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- 1) Mahon, K., Preferential Looking and Acuity Card Testing in the Private Practitioner's Office *American Orthoptic Journal*, Vol. 37, 1987, 86-94.

Abstract:

Clinical experience with the use of a forced-choice preferential-looking device and with an acuity card testing procedure in a private pediatric ophthalmology practice is described. An attempt was made to see if the use of either of these two methods was practical in the non-academic private practitioner's office. It was concluded that forced-choice preferential-looking was not practical, and that this variant of an acuity card testing procedure is practical for use now. The Teller Acuity Cards continue to be improved, so acuity card testing an evolving procedure. The entire pursuit of infant vision testing is constantly being modified.

- 2) McDonald, M., Dobson, V., Sebris, S.L., Baitch, L., Varner, D., and Teller, D.Y., The Acuity Card Procedure: A Rapid Test of Infant Acuity, *Invest. Ophthalmol. Vis. Sci.*, Vol. 26, 1985, 1158-1162.

Abstract:

Forced-choice preferential looking (FPL) and operant preferential looking (OPL) procedures for testing infant acuity typically require 15-45 minutes to derive an acuity estimate. This article presents a new acuity assessment technique ("acuity cards") that combines FPL/OPL stimuli with an observer's subjective assessment of an infant's looking behavior. The infant is shown a series of gray cards that contain grating targets of various spatial frequencies. An observer watches the eye movement patterns and behavior of the infant and judges whether the infant can or cannot see the grating on each card in the series. Acuity is estimated as the highest spatial frequency that the observer judges the infant to be able to see. With this technique, the binocular acuity of normal infants can be estimated with reasonable accuracy in the laboratory setting in 3-5 minutes.

- 3) McDonald, M., Sebris, S.L., Mohn, G., Teller, D.Y., and Dobson, V., Monocular Acuity in Normal Infants: The Acuity Card Procedure, *Amer. Jo. Opt/Physiol Optics* Vol. 63(2) 1986, 127-134.

Abstract:

An "acuity card" technique has been developed for rapid assessment of visual acuity in infants. In this procedure, an adult observer shows the infant a series of cards that contain gratings of various spatial frequencies and estimates acuity as the highest spatial frequency that the infant is judged to see. The present paper shows that the acuity card procedure can be used in a laboratory setting to estimate both monocular and binocular acuity in infants 1 to 12 months of age. Four monocular and two binocular acuity estimates were obtained on 36 normal infants, six each at ages 4, 8, and 16 weeks and 6, 9, and 12 months. Acuity estimate means and SDs agreed well with previously established preferential-looking (PL) norms for each of the test ages. Time required for a monocular or binocular test averaged 3 to 6 minutes.

- 4) Teller, D.Y., McDonald, M., Preston, K., Sebris, S., Dobson, V., Assessment of Visual Acuity in Infants and Children: The Acuity Card Procedure, *Devlpmntl Med/Child Nrlgy* 1986, 28, 779-789.

Abstract:

The "acuity Card" procedure described here is a simplified method of testing visual acuity of infants and young children, and has been developed to allow preferential looking to be assessed in a laboratory or clinic. A higher proportion of children can be tested successfully than has been reported for more traditional procedures. Initial studies indicate that the acuity card procedure is a fast, accurate method for assessing the acuity of normal infants and children, and those with visual or neurological impairments, across a wide age-range and in both clinical and laboratory settings.

- 5) Preston, K.L. and Freedman, H.L., The Teller Acuity Card Procedure: An Acuity Screening Technique for Pre-verbal Children, *American Orthoptic Journal*, Vol. 38, 1988, 24-32.

Abstract:

The acuity card procedure has been proposed as an acuity screening technique for pre-verbal children because of its ease and speed of use and the availability of age norms. In the present study, the visual acuity of 43 infants and toddlers between the ages of 1-44 months was assessed with the Teller Acuity Card Procedure during two, two-hour vision screenings in hospital settings. Each screening consisted of standard ophthalmological tests in addition to the acuity assessments. Ninety-one percent (39/43) of the children completed both monocular-right and monocular-left tests of acuity. All children who did not complete both monocular tests did cooperate for a binocular test. Acuity testing averaged 10 minutes per child. Nine children (21%) were referred for follow-up care. The acuity screening identified five of the nine children as having an interocular acuity difference of one octave or more and three were identified as needing follow-up care by acuity screening alone. Follow-up cycloplegic refraction of these three children revealed refractive errors and anisometropia was present in two of the children. Results indicate that the acuity cards provide useful screening information, but that if test time is a consideration, the procedure may be used as an adjunct to standard ophthalmological tests for those children identified as being at risk for ophthalmic disorders.

