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2018 Focus on Eye Health National Summit:
Research to Impact

Vision's Impact on Learning in Children

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Laura Anderko, PhD, RN

Georgetown University and

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Vision's Impact on Learning in Children

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Presenting Research on a Vision Development Tool for Children Ages Birth to 3

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Disclosures

- None

Vision screening – what, why and how

What is screening?

The Commission on Chronic Illness (CCI)[1] definition:

"the presumptive identification of unrecognized disease or defect by the application of tests, examinations or other procedures which can be applied rapidly"

Why?

Vision screening in children

- Early detection and treatment of common vision problems
    - Amblyopia and its risk factors
        - » Significant refractive error
        - Strabismus

Amblyopia Risk Factors

- Significant refractive errors
  - Prevalence dependent on age/race/ethnicity
- Amblyopia 2%[2,3]
- Estimated prevalence ~15%[4]

How?

Current Policy on Vision Screening[5]
Joint statement by the AAP, AAO, AAPOS,AACO

Assessment	Newborn to 6 mo	6-12mo	1-3y	4-5y	6y and older
Ocular history	x	x	x	x	x
External inspection of lids and eyes	x	x	x	x	x
Red reflex testing	x	x	x	x	x
Pupil examination	x	x	x	x	x
Ocular motility assessment	--	x	x	x	x
Visual acuity fixate and follow response	x	x	x	--	--
Visual acuity age-appropriate optotype assessment	--	--	x[1]	x	x
Instrument-based screening when available	--	x	x	x	x

Approaches to assess vision in infants and toddlers

- Visual impairment impacts
  - Motor development milestones[6]
  - Cognitive ability[7,8]
  - Overall development[7,8]

- Can visual behaviors explain how a child uses his/her vision?

An Example of Abnormal Visual Behavior: What's the Cause?

Video courtesy: Lea Hyvarinen MD

More Examples

- Looks at mom's face very early
- Follows bright objects by 6-12 weeks
- Eye contact by age 8 weeks
- Social smile at 12 weeks
- Finding hands at 14 -16 weeks
- Recognition of familiar faces at 7-8 months

Research Question

Given that traditional visual acuity tests cannot be administered in children under 3 years in a screening setting, can visual developmental milestones be used as a screening tool to detect vision problems?

Visual Development Questionnaire (VDQ)

- Questions are age appropriate for each 6 month age cohort
- Divided into two parts:
  - Visual development assessment
  - Risk assessment
- Filled out by parents/guardians

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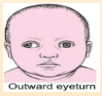
VISUAL DEVELOPMENT AND RISK ASSESSMENT SURVEY QUESTIONNAIRE
Healthy Eyes Healthy Futures Massachusetts
The New England College of Optometry

Children's Vision Massachusetts

Child's name: _____ Date of Birth ____/____/_____ Completed by: _____

These questions are about your child's vision development. Please read them carefully and answer the questions by placing a checkmark in the column that is most appropriate. Be sure to try each activity with your baby before answering the question. Make sure your baby is fed and well rested. Please return this questionnaire by _____

Birth-12 months:	**Yes**	**No**
1. When you smile, does your child respond with a smile?		
2. Does your child recognize family members before hearing their voice?		
3. Does your child look at his/her toys or his/her hands?		
4. Does your child follow your movement across the room? For example, do his/her eyes follow you as you walk across the room?		
5. When your child looks at you or a toy does one of his/her eyes appear turned in or out while the other eye is not?  		
6. Does anyone in the family have crossed-eyes or one eye that turns in a different direction?		
7. Was anyone in the family told to wear glasses at age 4 or younger?		
8. When your baby was born, did he/she have to stay in the hospital for more than 5 days?		
9. During pregnancy, did the mother smoke more than 5 packs of cigarettes per month?		
10. Was your child at least 8 weeks premature or born with low birth weight (3.5 lbs or less)?		

