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ARTICLE

Adaptive assessment of young children with visual impairment

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ABSTRACT The aim of this study was to assess the effect of adaptations for children with low vision of the Bayley Scales, a standardized developmental instrument widely used to assess development in young children. Low vision adaptations were made to the procedures, item instructions and play material of the Dutch version of the Bayley Scales of Infant Development – Second Edition (BSID-II), and the Original and Low Vision versions were administered to children with visual impairment over an interval of two weeks. Although quantitative analysis revealed no significant differences between the Original and Low Vision versions of the test in children's scores, feedback from test administrators indicates that the Low Vision materials make the test easier to administer and more engaging for children.

KEY WORDS *adaptive assessment, Bayley Scales, low vision adaptations*

INTRODUCTION

If a child is at risk for developmental delay or disability, early identification and intervention is crucial (American Academy of Pediatrics Committee on Children with Disabilities, 2001; Conlon, 2002; Shonkoff and Phillips, 2000). To facilitate effective intervention it is essential that procedures for appropriate and fair assessment are available. When a child has a specific cognitive and/or functional impairment, such as a vision impairment, it is even more critical for his/her development to be evaluated. Because of a visual impairment, a child may be less able to explore and understand the (visual) world around and therefore be more at risk of delayed development (Best and Corn, 1993; Groenveld, 1990; Warren, 1984). For children with a visual impairment, adaptations to standard procedures, such as changes in material (colour and contrast) and presentation are often necessary in order to properly administer a test. However, if the assessor wishes to obtain test results that are interpretable according to standardized norms, adaptations to the standard procedures prescribed in the manual are generally not permissible (American Educational Research Association, American Psychological Association, and National Council on Measurement in Education, 1999). On the other hand, when measuring cognitive functioning, an inferior performance could be interpreted as reflecting delayed cognitive functioning, when in fact the performance has been biased by the visual impairment of a child and the inflexibility of the test procedure and materials. Studies report visual impairment effects on performance when measuring cognitive functioning in young children (e.g. Bertone, Bettinelli, and Faubert, 2007; Groenveld and Jan, 1992; Looijestijn, 2004). Although the literature mentions the need for diagnostic tools specifically adapted for young children with visual impairment (e.g. Bradley-Johnson, 1994; Miller and Skillman, 2003), there is little empirical research that provides supportive data. Worldwide, only a few diagnostic developmental tests are available that take visual impairment into account. Three of them measure young children's cognitive development: The Reynell-Zinkin Scales (Reynell, 1979; Vervloed, Hamers, Van Mens-Weisz and Timmer-Van de Vosse, 2000), The Callier-Azuza Scale (Stillman, 1978) and The Oregon Project for Visually Impaired and Blind Pre-School Children (Brown, Simmons, Methvin, Anderson, Boigon and Davis, 1991). These scales all cover a large part of the aspects of a child's cognitive development, however, none of them offer the possibility to determine norm scores (although the Reynell-Zinkin Scales do offer age-equivalent scores). The above-mentioned scales are primarily targeted at providing information for assessment and intervention based on a developmental profile (reference scores).

In this article we describe a comparative pilot study on the need for low-vision adaptations when a standardized, norm referenced, instrument is administered to children with visual impairment. Within a period of two weeks an 'Original' and a 'Low Vision' version of a standardized developmental instrument was administered to 17 typically developing participants and 23 participants with visual impairment.

The Bayley Scales of Infant Development Second Edition (BSID-II, Bayley 1993) is a widely used instrument for assessing young children's cognitive and motor development, and is considered to be the 'gold standard' (Aylward, 2002; Gauthier, Bauer, Messinger and Closius, 1999). In the Netherlands the Dutch version of the BSID (BSID-II-NL, Van der Meulen, Ruiter, Lutje Spelberg, and Smrkovsky, 2002) is the only measurement tool for cognitive and motor development in infants and young children from the age of one month. The Dutch version consists of a translation of the BSID-II, a Dutch standardization (n = 1909), as well as separate utility studies.

Researchers of the Department of Special Needs Education in Groningen worked in close cooperation with qualified educational psychologists with extensive experience in working with children with visual impairment practitioners from the Royal Dutch Visio organization (a centre of expertise for blind and partially sighted people) to adapt the BSID-II-NL for use with children who have low vision. The procedures, item instructions and play material were of Dutch standardization.