- 6) Marx, M.S., Werner, P., Fridman, P., and Cohen-Mansfield, J., Visual Acuity Estimates in the Aged, *Clinical Vision Sciences*

Abstract:

Visual acuity was estimated in each eye and measured binocularly for 16 communicative nursing home residents using the Teller Acuity Cards (TAC). Teller Acuity Card acuities were compared to Snellen visual acuities. The Pearson correlations between visual acuity and Teller Acuity Card acuities were: 0.72 for the right eye, 0.84 for the left eye, and 0.72 for the binocular viewing condition ($p < .01$). Test-retest reliabilities of Teller Acuity Card acuity estimates and inter-observer reliability of binocular Teller Acuity Card acuity were high. These data are encouraging and suggest that the Teller Acuity Card procedure, previously employed only in pediatric ophthalmology, provides a reasonable estimate of visual acuity in the aged. The authors suggest that this assessment be incorporated into the health care delivery system of nursing home residents.

- 7) Adams, R.J., Courage, M.L., Assessment of Visual Acuity in Children With Severe Neurological Impairments, *Jo. Ped. Ophthalmology/Strabismus*, July/August 1990, Volume 27, Number 4.

Abstract:

We used the Teller Acuity Cards to assess visual acuity in children with severe neurological handicaps (N=12), all of whom had been previously untestable. With every child we were able to obtain at least an estimate of visual acuity, even with those described as likely having little or no visual function. However, in all cases, performance was poorer than that of unimpaired children of the same age. Our results confirm that the test is useful for assessing visual acuity in populations who, because of significant cognitive, linguistic, and motor deficits, cannot be assessed by more traditional techniques.

- 8) Hartmann, E.E., Ellis Jr., G.S., Morgan K.S., Love, A., May, J.G., The Acuity Card Procedure: Longitudinal Assessments, *Jo. Ped. Ophthalmology/Strabismus*, July/August 1990, Volume 27, Number 4.

Abstract:

Traditional methods of visual assessment in pre-verbal pediatric patients rely on refined but subjective measurement techniques. A standard ophthalmologic examination includes evaluation of a child's fixation patterns, with performance ranked on the basis of ability to fix and follow an objective (F & F) or maintain central, steady fixation (CSM). In the hands of a skilled clinician, these evaluations are important for diagnosis and treatment. Documentation of quantitative changes in visual abilities of pre-verbal patients, however, has only recently become feasible.

We began using the acuity card procedure in our pediatric clinical practice more than 3 years ago. This assessment, a modified version of the standard Forced-Choice Preferential Looking paradigm (FPL), provides quantitative evaluation of visual functioning in pre-verbal patients. The total number of patients assessed on one or more occasions exceeds 900. Of this group, we followed 83 patients with at least four acuity card evaluations on separate visits. Thirty of these patients, all with different diseases, have been evaluated with acuity cards on six or more visits.

We found the information provided by the acuity card assessments extremely helpful in quantifying the developmental and therapeutic changes in vision, previously monitored only qualitatively.

9) Romano, P.E., Advances in Vision and Eye Screening: Screening at Six Months of Age, *Pediatrician* 990;17:134-141

Abstract:

Eye and vision screening is a prototype preventative health measure. Increased knowledge of eye diseases in children and their treatment mandates much earlier screening than was recommended in the past. Advances in testing permit both the adoption of simpler and faster routine techniques and the application of more sophisticated and accurate screening methods. A thorough vision/eye screening at 6 months of age has been added to the previous examination schedule which only required screening at birth and again at 3.5-4 years of age. The simple scrutiny of the red fundus reflexes in the pupil with a direct ophthalmoscope (Bruckner test) provides superior screening for vision, binocular alignment and pathology in infants. The difficult-to-master cover test and its variants can be abandoned for screening purposes. In screening pre-verbal children, simple optotype charts (HOTV) are proving more efficient than the traditional "tumbling E" game. Color vision testing should be added to the preschool examination. Vision screening in infants can be enhanced where resources permit by using new preferential looking tests and by employing sophisticated electrophysiological testing. Photographic screening methods based on the red reflex hold considerable promise for more efficient screening of children.

10) Quinn, G.E., Dobson, V., Barr C.C., Davis, B.R. Flynn, J.T., Palmer, E.A, Robertson, J., Trese, M.T., Visual Acuity in Infants after Vitrectomy for Severe Retinopathy of Prematurity, *Ophthalmology*, January 1991, Vol 98, Number 1.

