REVISION OF THE REYNELL-ZINKIN DEVELOPMENTAL SCALES FOR YOUNG VISUALLY HANDICAPPED CHILDREN

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Abstract

The Reynell-Zinkin Scales were intended as assessment scales for intervention planning. Sometimes the scales are also used as developmental tests and as a means to measure treatment effects. Based on the clinical impression that the old norms overestimate visually impaired children the need was felt for new norms. To construct new norms based on chronological ages instead of social maturity ages 82 visually impaired children were studied between 0 and 48 months of age without additional impairments. A psychometric study was also performed, because no data are available on the reliability and validity of the scales. The results show that for the same raw score the social maturity ages of the original Reynell-Zinkin scales were in 87,5% of the cases higher than the new developmental norms. In 38% of the cases, this difference was greater than the standard error of measurement of the new norms. However, the differences were small, probably because only visually impaired children without additional impairments were studied, while Reynell and Zinkin had some multiple handicapped children in their study. The study on the reliability and validity of the scales with 145 visually impaired children showed that groups of multiple handicapped children can be distinguished from visually impaired children without additional impairments. It was also found that, given the internal consistency, the item variation, stability, and test-retest scores, the best time to administer the Reynell-Zinkin scales is between 1 and 3,5 years of age.

Introduction

According to Reynell (1979) the aim of the Reynell-Zinkin scales is, ".... to enable professional people, concerned with young visually handicapped children, to have some guidelines for assessment and developmental advice" (p. 11). Furthermore, as the strength of the scales she noticed, ".... they give a guide to the developmental stages the child has reached, and the progression of subsequent stages, so that appropriate early teaching may be given" (p. 11). Because of this functional relationship between assessment and intervention the scales are a useful tool in early intervention activities with visually impaired children (see, for instance, Tobin, 1994). Reynell (1979) states that the age scores

derived from the scales may be useful as: an indication of individual rates of progress; an indication of specific areas of difficulty at any stage; and to compare the rate of development of a particular child with that of others in a comparable visual category. In order to be able to use the Reynell-Zinkin scales as intended by Reynell (1979) the scales have to be validated, which has never been done. However, we felt that before a psychometric study could be performed new developmental age norms should be constructed for three reasons. First, we wanted to use a methodologically better design for the construction of the age norms than Reynell (1978), who used a combination of a cross-sectional and longitudinal design in the construction of the developmental patterns. Second, we wanted to have an assessment instrument that could give an indication of the developmental level of an individual child without having to administer a social maturity scale. In this respect the manual of the original scales is misleading, because under the graphics is wrongly written chronological age instead of social age (see page 22 and following in Reynell, 1979). Third, there was the clinical impression that the age norms of the Reynell-Zinkin scales overestimated the developmental rate of visually impaired children, especially in the cognitive domain. Thus, the children seemed to perform less well in daily living situations than could be expected based on the Reynell-Zinkin age norms.
In this article both the research on the new developmental norms as well as the psychometric study are reported (see also Vervloed, Timmer-van de Vosse, van Mens-Weisz, & Hamers, 1999).

Method

Subjects

The total database consisted of 279 recordings of 145 partially sighted children aged 4 to 51 months. There were 58 children with multiple handicaps, five children were suspected of having multiple impairments, and 82 children were only visually impaired. The 145 children were used in the analyses of the observer effects, external validity, stability, and test-retest effects. All other analyses, including the construction of the developmental norms, have been done with the 82 partially sighted children without additional impairments aged between 5 and 48 months.
Visual impairment was defined as the absence of visually directed reaching (see also the original manual for the scales by Reynell, 1979). Visual acuity of all the subjects was below 20/60, because this is the criterion for enrolment in the early intervention program of the Bartiméus foundation.

Procedure and design

The new developmental age scores for the Reynell-Zinkin scales were based upon existing cross sectional data. No scales were administered for research purposes only. Eight professionals tested the children in their homes as part of the early intervention services of the Bartiméus foundation. Not all children were tested with all the items in a scale. Based on clinical experience the person administering the scales decided where to start assessing the child. In case the first item was passed, all earlier items were scored positive too. The subjects have been assessed just once.

The results were analyzed per age group. The means, standard deviations, and percentile ranks were calculated. Two subjects with extreme scores were excluded from the analyses. In order to have smoother curves three months interval groups were formed by means of linear interpolation. For the calculation of the age scores we used smoothed means and standard deviations. The smoothing procedure was adopted from the Reynell Developmental Language Scales (Reynell, 1969; Reynell, & Huntley, 1987).