The Low Vision version of the BSID-II takes into account possible differences in children with visual impairment in relation to eye-hand coordination, spatial orientation, perception of the environment and distinctive visual capacity. The test procedure, item instruction and play material of the Mental and Psychomotor Scale were adapted so as to minimize the impact of the visual impairment on the test results. For example, more colourful and contrasting materials were used to enable the child to better explore and manipulate the material, and to enhance visually impaired children's opportunities to show their skills in a test situation. By leaving the item content and degree of difficulty of the test items essentially unchanged, the original norm tables can apply as before. If there is sufficient evidence to show that the Low Vision adaptations do not significantly alter what the test measures, it will not be necessary to conduct large-scale and time-consuming standardization research for this specific group of children. The use of a standardized BSID-II Low Vision, combined with the Original norm tables, will then

permit a comparison of the cognitive development of children with visual impairment with that of their typically developing peers.

As a first step in determining the validity of the BSID-II Low Vision, we give an account of the construction of the instrument and the applicability of the adapted materials. A comparative pilot study provides us with an indicative answer to the research question of whether test results for the Low Vision version of the Bayley test better reflect a child's true score than the Original version does. We hypothesized that the test results for typically developing children on both versions will not significantly differ (Hypothesis 1). We also hypothesized that test results on the Low Vision version of the Bayley test will be significantly higher than test results for the Original version for children with visual impairment (Hypothesis 2).

Within a period of two weeks, both typically developing children and children with visual impairment were tested twice, once with the Original version and once with the Low Vision version in counterbalanced order and under the same conditions.

METHOD

Subjects

Forty children participated in this study. Seventeen children represented the standard population. These children experienced typical development, without any specific physical or cognitive impairment (the 'Standard Group'). The Standard Group included ten girls and seven boys with a mean age of 25 months (range 5–42 months). All come from the city of Groningen. This group had already participated in the Dutch standardization study for the BSID-II. Their parents agreed to their participation in this additional study.

The 'Clinical Group' comprised 23 participants with visual impairment. The participants were all known to one of the centres for assessment and intervention for persons with visual impairment in the Netherlands (five centres) and in Belgium (one centre). We approached these centres via their educational psychologists with the request that they participate in this research. Since the Bayley test is a commonly used instrument in diagnosis and intervention planning in these centres, the test results were not for research purposes alone and could be integrated into the regular treatment structures of the centres. This was an important advantage for centres to take part in the study. The educational psychologists working at the centres recruited the participants on

the basis of formulated criteria that describe the minimum abilities required of a child to perform the test items. The participant was diagnosed with visual impairment (not blind)[1] and (a) developmental age ranged between 1 and 42 months, (b) sufficient auditory abilities and (c) could use at least one hand.

The Clinical Group was divided into two sub-groups, children with visual impairment experiencing typical development (n = 12) and children with visual impairment, but also diagnosed with developmental delay, which in some cases was severe (n = 11). The cause of their visual impairment varies, see Table 1.

The first sub-group numbered six male and six female with a mean age of 27.5 months (range 10–42 months). Their visual acuity was measured by determining the best-corrected visual acuity (Teller Acuity Cards and the Cardiff Test). In terms of the WHO classification (2001), the children had profound to moderate visual impairment (Snellen: 20/600 – 20/60)

The other sub-group comprised eleven children with visual impairment who had been diagnosed with developmental delay. They formed a heterogeneous group due to their differing levels of low vision, cognitive functioning and additional impairments such as motor impairment and hearing impairment. The majority of the children had been diagnosed with Cerebral Visual Impairment (CVI, n = 7), the other four children were diagnosed with Ocular Visual Impairment (cataract/amblyopia and coloboma n = 1; optic nerve atrophy n = 1; astigmatism n = 1; and hypermetropia n = 1). In terms of the WHO classification, the children ranged from profound visual impairment to near normal vision (Snellen: 20/1200 – 20/40 or 1/60 – 3/6). All children had an estimated developmental age of between one and 42 months.

Instruments

The original version of the BSID-II (Bayley, 1993) is a well developed, standardized and norm-referenced instrument for evaluating the general development of infants aged one to 42 months. The instrument consists of three scales: the Mental, Motor, and Behaviour Rating Scales. The Mental Scale consists of 178 items that measure the child's cognitive skills. The Mental Scale items relate to the processing of visual and auditory information, hand-eye coordination, imitation, language development, memory and problem solving. The Motor Scale consists of 111 items that measure skills related to gross and fine motor control, including movements such as rolling, crawling, standing, walking,

Table 1. Medical diagnosis of the clinical group (n = 23)

Medical diagnosis	N
CVI	7
Astigmatism	1
Hypermetropia	1
Optic nerve atrophy	1
Cataract, micropthalmus	1
Cataract, nystagmus	1
Cataract	1
Cataract/amblyopy and colobome	1
Albinism	1
Achromatopsy	2
Blue cone monochromacy	1
Nystagmus	1
Nystagmus, micropthalmus	1
Nystagmus, albinism	1
Eccentric fixation	1
Diagnosis unknown	1

running, and jumping. This scale also tests fine motor skills, such as hand-eye coordination, the use of writing materials and imitation of hand gestures. Most of the items in the Mental and Motor Scale are task items, dichotomously scored. Depending on the age and developmental level of the child, an age-appropriate item set with a specific start and stop item is administered for both the Mental and Motor scales. Raw scores are converted into a Mental Development Index (MDI) score and a Psychomotor Development index score (PDI), with a mean of 100 (*SD* 15).