Abstract:

During the course of the Multicenter Trial of Cryotherapy for Retinopathy of Prematurity (CRYO-ROP), 98 infants (129 eyes) from the randomized segment of the trial developed total retinal detachment from retinopathy of prematurity (ROP) before the 1-year examination. The authors report as a case series the results of acuity card assessment of monocular grating acuity at 1 retinal detachments but who did not undergo retinal reattachment surgery. The decision to undertake and the surgical technique used for a retinal reattachment procedure was not part of the randomized CRYO-ROP trial. Two eyes of one infant had pattern vision at the lowest measurable threshold after vitrectomy. None of the remaining eyes that had undergone vitrectomy and none of the eyes that did not undergo vitrectomy showed evidence of pattern vision. Their relatively poor visual outcomes in this case series suggest that efforts are well-spent in attempting to prevent retinal detachment in ROP.

11) Meeker, R., Simple Test Helps Prevent Vision Problems, *Foundation Health Plan Examiner*, Spring 1989

Abstract:

Ronald Meeker, O.D. describes his experiences using the Teller Acuity Cards in his clinical practice. Dr. Meeker describes some of the vision problems he discovered while using Teller Acuity Cards on patients ranging from 3 to 43 months; of these patients 18% were found to have vision problems.

12) Fielder, A.R., Frcs, Fulton, A.B., Mayer, L. Visual Development of Infants with Severe Ocular Disorders, *Ophthalmology*, August 1991 1Volume 98, Number 8, Pages 1306-1309

Abstract:

Among 11 patients who presented as blind in early infancy, with Leber's congenital amaurosis (5 patients), optic nerve hypoplasia (4 patients), or macular colobomata (2 patients), 8 developed visually guided behavior and measurable grating acuity by age 5 to 46 months. All children with measurable grating acuity demonstrated visually guided mobility. Grating acuity was predictive of later visual performance in 10 of 11 patients by age 12 to 16 months. The best grating acuity attained by 7 months was 1.3 to 3.0 cycles/degree (20/460 to 20/200) and 0.13 cycles/degree (20/4700) by month 8. Two patients with Leber's congenital amaurosis and one with optic nerve hypoplasia remained blind. No clinical features existed to differentiate these three patients from the eight whose visual status improved. Posterior visual pathway maturation may underlie the improvement.

13) Getz, L.M., Dobson, V., Luna, B. and Mash, C., Interobserver Reliability of the Teller Acuity Card Procedure in Pediatric Patients, *Invest. Ophthalmol/Visual Sci.* January 1996, Vol 37, Number 1, Pages 180-187

Abstract:

Purpose. To compare interobserver agreement for Teller Acuity Card estimates of grating acuity between children with ocular or neurologic abnormalities, or both, and age-matched health preterm children.

Conclusions. Teller Acuity Card testing conducted by experienced testers is a reliable in children with mild to severe ocular or neurologic abnormalities as it is in health children, even though children with abnormalities may be more difficult to test.

14) Trueb, L. Evans, J., Hammel, A., Bartholomew, P., and Dobson, V., Assessing Visual Acuity of Visually Impaired Children Using the Teller Acuity Card Procedure, *Amer. Orthoptic Jo.*, Vol. 42, 1992, 149-154

Abstract:

The Teller Acuity Card Procedure is a simple, subjective method of assessing visual acuity in pre-verbal children. Its usefulness has been demonstrated in populations where other available techniques would be difficult or impossible. However, its use in assessing children who are visually impaired may require special procedures.

It is important to use appropriate techniques to enhance each child's optimal visual functioning and encourage cooperation.

This paper presents specific methods and techniques that are effective in testing children whose diagnoses include: strabismus, extremely low vision, nystagmus, and neurological impairment.

15) Wells, W.A., and Helveston, E.M., Comparison of Fixation Preference and Forced Preferential Looking in Preverbal Children, *Amer. Orthoptic Jo.*, Vol. 42, 1992, 142-148

Abstract:

Clinical fixation preference was compared to forced preferential looking (FPL) acuity using the acuity card procedure (ACP) in 52 subjects between one and 34 months of age. Four of 6 subjects with more than 2 octaves inter acuity difference (IAD) were diagnosed as preferring the eye with better FPL acuity. If a one octave difference is considered

significant for IAD < 87% (20/23) subjects were correctly identified by noting fixation preference clinically. Disparity between IAD with FPL and fixation preference was more likely to occur with minimal IAD with FPL and in younger patients. This study assumed that FPL was the more precise measure of true IAD.