Pilot Study

- 249 subjects 3 months to 3 years of age
- Recruitment - Early Head Start and Early Intervention programs
- Methods:
  - Parents/guardians completed the VDQ
  - Masked examiners travelled study sites to conduct comprehensive eye examinations (gold standard)

Continued

Analysis

- Receiver Operating Characteristics (ROC) curve

Results

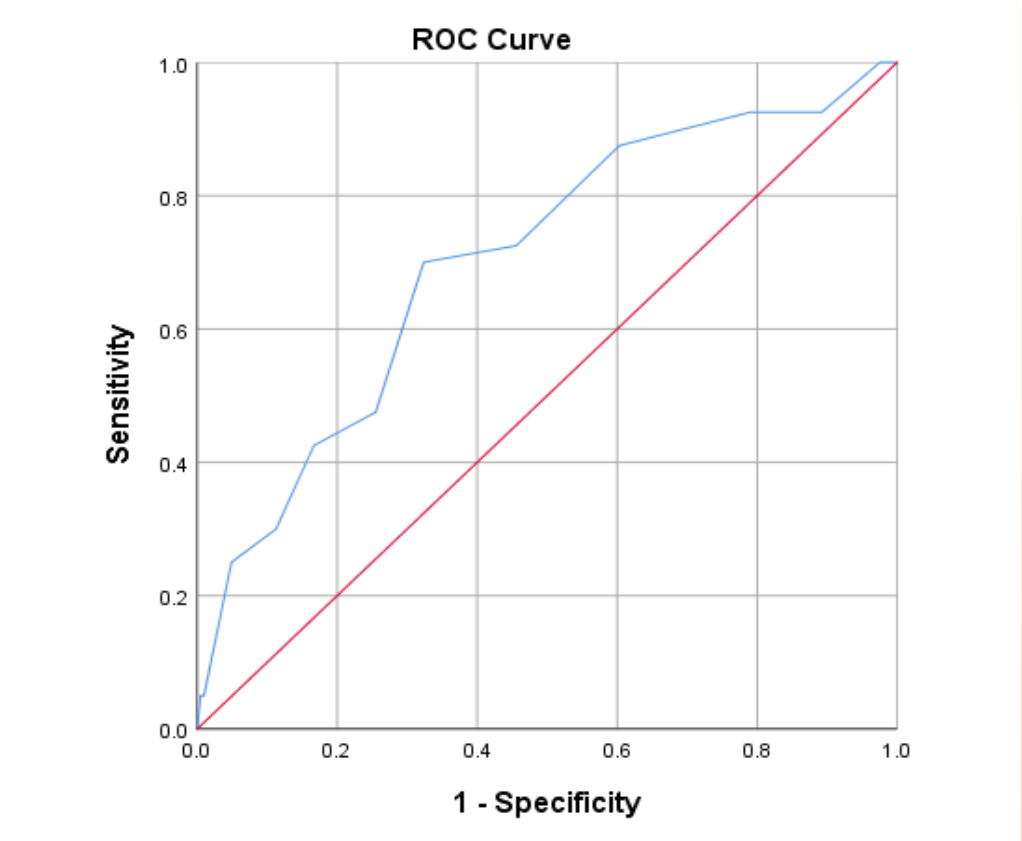
- 228 completed survey
  - Unavailable n=2
  - Incorrect n=19
- Mean age 22.83±8.89 mo

Results

Race/Ethnicity

- Hispanics 34.5%
- Non-Hispanics 33.7%
- Not Available 26.5%
- Other 5.2%

ROC Curve



Area under the curve (AUC)

0.703 (0.613-0.793, 95%CI)

Results

cutoff	sensitivity	specificity
3.5	0	0.995
4	0.0513	0.995
4.5	0.0513	0.989
5	0.128	0.973
5.5	0.154	0.967
6	0.256	0.946
6.5	0.308	0.886
7	0.436	0.832
7.5	0.487	0.739
8	0.692	0.658
8.5	0.718	0.533
9	0.872	0.37
9.5	0.974	0.163
10	0.974	0.0598

- Range of pass/fail scores with sensitivity and specificity

Summary

- Average/good AUC
  - The VDQ is a fair predictor of vision problems in children
- No clear Pass/fail score for using the VDQ yet

Limitations

- Small sample size
- Sample recruited from Early Education Centers

Next Steps

- Larger sample size
- Include medical practices to evaluate validity and feasibility

Thanks

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Impact of Uncorrected Hyperopia on Early Literacy & Attention in 4- & 5-year-olds

Marjean Kulp, OD, MS

for the

Vision In Preschoolers – Hyperopia In Preschoolers (VIP-HIP) Study Group

Supported by NIH/NEI R01EY021141

The funding organization had no role in the design or conduct of this research.