The Behaviour Rating Scale contains questions for consideration by the administrator after the test. These questions are designed to allow the administrator to assess the behaviour of the child during the test.

The BSID-II Low Vision. The Low Vision version of the BSID-II (The Low Vision version) adapts the test procedures, item instructions and play materials for administration to children with visual impairment. The low-vision adaptations have been designed for the Mental and Motor scale for the total age range of one to 42 months. The low-vision adaptations were developed in close cooperation with practitioner experts – qualified educational psychologists with extensive experience in working with children with visual impairment and after a review of relevant literature.

The most important conclusions were that, first, due to the visual impairment, time limits needed to be extended so that children could

be given sufficient time to visually and tactually explore the relevant materials and task environment before receiving the item instructions (especially when the child is asked to point to or name objects). Second, that the play materials and task environment needed enhancement in colour and contrast e.g. bright colours against dark backgrounds, contrasting colours for the play material, darker lines to accentuate the contours of the pictures and enlarged materials (e.g. doll). Third, that with regard to the general test procedures, directions should be given for positioning the child (e.g. with back to the window) and consideration should be given to the direction and intensity of artificial light (e.g. perpendicular, intensity between 500 and 2000 Lux). Finally, especially when testing the Motor scale, additional verbal prompting from the test administrator and/or the parent was required. On the basis of the above mentioned recommendations, an experimental version of the BSID-II Low Vision was designed. In reviewing each item, not only the content of the item was addressed, but also the instruction procedures for the administrator and range of acceptable responses possible from each item. The goal was always to preserve the original intent of the item. The changes for an item should not provide the children with an advantage, and should maintain its original content and difficulty. Several pilot studies (Duursma and Hamadani, 2006; Pepping, 2004; Qualm, 2003) provided us with practitioner expert answers to the question of whether the changes in testing procedures, item instructions and play material satisfied the conditions for providing an applicable, unbiased instrument suited to young children with visual impairment. The experimental Low Vision version of the Bayley was administered by trained and experienced practitioners to 13 children with visual impairment. The practitioners were asked to administer the Low Vision version of the BSID-II and to evaluate, using standardized forms, its applicability and usability for children with visual impairment. Suggested improvements and changes were evaluated and when they were judged to be clear and usable improvements, they were assimilated into the final version of the BSID-II Low Vision.

A major standardizing factor was that, following the example of the Original version, the detailed test procedures and item instructions for the Low Vision version were given in the manual as well (Tiben, 2008). The Low Vision version is not a separate instrument; it can only be administered in combination with the original material of the BSID-II.

Table 2 presents an overview of the number of adapted items and the scales to which they belong. Items with extended time-limits are included in the category 'Item requires instruction adaptation'. In the puzzle and pegboard items of the Mental Scale, time limits were

Table 2. Overview of the number of adapted items per category in the mental and motor scale between 1 months and 42 months

Category	Adaptation	Mental Scale (1–178) Number of items	Motor Scale (1–111) Number of items
1	Item is acceptable as it is, no adaptation	57	61
2	Item requires material adaptation	84	40
3	Item requires item instruction adaptation	10	3
4	Item requires item instruction and play material adaptation	27	7

extended by one-third. The manual also suggests letting the child finish the item beyond the time limit, and although in these cases the administrator cannot score the item, a note of the time the child needed to perform the item can be recorded.

Table 3 presents examples of adapted items in the Mental and Motor scale. The original procedures and material are described in the middle column; in the right-hand column are the adaptations to item instructions, scoring procedures and test materials.

Procedures

The group of sighted participants was examined by three Masters students in the playroom of the Department of Special Needs, Education and Child Care in Groningen. The students were all experienced BSID-II administrators and they had received intensive training in administering the Low Vision version. All participants were examined within a period of two weeks in counterbalanced order, once with the Original BSID-II and once with the Low Vision version. The participants with visual impairment were examined by one Master's student who was a very experienced BSID-II and BSID-II Low Vision administrator. When administering the test to participants with visual impairment, the test administrator was supervised by an expert practitioner who was familiar with the participants and the BSID-II. All tests with the participants from the low-vision group were carried out by two persons, one of whom

Table 3. Examples of adaptations of items that require instruction and material adaptation