Results

Developmental norms

In figure 1 an example is shown of the smoothed means and standard deviations for the scale Social Adaptation. For use in clinical practice we constructed graphs based on percentile ranks. Exact means and standard deviations per scale, exact percentile scores per age group, and the graphs based on the percentile ranks are given in the revised manual (Vervloed et al., 1999).

Insert figure 1 about here

No means and standard deviations are known for the original age scores published by Reynell (1978). Reynell gives only the range of age scores belonging to a certain raw score. Therefore, it is impossible to analyze statistically the age scores in the current study with the age scores in the original Reynell-Zinkin scales. Consequently, we had to analyze the old and new scores by face value. We compared for both scores the means belonging to a chronological or social maturity age of 6, 12, 18, 24, 30, 36, 42, and 45 months. The smoothed means were used for the new developmental norms. Social maturity ages were in 42 (87.5%) of the 48 comparisons lower than the chronological ages for the same smoothed mean. This means that for the same raw score the social maturity age will be higher than new developmental norm. In case of lower social maturity ages than the new developmental norms, the differences exceeded the standard error of measurement of the new norms in 16 (38%) of the 42 cases. Most differences did not exceed the standard error of measurement for the developmental ages found in the current study. Overestimation by the old norms is particularly found in the subscales social adaptation (3 times), sensorimotor understanding (5 times), exploration of the environment (4 times), expressive language structure (2 times), and expressive language content (2 times).

Item analysis

Whenever items are ordered hierarchically then passing a difficult item will always mean that all earlier items are passed too (cf. Guttman, 1944, 1950). Moreover, if the Reynell-Zinkin scales are perfect scales, the mean chronological age belonging to a total raw score is also the mean age at which the last item is mastered. In subsequent scalogram analyses the coefficients of reproducibility were calculated as a measure of the amount by which the scales deviate from the ideal pattern of a perfect scale. Perfect scales are not to be expected, therefore an acceptable approximation to a perfect scale has been set at .90 reproducibility (cf. Guttman, 1950). The sensorimotor understanding scale consists of two

parts: twenty hierarchically ordered items and three items concerning the meaningful use of objects. Two scalogram analyses were performed for this scale, one for 20 and one for 23 items. The coefficients of reproducibility ranged from .96 to .99 for the hierarchical scales. Reordering the items did not result in higher coefficients of reproducibility. The coefficient of reproducibility was .88 for the sensorimotor understanding scale when the last three items were included. Placing the items 21 and 22 before item 18 resulted in a coefficient of .91.

Reliability

Observer effects.

The recordings of two observers were used in this analysis. They assessed, respectively, 16 and 26 of the 82 partially sighted children without additional impairments. Hierarchical multivariate analyses were performed which assessed the effect of the factor observer after the effect of the factor age. For one scale, sensorimotor understanding, there was a main effect of observer, $F(1,25) = 7.96$, $p < .01$. There were no significant main observer effects for the other scales.

Internal consistency.

Internal consistency was determined by calculating Cronbach's alpha per scale for each age group. Only subjects without additional impairments were used in this analysis (N=82), in order to have a homogeneous study sample. If a reasonable reliability level of .60 for Cronbach's alpha is adopted, then only the sensorimotor understanding scale has reasonable internal consistency in the first 6 months, and the social adaptation and verbal comprehension scale in the second half of the first year. The expressive language scales are reliable from 19 months onwards. The social adaptation scale has sufficient internal consistency between 6 months and 3,5 year. Exploration of the environment shows sufficient internal consistency between 1,5 and 2,5 years. Sensorimotor understanding showed the most internal consistency, from 0 to 6 months and from 13 to 48 months of age.

Stability.

Stability coefficients could be calculated for scale scores of two consecutive recordings (interval 6-12 months) and for the first and third recording (interval of 12-18 months). The children differed in age at the first testing. Multiple handicapped children were also included in this analysis. Reasonable stability coefficients were found over periods of at least 6 and at the most 18 months. Only the scale expressive language, vocabulary and content, showed moderate stability ($r = .69$), the other coefficients ranged from .76 to .92. The overall mean stability coefficient was .85.

Test-retest.

The Reynell-Zinkin scales are supposed to be developmental assessment scales. Consequently, it should be possible to measure development by advanced responding at later ages. Test-retest data were analyzed for those children who were assessed twice with an interval of 6-12 months. All children performed significantly better on the second than on the first assessment, all the one-tailed probabilities were less than 5%.

Validity

The internal validity of the Reynell-Zinkin scales has been studied by looking at the factor structure and at the associations with personal and environmental factors. With regard to the external validity, the ability of the scales to discriminate multiple handicapped children from visually handicapped children without additional impairments has been studied.

