although the first part of this book addresses topics such as methodological, statistical and psychometric concepts in neuropsychology, the main purpose of the text is to review the main neuropsychological tests, which are organized by functions.

Other handbooks on more specific aspects of neuropsychological assessment include Baron's *Neuropsychological Evaluation of the Child* (Baron, 2004), Grant and Adams' *Neuropsychological Assessment of Neuropsychiatric and Neuromedical Disorders*, whose third edition was published in 2009 (Grant and Adams, 2009), and Tate's *A Compendium of Tests, Scales and Questionnaires: The Practitioner's Guide to Measuring Outcomes After Acquired Brain Impairment* (Tate, 2010).

In terms of periodic publications there are numerous journals which accept articles on neuropsychological topics, including all journals in the fields of neurology and psychiatry and many journals related to specific diseases or disorders (such as epilepsy, multiple sclerosis and Alzheimer's disease, among many others). The following table lists only those journals which are dedicated exclusively to neuropsychology.

**TABLE 1.** Main international journals of neuropsychology sorted by impact factor (Journal Citation Reports 2010).

<i>Publication</i>	<i>I.F. 2010</i>
Neuropsychology Review	4.231
Neuropsychologia	3.949
Neuropsychology	3.176
Journal of the International Neuropsychological Society (JINS)	2.910
Developmental Neuropsychology	2.440
Journal of Neuropsychology	2.364
Archives of Clinical Neuropsychology	2.304
Cognitive Neuropsychology	2.082
Clinical neuropsychologist	2.075
Journal of Clinical and Experimental Neuropsychology	1.805
Neuropsychological Rehabilitation: An International Journal	1.731
Child Neuropsychology	1.727
Aging, Neuropsychology, and Cognition	1.292

*Note.* I.F. = Impact Factor.

### **Conducting a neuropsychological assessment**

According to Boake (2008) the main professional activity of the clinical neuropsychologist is assessment. The assessment process begins with the setting of objectives, followed by an analysis of the characteristics of the participants to be tested and the selection of appropriate tests, which must then be administered, scored and interpreted them. The process concludes with the writing of either a clinical report, offering feedback to the patient, or a scientific paper, which enables the findings to be shared with the scientific community or the general public.

#### *Objectives*

The content of a neuropsychological assessment will vary depending on its purpose (in which the reason for referral must be taken into account), the clinician's preferred approach and the time available (Boake, 2008). The principal aim of such an assessment is to identify the behavioural, emotional and cognitive consequences of brain dysfunction, this being achieved through the analysis of cognitive deficits, of the cognitive processes that are preserved, and of the individual's everyday functioning (Blázquez-Alisente, González-Rodríguez, and Paúl-Lapedriza, 2008; Rodríguez, 2009).

The main research objective in neuropsychology involves testing hypotheses about brain functioning by means of a neuropsychological assessment (and its relationship to the results of other tests and techniques) in both clinical groups and healthy individuals. Indeed, the history of neuropsychology is founded on the accumulation of knowledge about the relationships between brain and behaviour, with neuropsychological testing being the principal tool used to this end. This is well illustrated by the work of Bechara, Damasio, Damasio, and Anderson (1994), who developed the *Iowa Gambling Task* to test the somatic marker hypothesis and the functioning of the ventromedial prefrontal cortex, or Grafman's use of script tasks to demonstrate aspects of his theory of frontal lobe functioning (Sirigu *et al.*, 1995). Similarly, the use of periodic assessments to monitor the evolution of neuropsychological functioning can provide information about an individual's long-term recovery or deterioration under specific conditions. Long-term monitoring is also of special interest in relation to childhood disorders as it can reveal not only interruptions to the normal developmental process but also the potential plasticity of the developing brain.

In addition to hypothesis testing the present paper considers a number of other key objectives of assessment, namely the description of profiles or performance, the provision of objective information about changes (developmental, relapses, post-treatment, etc.) and the gathering of data in order to design treatments or ways of helping patients. In the clinical context, subjects will be assessed individually, whereas researchers may use either single case studies or group assessments. At all events the abovementioned objectives are relevant in both these contexts. Indeed, the same assessment may serve a range of purposes.