	BSID-II	BSID-II Low Vision (adaptation)
Mental scale Item 165 *Complete blue board in 30 seconds*	*Administration:* Place the pieces on the table in front of you. Place the board on the table in front of the child. Hand the child a round piece. Motioning toward the holes, say: *Put the block in its hole. Put it where it belongs*. Start timing as soon as the child grasps the piece. Proceed by alternately handing the child a square and a round piece, one at a time, until the child has placed each to his/her satisfaction, regardless of whether the pieces are correctly placed. Stop timing when the child places all of the pieces correctly or when 150 seconds have elapsed.	*Administration:* Place the pieces on the blue placemat on the table in front of you. Subsequent idem Original.
	Scoring: Give credit if the child correctly places all the pieces in 30 seconds or less. To be correctly placed, a piece must fit completely in the hole.	*Scoring:* Time limit given to complete the item can be extended by half.
	Material: Puzzle board (blue side), four round pieces, five square pieces from the blue-block set and stopwatch.	*Material*: Pieces from the adapted yellow-block set.

(Continued)

Table 3. (Continued)

	BSID-II	BSID-II Low Vision (adaptation)
Motor scale Item 88 *Laces three beads*	*Administration:* Knot one end of each shoe string and place the beads on the table. Lace two beads on your string. Then give the child the other shoe string and three of the beads. If the child places all three beads on the string, push the remaining three beads to the child and say: *Put these on. Put them all on.*	*Administration*: Show the child slowly how to perform on this item. Lace a yellow bead followed by a green bead and then another yellow bead on a string. Give the child a red string and three of the beads. Say to the child: *Here is a string for you. Put the beads on the string. Put them all on.* If the child looks for the beads, help the child by placing them nearby or by ticking them on the table. If the child places all three beads on the string, push the remaining three beads to the child and say: *Put these on. Put them all on.* Give the child enough time to complete the item.
	Scoring: Give credit if the child puts at least three beads on the string at one time.	*Scoring:* Idem Original
	Material: Two shoe strings and eight square beads.	*Material:* Red string and three yellow and three green beads.

administered the test items while the other assisted the test administrator with practical aspects of the test (e.g. handling materials) or providing reassurance or motivation to the participant where necessary. All participants were examined at the centres.

To test the two hypotheses, content validity was examined in two ways. First, performance on the Original version and the Low Vision version were compared. Within a period of two weeks, participants from the Standard Group and the Clinical Group were tested twice, once with the Original version and once with the Low Vision version in counterbalanced order and under the same conditions. We expected that the Standard Group's test results for the Original and Low Vision versions would not differ significantly (Hypothesis 1). For the participants with visual impairment, we expected that the Low Vision version would maximize their test results, and the test results for the Low Vision version were expected to surpass those for the Original version. As a result of the adaptation, the validity of the test for the group of participants with visual impairment was expected to increase (Hypothesis 2). Test results for the Low Vision and Original versions of the BSID-II for both groups of participants were compared at the item-category level. Items were assigned to four categories. The categories (1–4) were based on the type of adaptation: no adaptation (Category 1), play material adaptation (Category 2), item instruction adaptation (Category 3) and play material and instruction adaptation (Category 4). Test results for typically developing children were not expected to vary significantly between the Low Vision and Original versions (Hypothesis 1). We expected that participants with visual impairment would obtain significantly higher test scores for the items in category 2, 3 and 4 (Hypothesis 2). After applying the Low Vision version of the BSID-II to a participant with visual impairment, expert practitioners were invited to evaluate the adequacy of the low vision adaptation in test procedure, item instruction and play material of each item on an evaluation form. They were presented with open questions. The administrator was thus able to comment on the adapted test procedures, item instructions and play materials generally and on their appropriateness for each child specifically.

RESULTS

Test performances at the scale-category and item-category levels were compared. Results were based on raw scores. Developmental Indices could not be obtained for most of the participants in the Clinical Group; either they were chronologically older than 42 months or their raw score points were too low to convert to a developmental index.

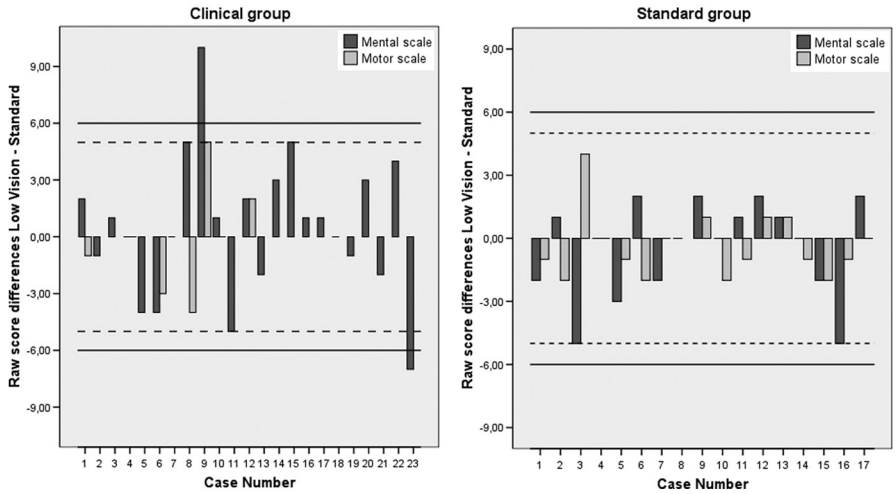

Figure 1. Raw Score Differences on the Mental and Motor Scale between the Low Vision and Standard versions of the BSID-II for the Clinical group and the Standard group