Vision In Preschoolers – Hyperopia In Preschoolers (VIP-HIP) Study Group

C=Coordinator EA=Educational Assessor EE=Eye Examiner

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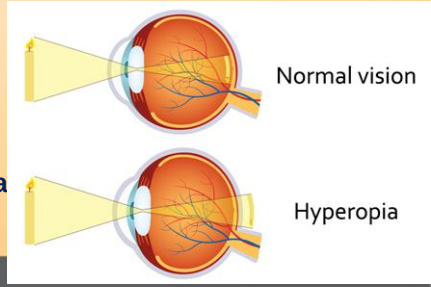
Hyperopia (Farsightedness)

- **4-14% of children with moderate-high farsightedness**
  - (MEPEDS, BPEDS) **Up to 1.7 million preschool children in U.S.**
- **Requires extra focusing effort (accommodation)**
  - **~2x more when looking up close vs. typical child**
  - **Children may have a lower amount of focusing ability than previously thought** (Anderson et al)
  - **More variable focusing, more under accommodation with more farsightedness** (Candy et al; Tarczy-Hornoch, McClelland and Saunders; Anderson et al.)
- **Associated with poorer reading & cognition in children**

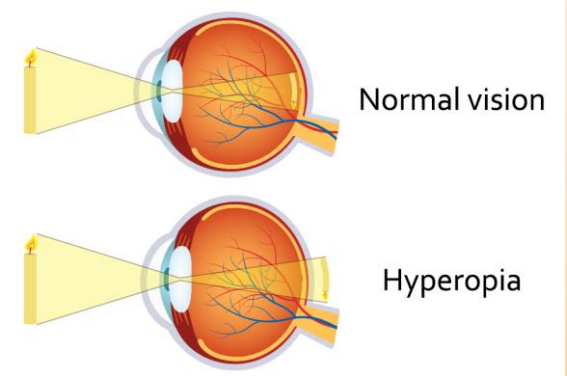
(Simons & Gassler, Rosner & Rosner, Stewart-Brown, Haslum & Butler, Quaid & Simpson, Thurston & Thurston, Narayanasmy et al, Williams, Eames)

- **May begin in preschool** (Shankar et al, Atkinson et al, Roch-Levecq et a



VIP-HIP Study

- **Do uncorrected, moderately hyperopic (farsighted) 4- and 5-year-old children perform worse on tests of early literacy & attention than emmetropes (children with typical refractive errors)?**



Participants

- **492 4- & 5-year-old children in preschool & grade K**
- **Moderate hyperopia (farsightedness) +3 to +6 D**
  - *(Astigmatism ≤ 1.5D; Anisometropia ≤ 1D)*

OR

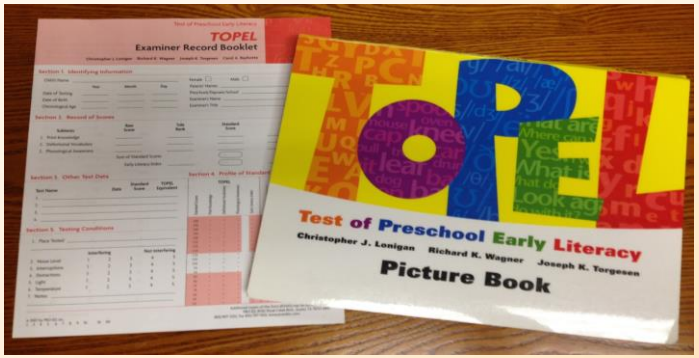
- **Emmetropia (typical refractive error)**
  - *Hyperopia ≤ +1.00D*
  - *Astigmatism, anisometropia & myopia all < 1D*
- ***No eye turn, no amblyopia (lazy eye), no prior correction, no Individual Education Plan***