Factor structure.

Three principal component analyses with varimax rotation have been performed on the raw scale scores. The first analysis was done for the total group of 82 subjects. Two additional analyses were performed to check the factor solutions of this first analysis. One analysis was done on the youngest children (0-24 months) and one on the oldest children (25-48 months). Given the fact that the Reynell-Zinkin scales consist of three language scales, we expected to find at least a verbal and a non-verbal factor solution. However, all the three analyses resulted in one factor with an eigenvalue > 1. This factor explained 88% of the variance for the total sample. All scales had factor loadings > .77 for this factor.

Associations with personal and environmental factors.

Other variables than age could also be valid factors in assessments with the Reynell-Zinkin scales. In several multivariate analyses of variance the main effect of the following variables has been studied: sex, parity, family size, genetic versus nongenetic cause of visual impairment, and ophthalmologic diagnose. The ophthalmologic diagnoses were clustered in four groups: cerebral and nervus opticus disorders, retina disorders, malformations of the eye, and albinism. The main effects were studied in separate hierarchical multivariate analyses of variance with age as the first factor. No significant main effects were found for the aforementioned variables.

External validity.

The external validity has been studied by looking at the significance of the factor multiple handicaps in an analysis of variance of the scale scores. We expected that multiple handicapped children would perform less well on the scales than the children with only visual impairments. We studied 67 visually impaired children without additional impairments and 53 multiple handicapped children less than 48 months of age. In a multivariate analysis with age as the covariate and multiple handicap (yes or no) as the independent factor, both factors were significant, $F(6,112) = 117.0$, $p < .001$, and $F(6,112) = 6.92$, $p < .001$, respectively. Only three multiple handicapped children were studied after the age of 30 months, and no children were tested at the age of 36 months. Because of this small number of children, the factor multiple handicaps was not significant after 30 months for all the scales, except the scale Verbal Comprehension.

Discussion

By studying assessment records of 82 visually impaired children without additional impairments between 0 and 48 months of age we were able to construct new

developmental age scores for the Reynell-Zinkin developmental scales. Means, standard deviations and percentile ranks are now known (Vervloed et al., 1999). The standard deviations vary considerably with age. This variation can be explained partly by ceiling and floor effects. There are just a few items suited for the youngest children. The possible range of performance is, therefore, also limited. With the exception of the verbal comprehension scale, the scales lack more advanced items for the older children. As a result, variation in results diminishes with age. Normalization of the scores was not attempted, because of the small sample size, and because it would give the false impression that the assessment with the Reynell-Zinkin scales is very much in detail. The developmental age scores should be used with caution. Only total raw scores can be converted to developmental ages, there are no norms for discrete items. The social developmental ages found with the original Reynell-Zinkin scales were in 87.5% of the cases higher than the chronological ages for the same smoothed mean, but the differences were also small. In 38% of the cases where the social maturity age was lower than the new developmental norm, the difference was greater than one standard error of measurement of the new norm. The clinical impression that the Reynell-Zinkin scales overestimate the development of visually impaired children has, therefore, been confirmed, and the need for new developmental norms has been justified.

The clinical impression of overestimation by the Reynell-Zinkin scales was probably also due to the fact that the test results of visually impaired children of the Bartiméus foundation were compared with their chronological age instead of their social maturity age. The difference between these two ages can be very large, especially for multiple handicapped children.

In order to be able to apply the scales in the manner Reynell (1979) thought useful, and to be able to use the scales as formal tests, it is necessary to have data on reliability and validity. Although the Reynell-Zinkin scales show good stability, and it is possible to measure developmental progression with them, not all the scales can be used at all the eight intervals between 0 and 48 months of age. Apparently, Reynell and Zinkin did not succeed in constructing scales with items that are suited for the whole age range for which the Reynell-Zinkin scales were intended. Concluding, given the internal consistency and the item variation, the best time to administer the Reynell-Zinkin scales is between 1 and 3,5 years of age.

The comparison of the single and multiple handicapped children showed that, except for two cases in the first six months, the multiple handicapped children had lower scores than the single handicapped children. Note, however, that these differences are group differences, and rather small. Statements about developmental delay should not by made up till 12 months of age, not even after repeated assessments, because the differences between single and multiple handicapped children is too small to be clinically relevant. We do not recommend to classify individual children as developmentally delayed based on a single assessment with the Reynell-Scales that is lower than the mean for the norm group. Only repeated measurement with the scales can give an indication of a, more or less, permanent developmental delay. Whether the Reynell-Zinkin scales are useful in predicting later developmental outcomes has to be studied in future research. It would be interesting to study the relationships between the language scales and later tests

for language development, and the association between the sensorimotor understanding scale and later performal intelligence.