Note: 1, The continuous line refers to Mental scale significance and the discontinuous line refers to Motor scale significance. 2, In the clinical group, case 1–11 refer to children with low vision and developmental delay; case 12–23 refer to children with low vision

Descriptive statistics of the individual test results suggest little difference between test performances on the Original BSID-II and the BSID-II Low Vision, even for the Clinical Group. The concrete difference in raw-score points is presented in Figure 1. In both sets of plots, a positive score (> 0.00) indicates that the raw score for the Low Vision version was higher than the raw score for the Original version.

As can be concluded from Figure 1, there is no clear advantages for using the Low Vision version of the BSID-II. This was confirmed by an analysis at group level using the Wilcoxon signed-ranks test (Siegel, 1996). There were no significant differences for the Standard Group on the Mental scale ($z = -.82$, $p = 0.41$) and Motor scale ($z = -.1.37$, $p = 0.17$), nor for the Clinical Group on the Mental scale ($z = -.64$, $p = 0.52$) and Motor scale ($z = -.14$, $p = 0.89$).

On the group level no significant differences were found, although on the individual level there were some differences in scores between the Original and Low Vision versions of the BSID-II. To analyse difference at the individual level, a minimally significant difference was calculated

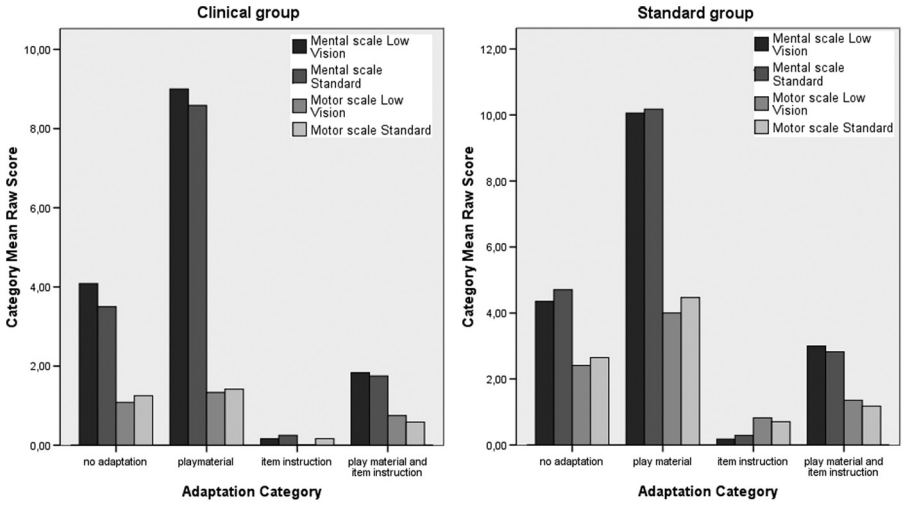

Figure 2. Mean Raw Scores of Items belonging to the different Item Categories for the Standard and Clinical Groups on the Mental and Motor Scale per Item Category

Note: The raw score was based on the number of positive items within the administered item set

between the individual scores for the Original and Low Vision versions, using $d_{\alpha} = z_{\alpha}.s.\sqrt{(2-r_{xx}-r_{yy})}$ (based on reliability and standard deviations of the standardization sample (see Ruiter et al., 2005: 12, 18). In terms of the Mental scale, one can speak of a significant difference when the difference in test scores ranges over a minimum of 6 raw points. For the Motor scale this is 5 points. From the analysis it would appear that only two participants from the clinical trial had deviant scores, one in favour of the score from the Low Vision version and one in favour of the Original version.

To determine whether performance on the Mental scale of both groups was significantly different when the items were assigned to categories, the mean raw scores were compared on a category level. The categories were based on the type of adaptation (see Table 2). Figure 2 shows the individual differences between the raw scores for the Low Vision and Original versions within item categories.

The Wilcoxon signed-ranks test demonstrated that in none of the item categories did the participants benefit significantly from the Low Vision version of the BSID-II. This held true for the Clinical Group as well as

the Standard Group. For the Clinical Group, the results were calculated for the non-verbal items of the Mental scale (103 items of the total of 178) as well. It is notable that, although 75 percent of the participants performed better on the Low Vision version of the BSID-II than on the Original version, no significant differences were found ($z = –1.29$, $p = .197$).