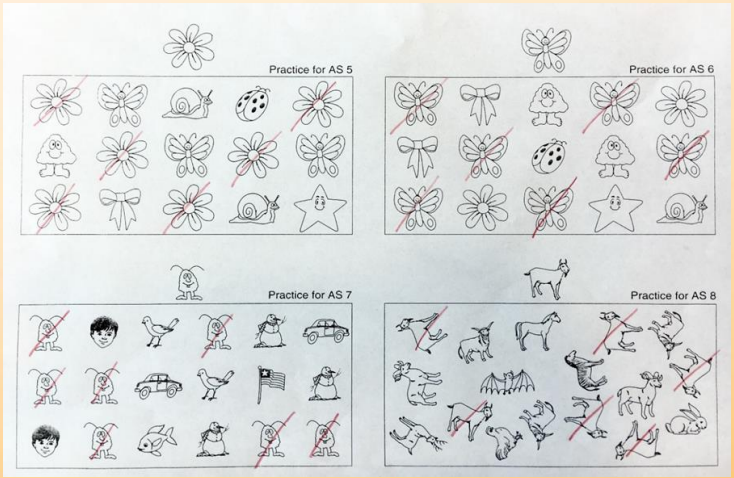
Vision Testing

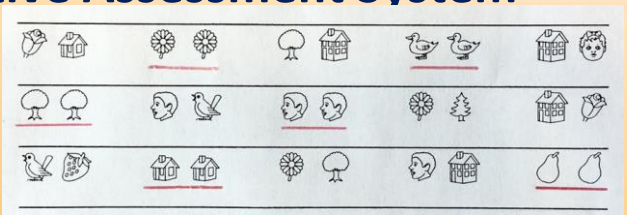
- **Visual Acuity**
  - *Distance*
  - *Near (both eyes)*
- **Accommodation**
  - *Focusing ability*
- **Stereoacuity**
  - *Binocular Depth Perception*
- **Eye Alignment**
- **Cycloplegic refraction**
- **Health**

Testing of early literacy and attention

- **Examiners masked to refractive error**
- **Test of Preschool Early Literacy (TOPEL)**
  - Designed to identify preschoolers at risk for literacy problems
    - **Print Knowledge**
    - **Definitional Vocabulary**
    - **Phonological Awareness**
- **Attention**
  - **Leiter**
  - **Cognitive Assessment System**







Statistical Methods

- **Comparison of Means - Analysis of variance**
  - Hyperopic vs. Emmetropic
  - Hyperopic ≥4D vs. Hyperopic <4D vs. Emmetropic,
  - Post-hoc pairwise comparisons, with correction of p-value using Hochberg procedure
- **Multivariable linear regression models**
  - Independent associations of hyperopia & visual functions with TOPEL scores
  - Visual function groups defined by accom. lag, near VA, stereoacuity
  - Cut points determined using limits of 95% confidence interval of emmetropes
- **Adjusted for age, race/ethnicity, and parent/caregiver's education**