In the introduction we stated that for the age scores belonging to the original Reynell-Zinkin scales to be valid, some psychometric properties of the scales should be known. Now that these properties are known and new age norms are available, it is possible to reconsider the usefulness of the age norms for the Reynell-Zinkin scales. Firstly, Reynell (1979) thought the age norms were useful as an indication of the rate of progress of an individual child. The results from the analysis of item variation, stability, internal consistency, and test-retest scores show that the scales can be administered between 1 and 3,5 years of age for this purpose. Secondly, the age scores were thought to give an indication of specific areas of difficulty at any stage. Although there are new age norms available, we do not recommend using the scales for this purpose, because the factor analysis could not delineate the six a priori scales. Moreover, for a valid comparison of the separate scales it is also necessary to have standardized scores, which are not available. Last, the age scores were also given to compare the rate of development of a particular child with that of others in a comparable visual category. The new norms and the availability of the standard error of measurement make it possible to make this comparison by calculating the 95% reliability intervals. If used in the ways described above, we believe the Reynell-Zinkin scales can be valuable assessment scales, and as such, they are a useful part of any early intervention program for children with visual impairments.

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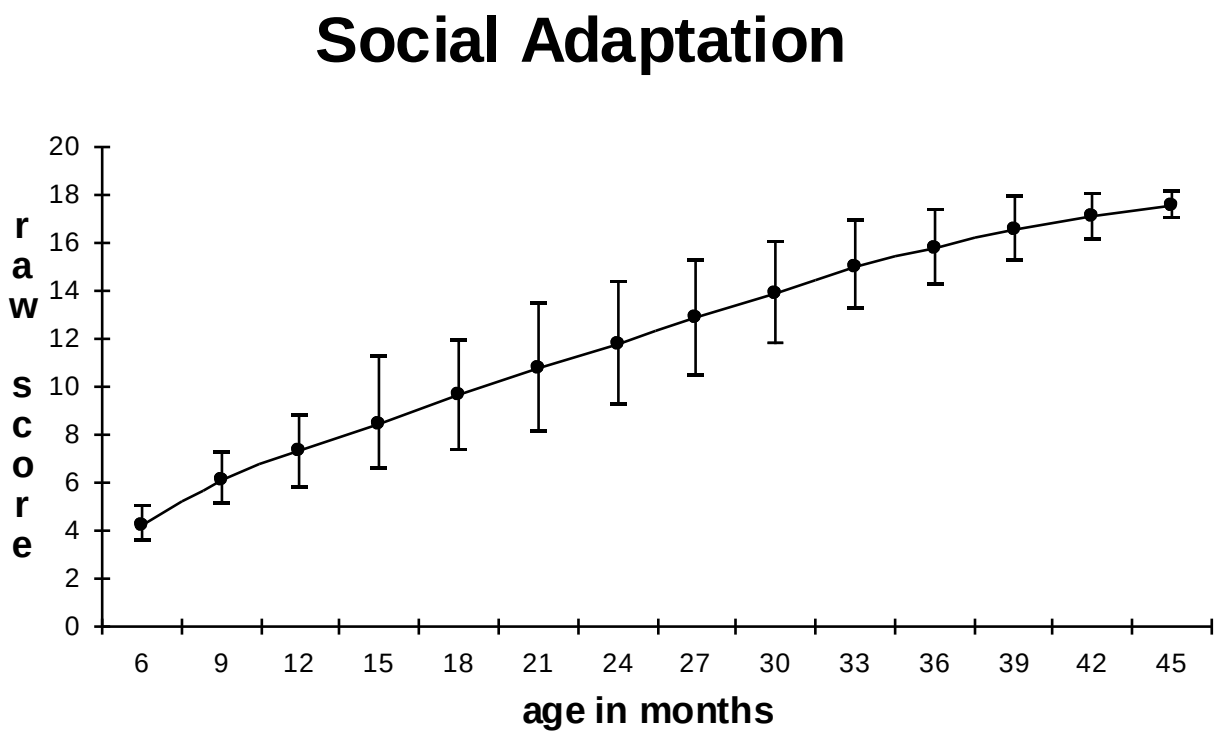
visually impaired children with reference norms for Dutch visually impaired children 0-48 months]. Zeist, The Netherlands: Bartiméus Foundation.

Figure 1


Social Adaptation
raw score
0
2
4
6
8
10
12
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16
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21
24
27
30
33
36
39
42
45
age in months