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Research in Developmental Disabilities



Estimating the level of functional ability of children identified as likely to have an intellectual disability

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ARTICLE INFO

Article history:

Received 19 May 2013

Received in revised form 31 July 2013

Accepted 5 August 2013

Available online 11 September 2013

Keywords:

Intellectual disability

Mokken scaling

Severity

Functional ability

Child and Adolescent Intellectual Disability

Screening Questionnaire

ABSTRACT

Screening tools can provide an indication of whether a child may have an intellectual disability (ID). Item response theory (IRT) analyses can be used to assess whether the statistical properties of the tools are such that their utility extends beyond their use as a screen for ID. We used non-parametric IRT scaling analyses to investigate whether the Child and Adolescent Intellectual Disability Screening Questionnaire (CAIDS-Q) possessed the statistical properties that would suggest its use could be extended to estimate levels of functional ability and to estimate which (if any) features associated with intellectual impairment are consistently indicative of lower or higher levels of functional ability. The validity of the two proposed applications was assessed by evaluating whether the CAIDS-Q conformed to the properties of the Monotone Homogeneity Model (MHM), characterised by uni-dimensionality, local independence and latent monotonicity and the Double Monotone Model (DMM), characterised by the assumptions of the MHM and, in addition, of non-intersecting item response functions. We analysed these models using CAIDS-Q data from 319 people referred to child clinical services. Of these, 148 had a diagnosis of ID. The CAIDS-Q was found to conform to the properties of the MHM but not the DMM. In practice, this means that the CAIDS-Q total scores can be used to quickly estimate the level of a person's functional ability. However, items of the CAIDS-Q did not show invariant item ordering, precluding the use of individual items in isolation as accurate indices of a person's level of functional ability.

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1. Introduction

The early recognition of intellectual disability (ID) is important to ensure appropriate support is provided to maximise the child's development (Guralnick, 2005); to facilitate access to resources (Goodman & Linn, 2003); to inform differential diagnosis; and to highlight situations where genetic testing or counselling may be required (American Academy of Pediatrics, Committee on Children with Disabilities, 2001). Many children, however, may not be identified as having ID until they are teenagers (Simonoff et al., 2006) or even young adults (Hamilton, 2006). One potential reason for this is that diagnosing ID can be complex and time consuming (Ryan, Glass, & Brown, 2007). The assessment of intellectual functioning,

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in particular, can cause delays in the diagnostic process because it requires the use of a standardised and validated assessment that is individually administered by an appropriately qualified applied psychologist (British Psychological Society [BPS], 2000).

This has led to the recognition that screening tools may offer a pragmatic solution in circumstances where there is a desire to reduce waiting times and channel referrals appropriately (BPS 2003) by having a quick method of identifying those individuals who should undergo full assessment. Screening tools may also be used by researchers (see Charman et al., 2007) to identify particular populations of interest, where the need to assess a large number of individuals may make the use of full diagnostic assessments unfeasible. Screening tools may also be used where there is the need for an early indicator of the potential support needs of children, for example in educational settings (Sonnander, 2000), while waiting for full diagnostic assessment to take place. Under all of these circumstances, it would be clinically useful if screening tools could provide more information about the potential support needs of the child, to allow service planning to begin at an early stage.

Screening tools, however, tend to use a cut-off score that results in a dichotomous classification of either ID or non-ID, reflecting their aim of identifying individuals who may have ID and who, therefore, should undergo further assessment (McKenzie & Megson, 2012). If, however, a screening tool was able to give an indication of the extent of the functional ability of a child, or be used to indicate what abilities are expected to develop ahead of others, then it may have additional clinical and research benefits.

Item Response Theory (IRT) analysis can be used to evaluate whether a clinical scale possesses the statistical properties such that it can validly be used in more extended ways in clinical settings (Reise & Waller, 2009). For example, while ROC analysis can be used to assess the classification accuracy of a screen for ID (and thus focuses on the range of the trait close to the diagnostic threshold), IRT based techniques focus more explicitly on how the test performs across the full range of the latent trait. Similarly, factor analyses can be useful in assessing the dimensionality of a scale and how well particular items measure identified dimensions, however, there is generally not an explicit focus on how items perform at different locations on these dimensions.

In general, IRT approaches offer many advantages and analysis options that are not readily available in these more traditional approaches to test development (Embretson & Reise, 2000). Meijer and Baneke (2004) have argued for the utility of non-parametric IRT models, in particular for the analysis of psychopathology scales. Unlike parametric IRT models, non-parametric models do not impose a specific structure on the relation between item responses and the underlying latent trait (the 'item response function' or IRF). This is an advantage when assumptions about the form of the IRF, for example the logistic function, are unrealistic for empirical data. Meijer and Baneke (2004) note that non-parametric IRT models can provide useful information about the performance of items and scales without the need to make these assumptions. In addition, samples in clinical studies tend to be of only modest size due to the relative infrequency of clinical disorders in the population and/or recruitment difficulties. Non-parametric IRT models generally have smaller sample size requirements than parametric IRT models.

Mokken scaling is a non-parametric IRT method that can be used to investigate important and clinically useful properties of scales (e.g., see Stochl, Jones, & Croudace, 2012). First, it can be investigated whether a scale conforms to the properties of the monotone homogeneity model (MHM) that is characterised by the assumptions of uni-dimensionality, local independence and latent monotonicity. When the assumptions of MHM hold, it is possible to infer stochastic ordering on the latent trait, that is, that higher test scores are probabilistic indications of a higher level on that trait. Although scale scores are frequently assumed to possess this property, it is important to explicitly test this assumption (Meijer & Baneke, 2004). In practical terms, evidence that MHM holds for a given scale provides some justification for the use of the scale in clinical practice for tasks that require an ordering of individuals based on severity of the trait of interest (e.g., referral for treatment).

It is also possible to investigate whether a scale conforms to the properties of the double monotonicity model (DMM). This is characterised by the assumptions of the MHM, plus the additional assumption of non-intersection of item response functions. When the DMM holds, items form a consistent hierarchy and both items and people can be characterised by their position on a continuum defined by levels or severity of the latent trait (e.g., 'level of functional ability'). That is, items located at higher levels of the latent trait (e.g., those requiring higher levels of functional ability) tend only to be endorsed if items located at lower levels of the latent trait (e.g., those requiring only a moderate level of functional ability) have also been endorsed. This means that items indicative of a more severe impairment will consistently be endorsed ahead of those indicative of a less severe level of impairment. As such, if DMM holds in a given scale, clinicians may be able to gain important information on the symptomology of a given disorder by the location of specific items on the severity continuum. Furthermore, investigating whether the MHM and DMM hold for a particular scale yields important information on item performance within the scale, and thus allows researchers and test developers to improve the utility of clinical scales.

Several authors have recently championed Mokken scaling in clinical measures as a means of enhancing their clinical utility (e.g., Watson et al., 2012). For example, Mokken scaling analysis has proven useful in disability research where estimating the severity or predicting the progression of difficulties is a key consideration in understanding and treating a disorder (Kingston et al., 2012; Watson et al., 2012). Similarly, Murray and McKenzie (2013) applied Mokken scaling analysis to an adult ID screening tool: the Learning Disability Screening Questionnaire (LDSQ; McKenzie & Paxton, 2006) and found that the scale conformed to DMM. Thus, information on responses to single items (not just total scores on the whole scale) are informative about a person's likely functional difficulties. That is, even if total scale scores were not available for an

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