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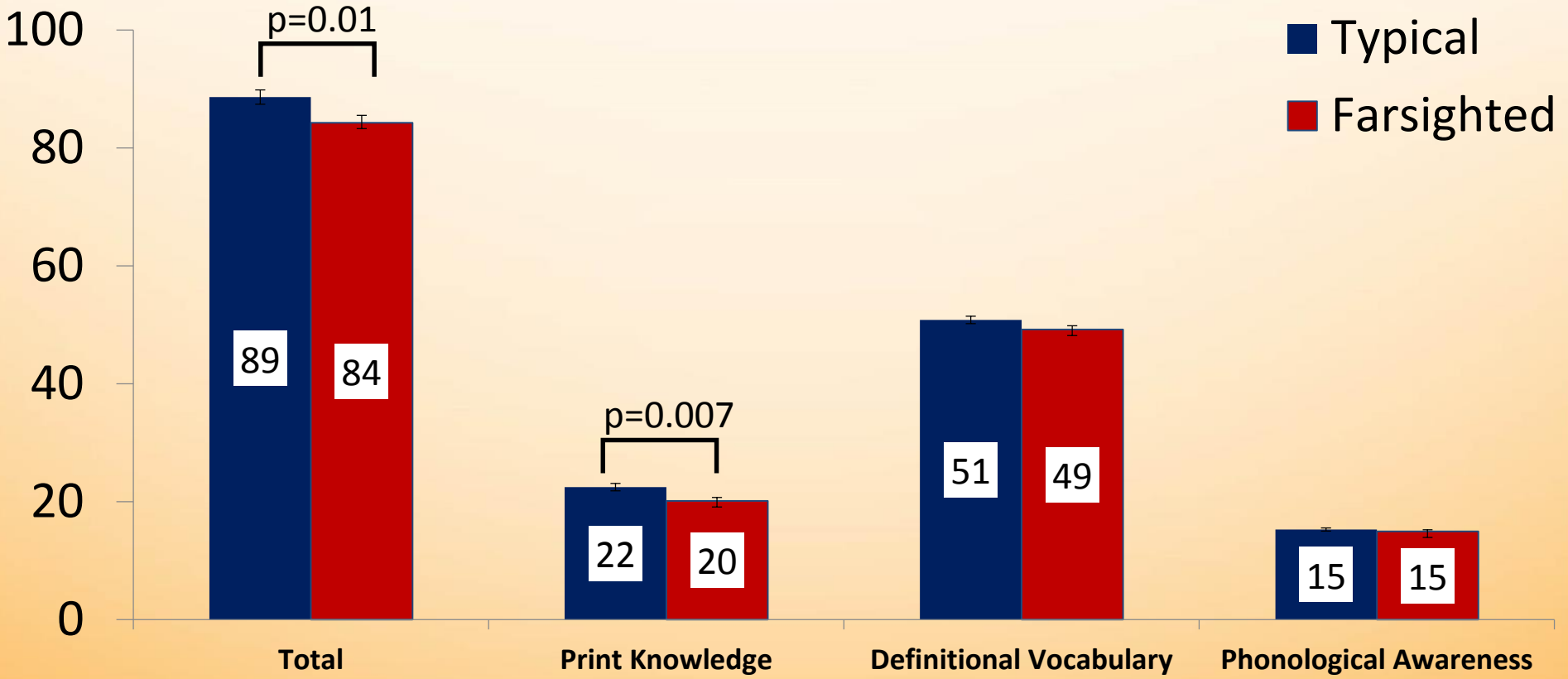
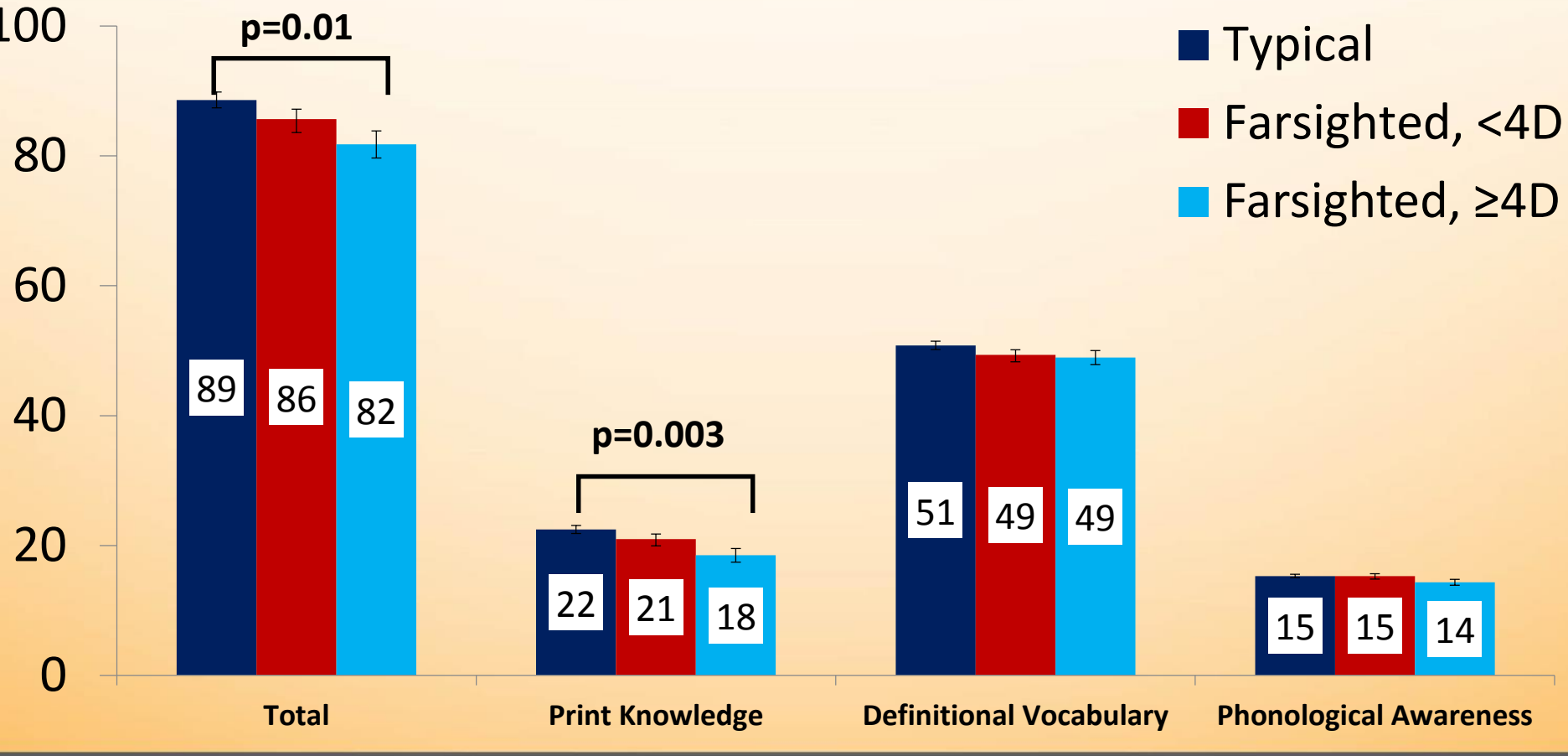
	Emmetropes N=248		Hyperopes N=244	
DEMOGRAPHIC	%		%	
Age in months				
48 to <60	58		62	
60 to <72	42		38	
Sex				
Male	52		47	
Female	48		53	
Ethnicity and race				
Non-hispanic black	60		57	
Non-hispanic white	8		11	
Hispanic	25		26	
Multiple/Unknown/Other	7		5	
Preschool/Kindergarten				
Head Start Preschool	90		88	
Other Preschool/Kindergarten	10		12	
OCULAR	Mean	SD	Mean	SD
Most hyperopic meridian, worse eye (D)	0.51	(0.48)	3.78	(0.81)
Spherical equivalent, worse eye (D)	0.37	(0.50)	3.47	(0.81)

