



Measuring intellectual ability in cerebral palsy: The comparison of three tests and their neuroimaging correlates



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ABSTRACT

Standard intelligence scales require both verbal and manipulative responses, making it difficult to use in cerebral palsy and leading to underestimate their actual performance. This study aims to compare three intelligence tests suitable for the heterogeneity of cerebral palsy in order to identify which one(s) could be more appropriate to use. Forty-four subjects with bilateral dyskinetic cerebral palsy (26 male, mean age 23 years) conducted the Raven's Coloured Progressive Matrices (RCPM), the Peabody Picture Vocabulary Test-3rd (PPVT-III) and the Wechsler Nonverbal Scale of Ability (WNV). Furthermore, a comprehensive neuropsychological battery and magnetic resonance imaging were assessed. The results show that PPVT-III gives limited information on cognitive performance and brain correlates, getting lower intelligence quotient scores. The WNV provides similar outcomes as RCPM, but cases with severe motor impairment were unable to perform it. Finally, the RCPM gives more comprehensive information on cognitive performance, comprising not only visual but also verbal functions. It is also sensitive to the structural state of the brain, being related to basal ganglia, thalamus and white matter areas such as superior longitudinal fasciculus. So, the RCPM may be considered a standardized easy-to-administer tool with great potential in both clinical and research fields of bilateral cerebral palsy.

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1. Introduction

Cerebral palsy (CP) is one of the most common causes of physical disability in early childhood and this disabling condition persists throughout the life of the affected children (Krageloh-Mann and Cans, 2009). The term 'cerebral palsy' encompasses a group of permanent disorders of movement and/or posture and of motor function due to non-progressive disturbances in the developing or immature brain, and in which accompanying impairments are becoming increasingly important (Rosenbaum et al., 2007; *Surveillance of Cerebral Palsy in Europe*, 2000). The Surveillance of Cerebral Palsy in Europe (SCPE) collaborative group recommends collecting information on at least four associated impairments, including the intellectual function (Christine et al., 2007). In this direction, the International Classification of Functioning, Disability and Health (ICF) considers the intellectual function as one of the essential ICF Core Sets for children and youth with CP (Schiariti, Selb, Cieza, & O'Donnell, 2015). Moreover, intellectual functioning is taken into account to gain access to different medical, educational and social resources.

It has been reported that between 34% and 64% of people with CP have an intellectual disability (intelligence quotient, $IQ < 70$) (Novak, Hines, Goldsmith, & Barclay, 2012). However, these data were based on different methods such as (1) estimates from clinical observation, from cognitive description provided by parents or from the type of education; (2) application of developmental scales; or (3) through formal IQ assessments based on psychometric tests. The lack of an established objective assessment for people with CP may lead to over- or underestimate their real intellectual ability. Brief and easily applied psychometric tests can provide a solution to this problem, since most intelligence scales usually involve long administration times and both verbal and manipulative responses, which hinders its application in people with CP. The use of inaccurate tools can lead to confuse the inability to respond to a task with a low intellectual performance, with the diagnostic consequences derived therefrom (Braden and Elliott, 2003; Sabbadini, Bonanni, Carlesimo, & Caltagirone, 2001). As some authors highlight, there is a need to identify which psychometric measures are more desirable in order to obtain standardized assessments for this population (Sabbadini et al., 2001; Schiariti et al., 2015; Sherwell et al., 2014). Moreover, it should be noted that most studies focus only on children, being still scarce the attention to intellectual performance in adults with CP. As some authors point, it is important to adopt a lifelong perspective on the disorder (Colver, Fairhurst, & Pharoah, 2014; Haak, Lenski, Hidecker, Li, & Paneth, 2009).

1.1. Intellectual ability assessments used in cerebral palsy

A recent systematic review has examined the most used IQ assessments for children and young adults with CP and concluded that all identified assessments are potentially suitable for cases with minimal motor involvement (GMFCS I–III and MACS I), but not for those cases with greater motor involvement (GMFCS IV–V or MACS II–V) or with communication impairments (Yin Foo, Guppy, & Johnston, 2013). However, some studies have shown that the typical and widely used Wechsler's intelligence scales not only cannot be carried out by severe cases (GMFCS IV–V, MACS IV–V or quadriplegia), but also that milder cases have problems completing them (Sherwell et al., 2014; Sigurdardottir et al., 2008). Specifically, in the study of Sherwell et al. (2014) 25% and 17% of GMFCS and MACS II and 43% and 47% of GMFCS and MACS III failed to complete the test. The use of shorter batteries, such as Stanford-Binet Intelligence Scales or Leiter International Performance Scale, increases the percentage of subjects who complete them, but still remains around a 20% who cannot (El-Tallawy et al., 2014; Majnemer et al., 2013; Majnemer, Shevell, Law, Poulin, & Rosenbaum, 2012). Intelligence assessments composed of one single task, or a smaller number of subtests, using non-verbal assessments with minimal motor requirements suitably accommodate the heterogeneous range of impairments experienced by this population. This could provide a standardized tool that would assess all subjects objectively and equally, minimizing the interference of motor and communicative impairments, which could be used both in clinical practice and in research. The most widely used tests in the field of CP that meet these criteria are the Raven's Coloured Progressive Matrices (RCPM) and the Peabody Picture Vocabulary Test (PPVT).

The RCPM aims to measure the ability to deduct relationships (Raven, Court, & Seisdedos Cubero, 2001) and its use is recommended for people with physical disabilities, aphasia, deafness or CP (Strauss, Spreen, & Sherman, 2006). The PPVT is an old and very commonly used standardized test of receptive vocabulary (Strauss et al., 2006) considered as a screening test of intellectual functioning (Dunn & Dunn, 1997). Because of its non-verbal aspect it is appropriate for those cases with severe expressive language impairment (Strauss et al., 2006) and it has been widely used in CP (Yin Foo et al., 2013). Recently, the Wechsler Nonverbal Scale of Ability (WNV) (Wechsler & Naglieri, 2006) has been created with the aim of measuring general intellectual ability but eliminating or minimizing the verbal content. While WNV has been tested in special groups, such as language disorders, hearing difficulties or intellectual disability, there is still no study that has applied it to people with CP. In addition, to date few studies have compared the RCPM and the PPVT in people with CP and very few indications exist of which one may be more suitable. Only three studies have provided correlations between both tests, with a result of medium ($r = 0.41$) (Nicholson, 1970; Peeters, Verhoeven, van Balkom, & de Moor, 2008) to large effect ($r = 0.734$) (Pueyo, Junqué, Vendrell, Narberhaus, & Segarra, 2008). However, these observed relationships do not automatically imply that there is good concordance between these two methods (Bland & Altman, 1986). Therefore, more studies comparing the IQ scores of these different intelligence tests are needed in an attempt to know how they score, how they classify subjects' cognitive ability and if they could be interchangeable or not.

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