Although the empirical data did not confirm our hypotheses, the evaluation from expert practitioners identified a number of favourable effects for the low vision adaptation in relation to the administration of the BSID-II. The expert's responses can be summarized as follows. In general the adaptations proposed were found to be both adequate and appropriate. In particular, the extension of the time limits and the additional auditory stimuli and the increased visual stimuli were considered very appropriate. Some specific adaptations were seen to be desirable but difficult to achieve in every test situation, e.g. 'a room without interfering sunlight, with light coloured walls, no visually disturbing stimuli such as wall paper, posters and no disturbing auditory stimuli such as buzzing lamps'. The experts mentioned favourably the possibility of deciding on the item level and the choice of following the original procedures and materials or using the adapted procedures and materials. The interchangeability of the material allows for the creation of an optimal test situation for the child. The Low Vision adaptations were felt to increase the response possibilities of a participant with visual impairment, the test material is more appealing and therefore the children's motivation to show their abilities increases. Several experts felt that a publication of a Low Vision version of the BSID-II finally enables them to administer the test in a standardized way, without the need for 'home-made' adaptations.

DISCUSSION

Assessing the developmental status of young children is an important, yet difficult task. It is striking that existing instruments seem to be unsuitable for children with visual impairment, especially when this group of children is in particular need of developmental assessment. Most assessment instruments are designed for, and developed with, typically developing children. As a consequence, the procedures, instructions, and materials described in the manual do not generally take special needs into account. Because the person administering the instrument has to comply with that manual for standardization purposes, a child with special needs might be unable to show his or her true abilities.

In this study we examined whether there was a need for an adapted diagnostic tool to compensate for visual impairment bias when a standardized instrument was administered to children with visual impairment. The BSID-II provides such standardized findings. The test material appeals highly to the visual and motor skills of a child. It was expected that using the Original BSID-II with children with visual impairment would affect individual performance and, in general, the efficacy and validity of the instrument. In close cooperation with practitioners, a BSID-II Low Vision version was designed to minimize the impact of visual impairment on a child's Mental and Motor performance.

The results indicate that performance on the BSID-II was not affected by using adapted low-vision material. Using the low-vision materials instead of the original material did not significantly influence test results for either of the two scales. The performance of children experiencing typical development on the Original and Low Vision versions of the BSID-II did not differ significantly. This result is in line with our first hypothesis. Item content and difficulty remain essentially unchanged. The supposition is supported that the administrator is free to present the child with the low vision material when needed without threatening the validity of the test and the applicability of the Original norm tables. Our second hypothesis could not be confirmed. In the Clinical Group, visual impairment did not significantly impair performance on the BSID-II. As with the Standard Group, the test performance of the Clinical Group did not significantly differ between the Original and Low Vision versions of the test. Participants with visual impairment did not prove to have benefited from the Low Vision adaptation of the BSID-II. Even when items were grouped together based on the way in which they were adapted, no difference was found between the results for either of the two versions. There was no significant difference found on the group level, and likewise when the scores per participant were analysed. Only two participants showed a significant difference in scores between the two versions, and only one that went in favour of the Low Vision version. These findings support the idea that children with visual impairment 'have adapted their behaviour' in order to make their sight more functional (Gunaratne, 2002). The possibilities for compensation, for example, by allowing a bit more time for the material to be examined, by putting the material closer so that it can be seen better, apparently allow the children to be fully able to understand the test items and accomplish the tasks.

Although the results of the statistical analyses did not confirm our assumption that validity should increase when the Low Vision version was administered to participants with visual impairment, the expert practitioners, without exception, stated that administering the test with low-vision material went more smoothly and that the Low Vision material was more appealing to the child than the Original material. These evaluation outcomes indicate that children with visual impairment profit from the use of the adapted test materials. This expert opinion was not systematically researched in this study when using the Low Vision material. In order to be sure that the assessment situation is optimal for the child with visual impairment (in such a way that visual impairment does not interfere with the test results), it is important that assessments of cognitive and motor development are made by clinicians who are familiar with children with visual impairment in general and preferably with the child itself.

LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

First, in this study our sampling procedure was limited. This was true for both samples, but especially for the Clinical Group. The Standard Group was not large, but consisted of children who formed a representative sample. However, to demonstrate conclusively that the original norm tables still apply when the BSID-II test is presented with Low Vision adaptations, a study on a larger scale should be conducted. This would enable us to analyse the item-difficulty ratings not only on the scale level, but also on the item level. The Clinical Group sample was small and diverse. Since the target group of children with visual impairment is small and heterogeneous, obtaining a large homogeneous sample would be highly ambitious, but to answer the research questions conclusively, follow-up studies should include a larger and more homogeneous sample of children with visual impairment. This pilot study was limited to the Netherlands and Belgium, a more extensive, preferably international, replication is recommended.