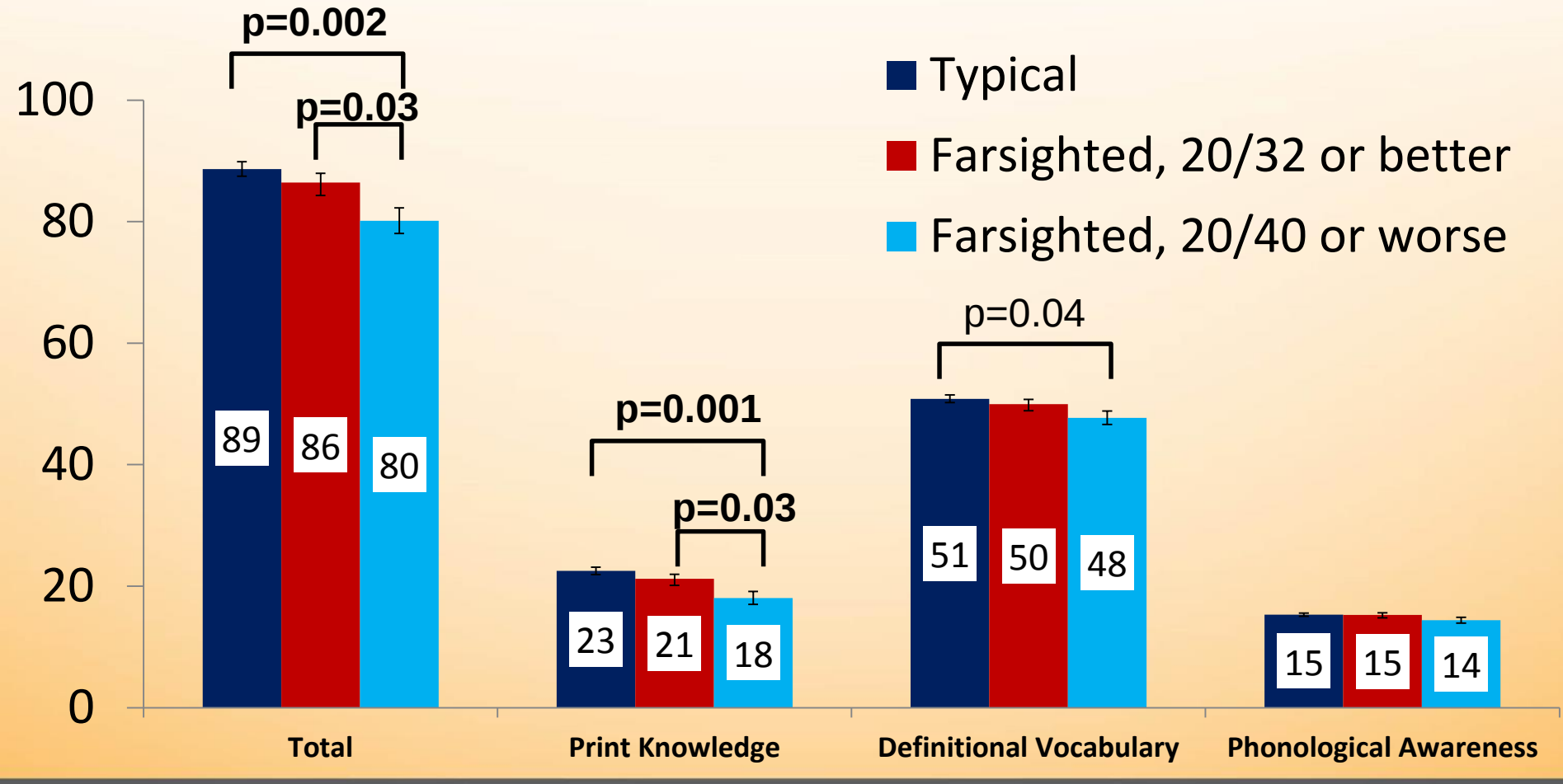
Early Literacy Scores by Refractive Error