16) Olsen, T.W., Summers, C.G., and Knoblock, W.H., Predicting Visual Acuity in Children With Colobomas Involving The Optic Nerve *Jo. Ped. Ophthalmgy/Strabismus*, 1996;33:47-51

Abstract:

Background: This study evaluates the relationship to visual acuity of four ophthalmoscopic features of colobomas involving the optic nerve. The goal was to identify those features that could predict potential visual acuity of children with these colobomas.

Methods: Fundus photographs of 23 eyes with colobomas involving the optic nerve met the entry criteria and were evaluated by two masked observers. The following features were evaluated: coloboma size, optic nerve color, foveal development, and subfoveal retinal pigment epithelial changes. Simple linear regression was used to identify the feature that most closely correlated with visual acuity. Refractive status was assessed by cycloplegic refraction.

Results: The only component that correlated with the development of good visual acuity was the degree of foveal involvement by the optic nerve coloboma ($P=.002, R=0.8$). Significant refractive error and anisometropia were common in patients with colobomas involving the optic nerve.

Conclusion: Central visual acuity in children born with colobomas involving the optic nerve correlates with the development of normal foveal anatomy, regardless of the size of the coloboma, the color of the optic nerve, or the presence of error is common, these children should receive an accurate refraction and amblyopia treatment.

17) Teller, D.Y., First Glances: The Vision of Infants. The Friedenwald Lecture *Invest. Ophthalmgy/Visual Sci*. October 1997, Vol 38, Number 11, Pages 2183-2203 Abstract: This article is an overview of infant testing.

18) Connolly, B.P., MD, McNamara, J.A. MD, Regillo, C.D. MD, Tasman, W. MD, Sharma, S. MD Visual Outcomes after Laser Photocoagulation for Threshold Retinopathy of Prematurity, *Ophthalmology*, Vol 106, #9 September 1999

Abstract:

Objective: To determine the long-term visual acuity after diode laser photocoagulation for threshold retinopathy of prematurity.

Design: Retrospective, noncomparative case series.

Intervention: Photocoagulation of the peripheral avascular retina with a diode laser indirect ophthalmoscope.

Main Outcome Measures: The principal outcome evaluated was best-corrected visual acuity (BCVA). The most recent refractions for these eyes were also collected for analysis.

Participants: Thirty-five infants with threshold retinopathy of prematurity treated with laser photocoagulation from 1991 to 1996.

Results: After bilateral laser treatment, 14(56%) of 25 patients who were capable of accurate visual acuity testing has 20/50 or better BCVA in at least 1 eye with 11(44%) of 25 patients having at least 20/50 BCVA in both eyes. After unilateral treatment, four (40%) of ten had 20/50 or better BCVA in the treated eye while five (50%) of ten laser-treated eyes had a BCVA at least equal to the untreated fellow eye. Compared to eyes with 4 or more diopters (D) of myopia, those with less than 4D of myopia were 6.4 times more likely to achieve 20/50 or better BCVA (95% confidence interval, 1.7-22.7). The average age at follow-up 3.7 years.

Conclusion: After laser photocoagulation for threshold retinopathy of prematurity, 29 (48%) of 60 eyes had 20/50 or better visual acuity. Eyes with 4 or more D of myopia were significantly less likely to achieve 20/50 or better visual acuity than eyes with less than 4 D of myopia.

19) Solange Rios Salomao and Dora Fix Ventura, Large Sample Population Age Norms for Visual Acuities Obtained With Vistech - Teller Acuity Cards. *Investigative Ophthalmology & Visual Science*, March 1995, Vol. 36, No. 3

Abstract:

Purpose: To determine population age norms in the first three years of life for binocular and monocular grating visual acuity (VA) obtained with Vistech-Teller Acuity Cards (TAC).

Methods: TAC was used to estimate grating acuity in 646 health infants and children born at due date + 2 weeks, all of whom underwent ophthalmologic and orthoptic evaluation. The sample consisted of 20 age groups from 0 to 36 months. Sixty-nine percent of the children attended day care centers in the city of Sao Paulo. The sample was composed of White (63.0%), Mulatto (25.2%), African-Brazilian (11.0%), and Asian (0.8%) infants and children, most of whom (97%) were from low-income families. Tests were conducted by eight highly trained testers, six of whom were orthoptists.