Clinical neuropsychology is always based on individual assessment and seeks to answer a specific question, which is often the reason for referral. This then leads to an interpretation of the findings and the writing of a final report. However, in specialist publications the reporting of single neuropsychological case studies is usually associated with disorders which are so rare that it is difficult to recruit homogenous study groups; this would also be the case when a patient suffers from more than one disorder, presents a striking combination of brain lesions or shows an atypical clinical evolution. Whatever the case the objectives would be in line with those stated above: to describe the functions that are preserved and altered in the patient, to conduct several assessments over time in order to monitor the patient's evolution (improvement or deterioration), or to demonstrate the changes which have resulted from a given treatment. An especially interesting clinical case may also serve to test a hypothesis about brain functioning, although the choice of this case would need to be carefully justified. According to McKenna and Warrington (2009), single case studies are of interest if the patient has a selective, consistent and quantitatively significant deficit, in relation to which the neuropsychologist can prepare exhaustive tests. Further information about the use of clinical case studies in psychology can be found in Virués-Ortega and Moreno-Rodríguez (2008).

### *Participants*

Information about the individual to be tested is mainly obtained through the initial clinical interview and by reviewing previous reports, whether medical, academic, psychological or neuropsychological. For any assessment the clinician should take a medical, neuropsychological and social history, and also enquire about current life circumstances and any other related aspects, such as the reason for referral and the relevance of the assessment for the patient (for example, an assessment may be linked to a compensation claim regarding the sequelae of the patient's lesion) (Boake, 2008; Lezak *et al.*, 2004). During the clinical interview the clinician should also observe the patient's general level of alertness, awareness of any deficits, the potential influence of emotional and motivational aspects, and any other relevant problems (Boake, 2008).

As regards the social history, patients' educational and employment experiences are the best source of information about their original cognitive potential, although it is also necessary to enquire about their socio-economic status and family of origin. The current life circumstances which need to be taken into account include employment status, income, debts, leisure activities, the presence of sexual dysfunction, and family or marital problems.

With respect to the medical history and current medical status a number of aspects should be considered. When assessing patients with a neurological problem it is important to ascertain not only the diagnosis but also the specific features of the problem in this particular patient (for example, the location of the lesion or the duration of the illness). Any associated deficits should also be noted, even if they are not inherent to the primary disorder (comorbid epilepsy, sensory or motor deficits, etc.). The clinician should also enquire about substance abuse or the use of any prescribed medication that might interfere with neuropsychological functioning. Although they are not always included in the medical history it is important for the neuropsychologist to be aware of any visual or hearing deficits, as well as the patient's sleep pattern. Advanced knowledge of the relationship between brain and behaviour is thus required in order to be able to interpret the patient's medical history, to evaluate the relevance of any neuroimaging and neurological reports, to contemplate different diagnostic possibilities, and to identify prognostic signs.

### *Test selection*

Prior to choosing the tests to be administered it is important to consider which functions or capacities need to be evaluated or measured in order to fulfil the assessment objectives. Having done so, the clinician can then seek out the most appropriate tests in relation to each function. The choice of test battery also depends on the subject's ability and willingness to perform the proposed tests, as well as on the existence of any previous test results, the suitability of the chosen tests for the individual in question, and the amount of time available (Boake, 2008). The validity, reliability, sensitivity and specificity of the tests must also be taken into account (Lezak *et al.*, 2004). The abovementioned handbooks are a good starting point when it comes to test selection, as they are generally organized according to functions and include comments about the applicability of tests to different populations, as well as data regarding viability and validity.

The criterion for choosing tests in the research context is that they are indeed capable of testing the proposed hypothesis or demonstrating the phenomenon in question. One must also take into account certain practical aspects, such as the time available and whether or not the instruments are suitable for the study population (Lezak *et al.*, 2004). As before, the first question to be asked is not which tests am I going to use, but rather, what functions and abilities do I need to assess.

Lezak *et al.* (2004) recommends starting with a basic test battery covering attention, visual perception and reasoning, learning and memory, verbal functions and academic skills, construction, concept formation, executive functions and motor abilities, and emotional status. Other tests can then be introduced or ruled out as the assessment proceeds and the hypotheses are tested. Lezak is critical of pre-established test batteries, arguing that they are no substitute for clinical judgment, and also that they lead to the majority of patients undergoing more tests that are necessary, but often without including those which are indeed required to answer the specific questions arising from their problems. Consequently, the trend within the profession is now to select tests on an individualized basis. In a survey of clinical neuropsychologists in the USA, Sweet, Nelson, and Moberg (2006) found that fewer than 10% always used the same battery of tests, whereas around 75% said they took a flexible approach, administering a core set of tests to the majority of their patients and then adding further tests as required. The situation is somewhat different in the context of a research protocol, and here the examiner has less freedom and flexibility over test selection and presentation than is the case in clinical practice. As a result, tests must be chosen carefully at the outset, since it is not advisable to change instruments or the procedure once an assessment is underway, as doing so could confound the results. Nevertheless, some authors have argued that it is also important to be flexible in the research context (Fischer, Rudick, Cutter, and Reingold, 1999).