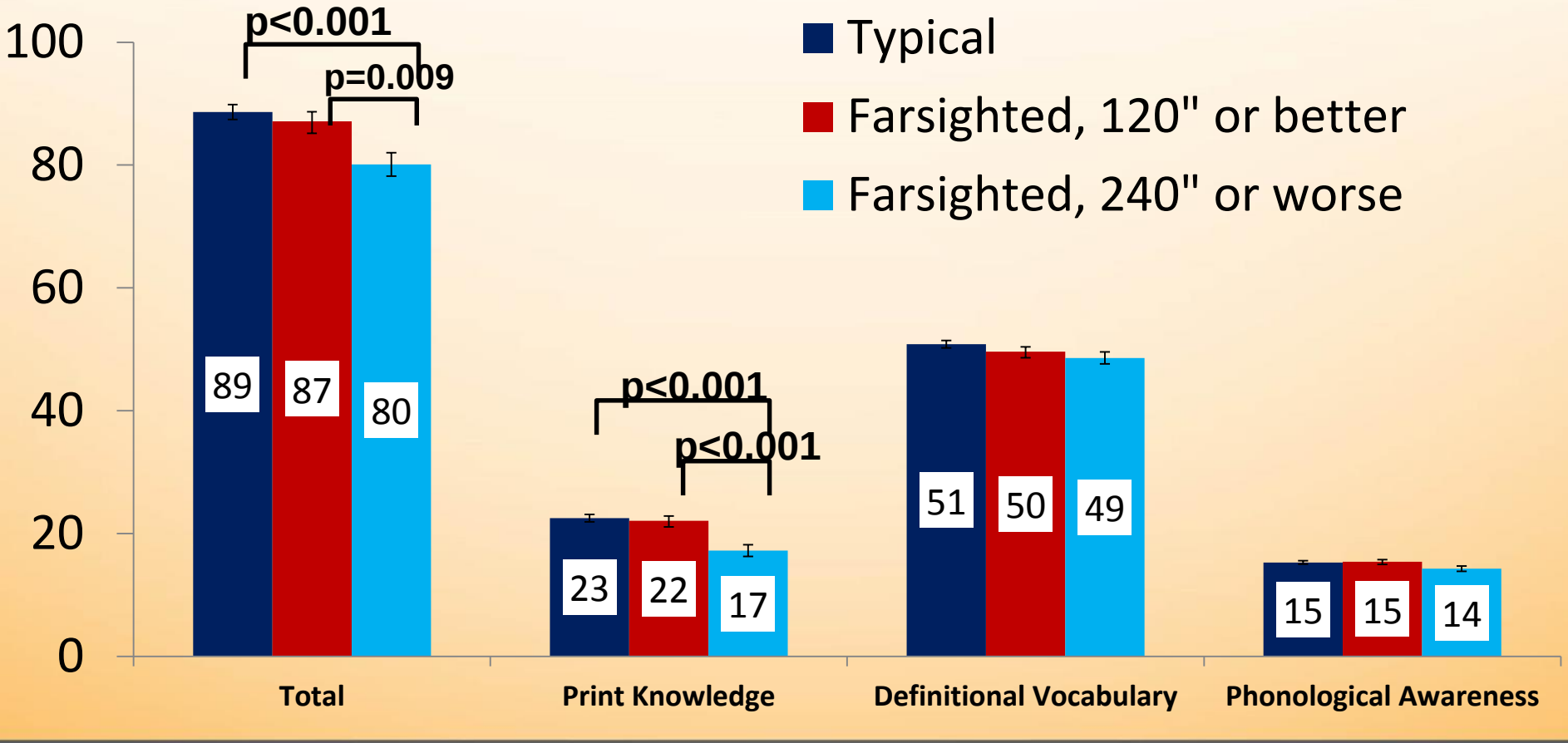
Early Literacy Scores by Refractive Error