Results: Binocular and monocular norms for grating VA are presented in terms of tolerance limits for 90% of the population with 95% probability. The range of tolerance limits is approximately 2.5 octaves at most ages. There were no statistical differences among scores obtained by the different testers. There were no differences in VA due to race, sex, and first or second eye tested. The results on binocular (99.3%) and monocular (96.2%) testability and on mean test duration (13 minutes for one binocular and two monocular measurements) confirm the clinical applicability of TAC.

Conclusions: The binocular and monocular grating VA norms obtained in this large-sample study are different from the preliminary norms published with the TAC. Results from this and other studies (see Mayer et al, page 671, this issue) strongly point to a need for redefinition of the preliminary VA norms.

20) Mayer, D.L., Beiser, A.S., Warner, A.F., Pratt, E.M., Raye, K.N., and Lang, J.M., Monocular Acuity Norms for the Teller Acuity Cards Between Ages One Month and Four Years. *Investigative Ophthalmology & Visual Science*, March 1995, Vol. 36, No. 3, 671-691

Abstract:

Purpose: To derive norms for monocular grating acuity and interocular acuity differences that are appropriate for clinical applications using the acuity card procedure (ACP) and Teller Acuity Cards (TAC).

Methods: Monocular acuities were measured in 460 children in 12 age groups between 1 month and 4 years. Inclusion criteria were term birth, good general health and normal development, normal eyes, and cycloplegic refraction within specific limits. Each child was tested by two ACP testers who were aware of TAC spatial frequency but not grating location during testing.

Results: Three monocular tests were completed in the first session in 99% of children. Median time to complete the tests of both eyes ranged from 3.2 to 8.4 minutes. Monocular acuity norms were calculated using 95% and 99% prediction limits. The new norms spanned higher spatial frequencies than the preliminary ACP norms between ages 1 month and 18 months but were similar between 24 and 36 months. The lower normal 2.5% limits were similar to lower limits of other normative studies. The interocular acuity difference was zero or 0.5 octave in 99% of subjects of all ages. Acuities obtained by the same tester on different days and by different testers on the same day were within 0.5 octave in at least 90% of subjects, comparable to previous studies.

Conclusions: This study provides monocular acuity norms that are appropriate for clinical settings in which the ACP and TAC are used and should replace the preliminary ACP norms.

21) Dobson, V., Quinn, G.E., Tung, B., Palmer, E.A., and Reynolds, J.D. for the Cryotherapy for Retinopathy of Prematurity Cooperative Group. Comparison of Recognition and Grating Acuties in Very-Low-Birth-Weight Children With and Without Retinal Residua of Retinopathy of Prematurity. Investigative Ophthalmology & Visual Science, March 1995, Vol. 36, No. 3, Pg. 692

Abstract:

Purpose: To compare recognition (letter) and resolution (grating) acuity in eyes with and without retinopathy of prematurity (ROP) residua.

Methods: Letter acuity measured with the crowded HOTV chart or pocket cards (Good-Lite), and grating acuity measured with the Teller Acuity Card (TAC) procedure, were compared at the 3-1/2 and 4-1/2 year follow-up exams in the CRYO-ROP study. Testers were unaware of the retinal status of individual eyes.

Results: Measureable scores for both letter and grating acuity were obtained from 1694 eyes at 3-1/2 years and 2101 eyes at 4-1/2 years. Correlation analysis showed that the relation between crowded HOTV and grating acuity scores was best described by a quadratic function, with r^2 values of 0.57 at 3-1/2 years and 0.68 at 4-1/2 years. Difference scores were calculated for each eye by subtracting the log of the HOTV score (converted to cyc/deg based on the convention that 20/20 = 30 cyc/deg) from the log TAC score. Normal eyes showed HOTV acuity that was higher than TAC acuity by an average of 0.37 octave (SD = 0.46, n=1150) at 3-1/2 years and 0.27 octave (SD=0.43, n=1337) at 4-1/2 years. HOTV and grating acuity scores were similar to each other in eyes with retinal residua of ROP. Overall, eyes with acuity better than 20/150 to 20/300 tended to show better HOTV than grating acuity, whereas those with acuity below 20/150 to 20/300 generally showed better grating than HOTV acuity.

Conclusions: There is a significant correlation between crowded HOTV letter acuity and TAC grating acuity in young children for normal eyes and eyes with ROP residua. In both groups of eyes, eyes with lower acuity show better grating than letter acuity, whereas eyes with better acuity show slightly higher letter than grating acuity.

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