As is the case when deciding upon treatment the choice of tests should not overlook the current consensus regarding the use of scientific evidence. The evidence-based approach means that the best medical evidence can be accessed via bibliographic databases, scientific journals, the secondary or tertiary literature (such as the Cochrane) and rigorous and tested clinical practice guidelines.

As the brain functions in an integrated way, performance in relation to one function always depends to some extent on the correct performance of other functions. In this regard Lezak *et al.* (2004) makes some interesting points about how performance in brain-damaged individuals can vary according to attentional problems, the ability to retrieve information, fatigue, lack of motivation, or signs of depression. Therefore, if our aim is to study a pathological condition which has been shown in the scientific literature to be associated with altered cognitive functions, these functions should also be assessed, even though they are not the target objective.

Mention should also be made of the attempts by various research groups in the field of neuropsychological assessment to reach a consensus regarding the most suitable tests for specific disorders. This is the case of the work by Benedict *et al.* (2002) in relation to multiple sclerosis, or that of Nuechterlein *et al.* (2008) in schizophrenia. A consensus has also been reached regarding the assessment of malingering and response



bias (Heilbrunner, Sweet, Morgan, Larrabee, and Millis, 2009). At all events, prior to deciding which specific tests will be used in a study it is necessary to review the literature for the disorder in question, as this will make it easier to compare and discuss the results obtained.

When conducting a neuropsychological assessment it is important to choose tests that provide normative data. In addition to age adjustments many tests also include adjusted data in relation to educational level and other influential demographic variables (Heaton, Miller, Taylor, and Grant, 2004). The evidence suggests that demographic adjustments improve the accuracy of normative comparisons and reduce the error rate. In relation to the Spanish population the series of studies carried out by the Neuronorma Project is especially interesting in this regard (Peña-Casanova *et al.*, 2009). In the assessment of children it is particularly important to ensure that any normative data are adjusted for age and sex, since boys and girls develop at a different rate (Baron, 2004; Strauss *et al.*, 2006).

With respect to the concepts of reliability, validity, sensitivity and specificity a good source of information is the article published in this journal by Carretero-Dios and Pérez (2007). Given the disadvantages of test translation (Artiola i Fortuny *et al.*, 2005; Lezak *et al.*, 2004) it is important to consider whether the subjects' mother tongue is the same as that used in the original test material, and also whether the subjects are bilingual, as these aspects can affect performance (Ardila *et al.*, 2000). With respect to the question of whether it is advisable to use updated versions of tests, readers are recommended to consult the paper by Bush (2010).

Finally, when the same subject or group of subjects are scheduled to undergo more than one assessment at different points in time the choice of tests should include consideration of practice effects, as these depend on the characteristics of the tests used (Wilson, Watson, Baddeley, Emslie, and Evans, 2000). The problem of practice effects is especially relevant in relation to memory tests, although it has a minimal influence on tests that are difficult to conceptualize, such as the Block Design subtest of the Wechsler batteries. McCaffrey, Duff, and Westervelt (2000) discuss those tests which are most prone to practice effects, as well as which groups of patients are most susceptible to the problem. It should also be remembered that practice effects may vary across different ages (Salthouse, 2010). One proposed solution to the problem of practice effects is the use of parallel test forms. However, these must be used with caution due to the possibility of differences in difficulty level between the forms, to the generation of positive or negative expectations following the first administration (for example, making a greater effort on certain tasks which the subject remembers as being difficult), or even to the possibility that the subject has practised similar tasks in the interval between two assessments, which would increase the practice effect (Baron, 2004). One should also bear in mind that parallel forms are difficult or even impossible to develop for some classic tests such as the Wisconsin Card Sorting Test (Strauss *et al.*, 2006). Furthermore, if parallel forms are not developed correctly their use may introduce more variability than would have resulted from the practice effects they seek to overcome (Benedict and Zgaljardic, 1998).