The second limitation lies in the fact that, although the Bayley Scales are known as the 'gold standard' in assessing cognitive and motor development in young children, it is only one instrument out of a wide variety of tests one might choose from. To be able to generalize our findings, extended research is needed that would include similar instruments, perhaps the third revision of the Bayley Scales, the

Bayley III (Bayley, 2005) initially, but also the Wechsler scales for young children (WPPSI-III, Wechsler, 2002) or the Mullen Scales of Early Learning (Mullen, 1995).

Finally, it should be noted that the Low Vision adaptations were designed in such a way as to compensate for low vision bias, while at the same time staying as close to the Original version as possible so that the scoring reflects the Original norm tables. Therefore, it is possible that complying with these conditions yields adaptations that are not radical enough to reveal any provable difference for young children with visual impairment. An extended study can address the following questions: Do Low Vision adaptations need be more rigorous to make a difference? The possibility exists that, for children with even poorer vision than those in the Clinical Group, some advantage might arise if more radical changes were to be made to the Original version of the Bayley test, for example the use of additional tactile stimuli, a shortened version with only verbal and tactile items, and the use of Low Vision adaptations in combination with low motor and non-verbal adaptations (Ruiter, 2007). Extended research could also address the question whether an observation instrument identifying the degree of limitation to an individual's visual abilities (the Visual Profile, Looijestijn, 1995), would enable us to administer a test optimally adjusted to the child's needs and to put the test results in perspective, by taking the observed visual limitations into account.

The outcome of this study suggests that the Bayley Scales can be administered to children with visual impairment as in the Original version and subsequently adapted materials can be applied to determine whether Low Vision adaptations maximize the test results (test the limits). With regard to the child's motivation to perform in test situations, the adapted play materials increase the child's intrinsic motivation to collaborate and show the child's skills in a test situation. A remark often made by expert practitioners concerned the favourable effect of being able to decide at the item level whether an item should be presented according to the Original or Low Vision version of the BSID-II. Due to the interchangeability of the items (instruction and material) an optimal test situation can be created for a child. Finally, the adapted test situation can provide information about the extent to which a child can profit from adapted materials, instruction and environment. The assessment not only provides information on the current developmental state of a child, but also on the ideal learning conditions for that child.

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Note

1 The WHO has made a classification of severity of visual impairment based on acuity and field loss. The term low vision is for the categories with an acuity with the best correction less than 6/18 until equal to 3/60 and with a visual field greater than 10 degrees. In rehabilitation it is common to take other visual function into account and visual impairment can be very serious even with normal acuity, for instance by impairment in other visual sensory functions like contrast sensitivity, or oculomotor, visual perceptual-cognitive of visuomotor functions (Looijestijn, 1994).

References

AYLWARD, G. P. (2002) 'Cognitive and Neurological Outcomes: More Than IQ Scores', *Mental Retardation and Developmental Disabilities Research Reviews* 8: 234–40.

AMERICAN ACADEMY OF PEDIATRICS COMMITTEE ON CHILDREN WITH DISABILITIES (2001) 'Developmental Surveillance and Screening in Infants and Young Children', *Pediatrics* 108: 192–6.

AMERICAN EDUCATIONAL RESEARCH ASSOCIATION, AMERICAN PSYCHOLOGICAL ASSOCIATION, AND NATIONAL COUNCIL ON MEASUREMENT IN EDUCATION (1999) *Standard for Educational and Psychological Testing*. Washington, DC: Author.

BAYLEY, N. (1993) *Bayley Scales of Infant Development, Second Edition: Manual*. San Antonio, TX: The Psychological Corporation.

BAYLEY, N. (2005) *Bayley Scales of Infant and Toddler Development, Third Edition*. San Antonio, TX, Psychological Corporation.

BERTONE, A., BETTINELLI, L. & FAUBERT, J. (2007). 'The Impact of Blurred Vision on Cognitive Assessment', *Journal of Clinical and Experimental Neuropsychology* 29(5): 467–76.

BEST, A. B. & CORN, A. L. (1993) 'The Management of Low Vision in Children: Report of the 1992 World Health Organization Consultation', *Journal of Visual Impairment and Blindness* 87: 307–9.

BRADLEY-JOHNSON, S. (1994) *Psychoeducational Assessment of Children*, 2nd edn. Austin, TX: Pro-Ed.

BROWN, D., SIMMONS, V., METHVIN, J., ANDERSON, S., BOIGON, S. & DAVIS, K. (1991) *The Oregon Project for Visually Impaired and Blind Preschool Children*, 5th edn. Medford, OR: Jackson Education Service District.

