Normative data for the redesigned Kay Pictures Visual Acuity test

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The Kay Picture Test of visual acuity (VA) is used extensively in the diagnosis and management of children within the ophthalmic clinic. The test has been redesigned and validated to meet the international visual acuity chart guidelines, necessitating the collection of new normative data. The data presented here demonstrates that the VA's of children under 60 months of age with no visual deficiency improve with age and show no significant intraocular difference. This is the first report of normative data in young children for the redesigned Kay pictures visual acuity test, singles format. The data presented here will aid interpretation of the VA results of children to determine whether there is a deficit of VA.

The Kay Picture Test of visual acuity (VA) was introduced in the 1980s[1, 2] and since its creation the design of VA tests have changed significantly, with current recommendations being that the optimum design requires to be a logMAR format, crowded and with five optoptyes per line.[3,4] Therefore a new version of the Kay picture test was created to encompass the requirements, available in single and linear formats, both presented within crowding boxes. The selection of pictures for the new test was based on data relating to their recognition within a crowding box and equal legibility, and were also evaluated for their comparability with the gold standard ETDRS chart.[4]

Aims

It is known that non-letter based tests (pictures and symbols) give a numerically lower VA score than letter-based tests in adults,[5,6~~4, 5~~] making it essential to know what is normal for the test and age group being tested to allow accurate interpretation of the results. Therefore, the aim of this study was to test young children without visual problems to determine what a normal level of VA is for the redesigned Kay pictures VA test, using the single optotype presentation (see efigure1).

Materials and Methods

This research protocol observed the tenets of the Declaration of Helsinki and was approved by the University of Liverpool~~XXXXXXX~~ ethics committee and the NHS MREC. Orthoptists who use the Kay Picture test were invited to participate and data were collected from 13 sites.

Inclusion criteria

Children under 60 months of age who could identify (by naming, matching or signing) all six pictures prior to testing, ~~and without refractive error~~following refraction/auto-refraction were not prescribed glasses or considered at risk for needing glasses in the future ~~(identified by refraction or auto-refraction)~~, and without ~~or~~ manifest strabismus (determined by cover test at near and distance fixation). Any child with a known or suspected visual impairment or developmental delay was excluded.

Testing procedure

The test was performed uniocularly (method of occlusion chosen by clinician) at three metres starting at 0.6logMAR with one optotype chosen. If the picture was correctly identified, a 0.4 optotype was shown. Following the correct identification, one optotype at each level was shown until an incorrect answer was given, then the optotype was increased in size by 0.1 and the complete line shown (five single optotypes). If correct, the size was again reduced by 0.1 and repeated. Testing continued until three pictures or fewer were identified at that level. VA was scored per optotype (0.02logMAR). Clinicians recorded any concerns regarding the child's concentration or other factors that may have impacted on the reliability of their responses.

Statistical analysis

Comparison between age groups was performed using an ANOVA test, with LSD post-hoc analysis, and ~~correlation~~ relationship between~~of~~ VA ~~with~~ and age was assessed with a ~~Pearson's test~~linear regression analysis.

Results

A total of 283 children were tested, age range 20 to 57 months, including six who were under the age of two years but only one was able to provide reliable monocular results. Table 1 shows the VA results for monocular VA and interocular acuity differences by age and testability rates (providing reliable data following the rigid testing protocol). ANOVA testing showed that the monocular VA's showed a statistically significant ~~change over time~~difference with age at testing (RE $p<0.001$, LE $p<0.001$) but the interocular acuity differences remained the same ($p=0.13$). Data from the oldest age group were not included in the ANOVA due to the small numbers.

A comparison of the right and left eye data demonstrated no significant difference (Paired t-test, $p=0.7$). Therefore, the lower limit considered "normal" is defined as two standard deviations below the mean for the right eye. This figure is similar across all ages groups (see table 1) but improving slightly to 0.17 in the oldest age group.

As shown in figure one, the majority of responses were above the x axis (0.0 logMAR). ~~Correlation~~ Linear regression analysis ~~(Pearson's)~~ of VA with age shows a statistically significant ~~but weak~~ relationship, right eye $p<0.001$ beta coefficient~~r~~=-0.037~~277~~, left eye $p<0.001$ ~~r~~beta coefficient=-0.035~~-0.283~~.

Discussion

This is the first report of normative data for the redesigned Kay Picture Test of VA which are important for the clinical interpretation of VA results. The data demonstrate that children with no

visual abnormality show an improved ability to resolve optotypes with increasing age of almost one logMAR line (0.1) over two years. This is similar to other paediatric tests (as shown in etable 1), and, as expected, the mean VA levels using the Kay Picture Test are numerically lower than HOTV (the difference varying between 0.03 and 0.11 depending on the study compared against), emphasising the need to ~~make appropriate comparisons when interpreting VA responses~~reference the appropriate normative values when interpreting VA measures. Of the two VA tests stated by Anstice and Thompson[3] to meet all seven international VA test guidelines, no published normative data were found for Patti pics, and while there are published data on Lea symbols (see etable 1) the sample size is considerably smaller, with a wider variability within the sample. In addition, a key advantage of the Kay Picture Test is the high testability rates of over 74% from the age of two years, increasing to 95% by the age of three years.

One limitation of this study is the smaller numbers in the older age group, especially given the statistically significant improvement in VA in the older children. Further testing is required to determine at what point VA reaches a plateau and for determining normal values for older children.

The optotypes in both the singles and linear versions of the test are presented in an equally crowded format, the linear presentation is simply designed for ease of delivery, with fewer pages to hold and turn. ~~Therefore, it is not anticipated that the VA would be different using the linear format, but~~ While the presentation is similar, further testing will be undertaken to evaluate ~~this assumption~~if the presentation of the optotypes impacts on the normative values.

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Figure 1 Scatter plot of the right eye VA across ages

eFigure1 Kay picture test single crowded book and matching card