### *Administration and scoring*

Test administration should begin with a brief preparatory interview. The first 15-20 minutes serve to ensure that the patient understands the purpose of the assessment, and to obtain his or her consent. In this initial stage, patients should be informed about the purpose and nature of the assessment, how the information obtained will be used, confidentiality, the fact that they will be given feedback about the results, and, briefly, the procedures that will be used. They should also be asked about how they feel in relation to the tests. It is advisable for this initial interview to be conducted in the presence of either a relative of the patient or the person who has accompanied him/her to the appointment. Efforts should also be made to ensure that the setting, the number of sessions and the order of test presentation are conducive to assessment in a given individual. For most subjects with brain damage these optimum conditions include a room with no distractions, a non-threatening emotional climate and a procedure that minimizes fatigue. In order to optimize performance it is also a good idea to begin the session with those tests that may be more difficult, as subjects will be less tired at the outset. Alternating verbal and non-verbal tests can likewise help to avoid a string of unpleasant or difficult tests (Lezak *et al.*, 2004).

Sweet *et al.* (2006) report that around half the neuropsychologists they surveyed used assistants for test administration. In the research context the battery of tests has already been chosen and the qualitative analysis of subjects is of limited relevance, hence the use of assistants is a recognized way of reducing project costs and time (Axelrod *et al.*, 2000). At all events the person who administers the tests must have sufficient clinical experience to be able to make and interpret any observations in relation to the scores obtained. The actual interpretation of scores obviously requires knowledge of and specific training in neuropsychology.

In the case of a research protocol regarding a specific group of subjects it is first necessary to decide whether the test administration will follow the established procedures for standardized versions, or if any variations will be introduced according to the sample characteristics. Obviously, any procedural modifications may then imply changes to the scoring and interpretation of tests.

At all events the scoring of tests will depend on the assessment objectives. For example, the description of profiles or performance and the identification of changes, the two most common objectives, almost always require the transformation of raw scores, often into standard scores such as T or z. In the Wechsler batteries, raw scores are converted into scaled scores, and the standard score for intelligent quotient can also be obtained. In other cases raw scores are converted into non-standardized scores such as percentiles. The transformation of scores onto a single scale makes it possible to produce a graphical representation of overall performance (Strauss *et al.*, 2006).

The identification of changes usually includes the concept of deficit. As Lezak *et al.* (2004) point out this concept presupposes some idea of prior functioning with which the patient's performance must be compared. However, as such information is not always available the comparison is usually made with normative data, particularly the mean and standard deviation of the population. A neuropsychological deficit implies a significant discrepancy between a person's actual level of performance and the expected

level for a given cognitive function or activity, although there is still no consensus regarding the criterion for determining what significant means. Some authors consider a deficit as being a level of performance that is more than one standard deviation from the mean (Taylor and Heaton, 2001), while others suggest using the criterion of two or more standard deviations (Baron, 2004; Lezak *et al.*, 2004). It should also be noted that authors such as Lezak *et al.* (2004) stress the importance of basing any conclusion regarding a functional deficit on the results of more than one test.

When a comparison is made with normative data it is advisable to accompany scores with the classification of ability levels, as is proposed for the Wechsler batteries. This information can help to avoid errors of interpretation, whereby the neuropsychologist concludes that a different ability is present because one score is lower than another. To take an example from Lezak *et al.* (2004) one should not assume that a person with a scaled score of 9 on Similarities and 11 on Arithmetic has poorer verbal reasoning than mathematical ability, since both scores fall within the average range. Likewise, a given score does not necessarily merit the same interpretation: if this score is the best that a subject has ever achieved it should not be interpreted in the same way as if the score represents a decline from a clearly superior premorbid level.