CONLON, C. J. (2002) 'Early intervention', in M. L. Batshaw (ed.) *Children with Disabilities*. Baltimore: Paul H. Brookes Publishing Co.

DUURSMA, M. & HAMADANI, I. M. (2006) *BSID-II-NL Low Vision 1–42, Experimental Version*. Groningen: University of Groningen, (unpublished master thesis).

GAUTHIER, S. M., BAUER, C. R., MESSINGER, D. S. & CLOSIUS, J. M. (1999) 'The Bayley Scales of Infant Development II: Where to Start?', *Developmental and Behavioral Pediatrics* 20: 75–9.

GROENVELD, M. (1990) 'The Dilemma of Assessing the Visually Impaired Child', *Developmental Medicine and Child Neurology* 32: 1105–13.

GROENVELD, M. & JAN, J. (1992) 'Intelligence Profiles of Low Vision and Blind Children', *Journal of Visual Impairment and Blindness* 86: 68–71.

GUNARATNE, L. A. (2002). *Visual Impairment: Its Effect on Cognitive Development and Behaviour.* Available at: www.intellectualdisability.info

LOOIJESTIJN, P. L., & Smrkovský, M. (1995). *Visual Profile BOS 2-30 (BSID, Dutch Version) Adapted for Use with Children with Low Vision.* Huizen, Nederland: Visio.

LOOIJESTIJN, P. L. (2004) *The Visual Profile*. Groningen: Stichting Kinderstudies.

LOOIJESTIJN, P.L. (1994). Suggestions for the Classification of Impairments and Disabilities of Low Vision, in A.C. Kooijman, P.L. Looijestijn, J.A. Welling, & G.J. van der Wildt (Eds.). *Low Vision: Research and New Developments in Rehabilitation*. Amsterdam: IOS Press.

MEULEN, B. F. VAN DER, RUITER, S. A. J., LUTJE SPELBERG, H. C. & SMRKOVSKY, M. (2002) *Bayley Scales of Infant Development, Second Edition: Dutch version*. Amsterdam: Harcourt.

MILLER, J. C. & SKILLMAN, G. (2003) 'Assessors' Satisfaction with Measures of Cognitive Ability Applied to Persons with Visual Impairments', *Journal of Visual Impairment and Blindness* 97(12): 769–74.

MULLEN, E. M. (1995) *Mullen Scales of Early Learning: AGS Edition*. Circle Pines: American Guidance Service.

PEPPING, M. (2004) *Applicability of the BSID Low Vision (30–42 months of age)*. Groningen: University of Groningen (unpublished master thesis).

QUALM, A. (2003) *Adaptation of the BSID-II-NL for use with very Young Children with Low Vision (30–42 months of age); Pre-Pilot Study.* Groningen: University of Groningen (unpublished master thesis).

REYNELL, J. (1979) *Manual for the Reynell-Zinkin Developmental Scales for Young Visually Handicapped Children, Part 1. Mental Development.* Windsor, England: NFER-Nelson.

RUITER, S. A. J., SPELBERG H. C., LUTJE & MEULEN, B. F. VAN DER (2005) *BSID-II-NL, Part II: Standardization and Psychometric Qualities.* Amsterdam: Harcourt Test Publishers.

RUITER, S. A. J. (2007) *The BSID-II-NL for Assessing Children with Specific Impairments*. Groningen: Stichting Kinderstudies.

SHONKOFF, J. P. & PHILLIPS, D. A. (Eds.) (2000) *From Neurons to Neighborhoods: The Science of Early Childhood Development*. Washington, DC: National Academy Press.

STILLMAN, R. D. (1978) *The Callier Azuza Scale*. Dallas, TX: South central regional center for services to deaf-blind children.

SIEGEL, S. (1996) *Non-parametric Statistics for the Behavioral Sciences,* 75–83. New York: McGraw-Hill.

TIBEN, H. J. H. (2008) *The BSID-II-NL Low Vision 1–42 Maanden*. Groningen: University of Groningen (unpublished master thesis).

VERVLOED, M. P. J., HAMERS, J. H. M., VAN MENS-WEISZ, M. M. & TIMMER-VAN DE VOSSE, H. (2000) 'New Age Levels for the Reynell-Zinkin Developmental Scales for Young Visually Handicapped Children', *Journal of Visual Impairment and Blindness* 94(10): 613–24.

WARREN, D. H. (1984) *Blindness and Early Childhood Development*, 2nd edn. New York: American Foundation for the Blind.

WECHSLER, D. (2002) *Wechsler Preschool and Primary Scales of Intelligence*, 3rd edn. San Antonio, TX: Psychological Corporation.

WORLD HEALTH ORGANIZATION (2001) *International Classification of Functioning, Disability and Health: ICF*. Geneva: WHO.

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