### *Interpretation*

The greatest challenge in a neuropsychological assessment is to integrate the test results with background information about the patient in order to reach diagnostic and prognostic conclusions. According to Lezak *et al.* (2004) blind analysis, in which the examiner considers a series of scores without taking into account the patient's history, previous reports or observational data, is not a good basis on which to base clinical decisions. Indeed, the clinical neuropsychologist must be able to identify neurobehavioural syndromes that correlate with the neurological and neuroimaging data. Furthermore, the interpretation stage of a neuropsychological assessment should be regarded as a process. Correct assessment requires both quantitative interpretation, in terms of normative comparisons, and a qualitative appraisal based on the patient's attitude towards the tests administered and any patterns in the errors made. This qualitative evaluation is discussed in the abovementioned handbooks and is considered a necessary part of good clinical practice (Baron, 2004; Lezak *et al.*, 2004; Mitrushina *et al.*, 2005). Indeed, the incorporation of qualitative data lends the neuropsychological assessment greater diagnostic and predictive capacity than would be achieved through the use of quantitative data alone (Ogden-Epker and Cullum, 2001). However, given that qualitative data are usually recorded in descriptive form they have rarely been used in the research context. In this regard the review by Porech (2000) provides an interesting discussion of the quantification of qualitative aspects. Other examples of the quantification of qualitative data can be found in widely used tests such as Rey's Complex Figure (Rey, 2003) or the Block Design subtest of the Wechsler batteries (Joy, Fein, Kaplan, and Freedman, 2001).

As noted earlier, a common objective of neuropsychological assessment is the identification of changes. When follow-up assessments are performed then the same

type of score will be compared, but it is often necessary to identify changes by comparing present performance with that at a previous point in time. However, a record of premorbid performance is not always available, and thus the deficit has to be measured indirectly: the examiner compares the present performance with an 'estimate' of the patient's original ability. The most widely used indirect methods are based on socio-demographic variables, the scores on cognitive tests that correlate with education, or the combination of the two. Among socio-demographic variables, educational background offers the best estimate of a subject's premorbid performance. Scores on the Wechsler intelligence scale, such as the performance intelligence quotient or the score on the Vocabulary subscale (regarded as resistant to cognitive deterioration), as well as reading tests (such as the North American Adult Reading Test [NAART] or the Wide Range Achievement Test [WRAT]), have been considered useful for estimating premorbid intelligence. In the Spanish context a suggested equivalent to the latter is the *Test de acentuación de palabras* developed by Moltó, Igual, Pastor, González-Aniorte, and Asensio (1997). Premorbid ability can also be estimated using equations that include different factors: demographic variables alone or in combination with test scores (for example, age, employment and education, combined with Vocabulary or Picture Completion).

#### *Feedback of results*

In clinical practice the assessment process ends with a written report of the interpreted results, and this is often accompanied by verbal feedback to the patient concerned. Once again the purpose of the assessment will determine the form and content of the feedback given. Clinical reports may sometimes resemble the sort of report that would derive from a neuropsychological assessment conducted for specifically scientific purposes. The next section presents a series of potential guidelines for authors in this regard.

### **Writing a paper on neuropsychological assessment**

There are a number of key aspects to be addressed when writing an article about neuropsychological assessment. In this section these will be discussed in line with the above description of the assessment process, as well as by taking into account the main guidelines of the journal *Neuropsychologia*. This journal is currently ranked in the first quartile of the category *Behavioural Sciences* and has the highest impact factor among specific research journals in the field (see Table 1), thereby making it a good example to follow. This section does not consider aspects to be included in the introduction and discussion of articles, since the requirements here are the same as for any scientific paper in the health sciences, and can be consulted in Bobenrieth Astete (2002) and Fernández-Ríos and Buéla-Casal (2009). A distinction is made between those aspects which are considered essential to include when writing a paper about neuropsychological assessment and those which are recommended. These aspects are shown in the Appendix 1 to the present paper.

### Method

The guidelines for authors of the journal *Neuropsychologia* state that this section should contain sufficient detail to enable the study to be replicated.

#### *Participants*

Given the importance of study group characteristics in relation to the results of neuropsychological research (Falautano, 2010) it is essential that this section of a paper clearly states the inclusion and exclusion criteria that were applied, and it is also advisable to reference the scales that were used to check these criteria. In those studies in which low IQ or dementia are among the exclusion criteria it is important to specify and reference the corresponding test and cut-off score used.

In addition to the usual data such as the final number of subjects and the obtaining of informed consent it is also necessary to specify all those characteristics which might affect performance. Therefore, alongside variables such as the age and sex of subjects the sample description or a related table should include some measure of premorbid performance (for example, educational level). All this information is relevant regardless of the study design and should be presented with the corresponding descriptive data, *i.e.* mean, standard deviation and range for age and years of schooling, and frequencies for gender.

Given that in many studies involving neuropsychological assessment the subjects have a medical status and history of interest it is also necessary to set out all those characteristics which, while not being exclusion or inclusion criteria, might nonetheless interfere with neuropsychological performance: duration and severity of an illness, location of the lesion, associated deficits, substance abuse or use of medication. Some studies have also considered the presence of pain as a factor that affects performance (Nicholson, Martelli, and Zasler, 2001). As regards illness severity it is advisable to reference the scales used to determine this. At all events the relevance of medical data will depend in part on the study sample. For example, when comparing groups with sudden onset of an acquired disorder it is necessary to state the time elapsed between onset and assessment. In the assessment of acute and post-acute states (up to approximately twelve weeks after onset) it is especially important for the range of hours or days to be as small as possible, as in these early stages the patient's neuropsychological status can vary from one day to the next, and both fatigue and the degree of awareness of poor performance can have a greater influence on test results than is the case in more advanced stages.

#### *Neuropsychological assessment*

This section should include a detailed description of the material used and the procedure followed. Any paper that includes a neuropsychological assessment should specify the correct name of any instruments applied and give the corresponding references. It is also advisable to state the main reasons why these tests were chosen. The suitability of a test for measuring a particular function is the main criterion on which this decision should be based, and since the same test may enable more than one function to be assessed it is important to justify its selection in the case in question.

At times the reference which supports the use of the test will be the original paper describing its development, while on other occasions it may be necessary to cite assessment handbooks, such as those mentioned above, or previous research. If tasks are grouped according to functions for the purposes of analysis it is necessary to justify this grouping on the basis of theory, previous results or factor analysis.

When justifying the choice of tests one should also take into account their psychometric properties, and it is advisable to consult the literature regarding their use in populations similar to the study sample. Obviously, these justifications should all be referenced. In the event that performance on the same test is compared across different points in time it is necessary to explain how possible practice effects were controlled for. If parallel test forms are used it is advisable to include a reference to a study of the reliability between forms.

The description of the test must cover at least the material used, its administration and the scoring system. As some tests can be administered and scored in different ways it is necessary to specify if this was done according to the test handbook. The test material, administration and scoring should be described in more detail if any modifications have been made as regards the original test and these have not been previously reported in the literature (preferably with populations of similar characteristics). When the original reference for verbal tests is not in the mother tongue of the study sample it is important to specify which adaptation or translation has been used.

The performance registered by a test may vary according to the scoring system used (Lezak *et al.*, 2004). When using raw scores it is important to specify the maximum score possible on the test. The use of raw scores to compare neuropsychological performance is the most common approach when comparing different groups or the same group at different points in time. In those studies in which scores are analysed with respect to normative data it is necessary to specify whether the normative data are taken from the test handbook or have been obtained from journals, book chapters or even unpublished material.

It is advisable to state the number of assessment sessions, their duration and the order in which the tests were administered in each session, as well as any other characteristics that could affect performance. The professional who administered the tests should also be specified, and in the event that this person was only an assistant or not a clinical neuropsychologist it is important to state his or her qualifications.

### *Statistical analysis*

In this section one should make clear whether the variables analysed (number of correct responses, number of errors, performance time, etc.) are presented as raw scores or as transformed scores ( $z$ ,  $T$ , scale, percentiles or others) with respect to normative data. If the presence or absence of a deficit is used as a study variable it is important to justify the percentile or standard deviation chosen to classify subjects' performance.

All the statistical analyses performed should also be described, including those that serve to control for the influence of any confounding variables as regards neuropsychological performance: age, sex, measures of premorbid performance, characteristics of the disorder, or neuropsychological alterations that might interfere

with the results. The variables on which the groups differ are usually entered as covariates in the principal analyses.

It is also advisable for this section to include analyses that the current literature considers as suitable for assessing the clinical significance of any differences found or the effect size, as well as a Reliable Change Index or other estimators of clinically significant change.

### Results

This section should begin with a comparison of the groups in terms of the characteristics that might influence neuropsychological performance, or another type of analysis that serves the same purpose.

When presenting the results according to the study objectives any tables should include the names of the functions studied and the tests used to assess them. It must also be clear in these tables which variable is being compared and the type of score used. The mean, standard deviation and range of scores should be stated.

It is advisable to produce figures for those assessments that include performance profiles, interactions between variables, comparisons of more than two groups, or whenever necessary due to the complexity of the analysis.

### Conclusions

Neuropsychological assessment is a complex process that goes well beyond the mere administration of tests. Whether performed from a clinical or research perspective it always implies a number of stages and numerous factors that must be controlled for. Training in neuropsychology is obviously essential in order to conduct a clinical assessment correctly. However, the danger in the research field is that the mere use of tests classified as neuropsychological may be regarded as sufficient for a study to be based on correct neuropsychological assessment. This is why we have sought, throughout this paper, to highlight the importance of controlling for any characteristics of subjects which might affect performance, of basing test selection on well-founded criteria, of being clear about the process of test administration, and of being accurate in the description of results. In our view this is only possible when one has adequate knowledge and sufficient expertise in neuropsychology. Ensuring that this criterion is met would not only boost the quality of research but would also aid the communication of findings to other professionals. This, in turn, would help to produce a better understanding of the relationship between brain and behaviour, and improve the practice of clinical neuropsychology.

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**APPENDIX 1. Relevant issues for reporting a neuropsychological assessment.**

<b>METHOD: PARTICIPANTS</b>		<i>YES</i>	<i>UNCLEAR</i>	<i>NO</i>
<b>Essential aspects</b>				
1.	Describe the inclusion criteria			
2.	Describe the exclusion criteria			
3.	If cognitive ability (low IQ or dementia) is one of the exclusion criteria, specify and reference the scale and cut-off point used			
4.	Make clear that informed consent was obtained			
5.	State the mean, standard deviation and range for the age of each group			
6.	State the proportion of males and females in each group			
7.	State the mean, standard deviation and range for the number of years of education for each group, or the percentage of subjects with a given educational level or any other socio-demographic data that may influence performance			
8.	If any of the groups has a medical condition, list any characteristics that may influence performance (duration and severity of the illness, location of the lesion, associated deficits, medication)			
<b>Recommended aspects</b>				
1.	Include references for any scales on which the inclusion/exclusion criteria are based			
2.	Include references for any scales used to determine the severity of a medical condition			
<b>METHOD: NEUROPSYCHOLOGICAL ASSESSMENT</b>				
<b>Essential aspects</b>				
1.	Specify the correct name of the test			
2.	Include the reference for the test			
3.	If the reference for the test does not justify its use to assess the function in question, include the reference which does do so			
4.	If test performance is compared at different points in time, explain how practice effects were controlled for			
5.	Describe the test: material, administration and scoring			
6.	Make clear if the original test procedure was followed or whether modifications were introduced (the latter must be spelled out, referenced and justified)			
7.	If the reference to any verbal tests administered is not in the same language as the subjects' mother tongue, specify which adaptation or translated version was used with these subjects			
8.	If raw scores are used, indicate the maximum score possible			
9.	If using normative data other than those reported in the original test reference, specify the origin of these data			
10.	Specify the qualifications of the professional who administered the tests			
<b>Recommended aspects</b>				
1.	Explain clearly why the tests were chosen (correspondence with the assessed function, psychometric properties, use in similar disorders)			
2.	If parallel forms are used, include the reference that reports the reliability across forms			
3.	Describe the number of assessment sessions, their duration and the order in which tests were administered			

**METHOD: STATISTICAL ANALYSIS**

YES	UNCLEAR	NO
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**Essential aspects**

1.	Make clear which variables were analysed (number of correct responses, number of errors, performance time, etc.)			
2.	State whether scores are raw or which type of transformed score has been used (z, T, scale, percentiles or others)			
3.	Describe the statistical analyses in relation to possible confounding variables (age, sex, premorbid performance measures, characteristics of the disorder or neuropsychological alterations that could interfere with the results)			

**Recommended aspects**

1.	Discuss the clinical significance of any observed differences or any clinically significant change			
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**RESULTS**

YES	UNCLEAR	NO
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**Essential aspects**

1.	Show the analyses carried out to control for confounding variables			
2.	Include in the tables the names of the functions assessed and the tests used			
3.	Set out in the tables the performance scores analysed (number of correct responses, number of errors, performance time, etc.)			
4.	If raw scores were not used make clear in the tables the type of score reported			
5.	Indicate the mean, standard deviation and range of scores in the tables			

**Recommended aspects**

1.	Produce figures to help the reader understand complex analyses			
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