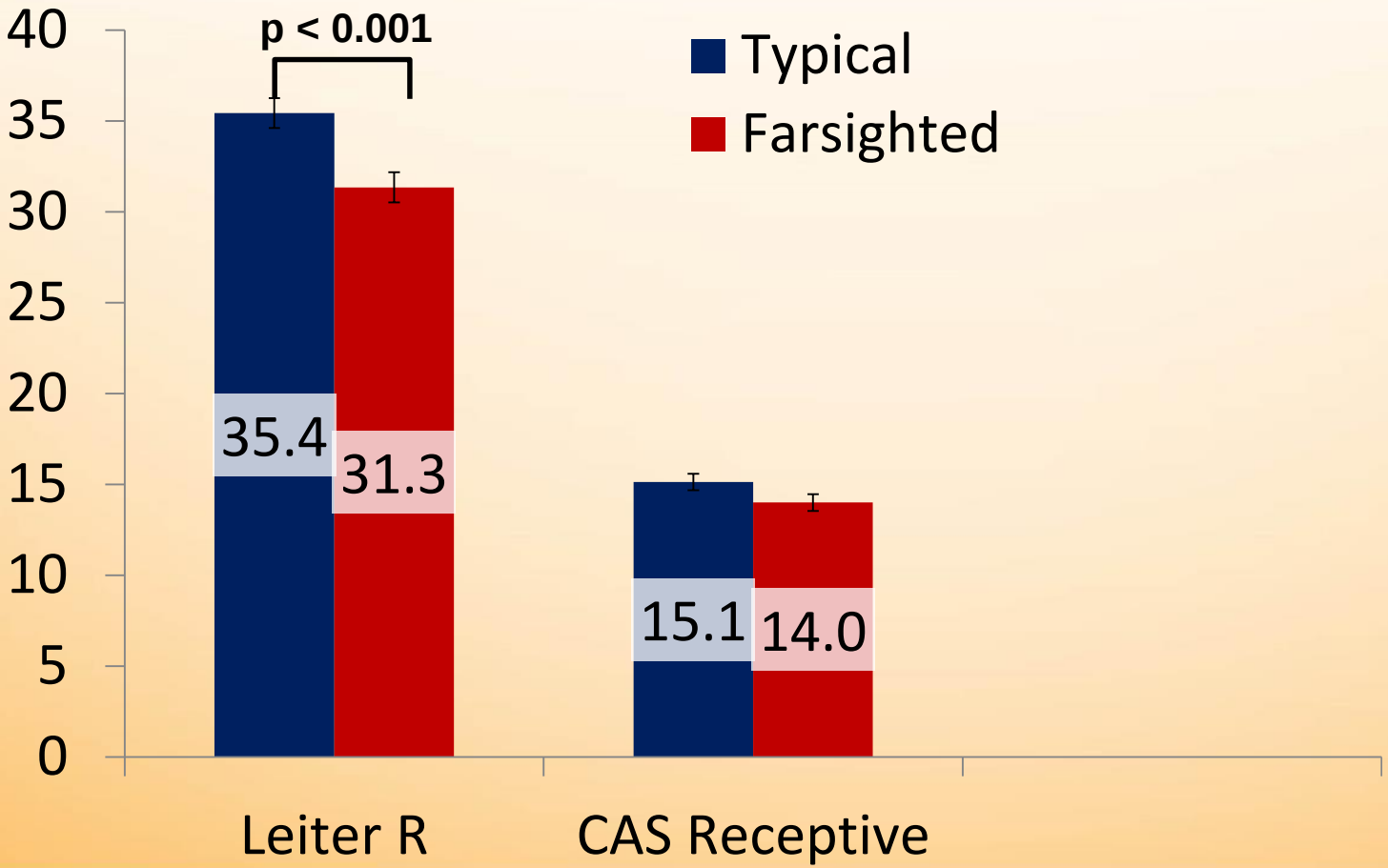
Literacy Score by Refractive Error & Near Acuity



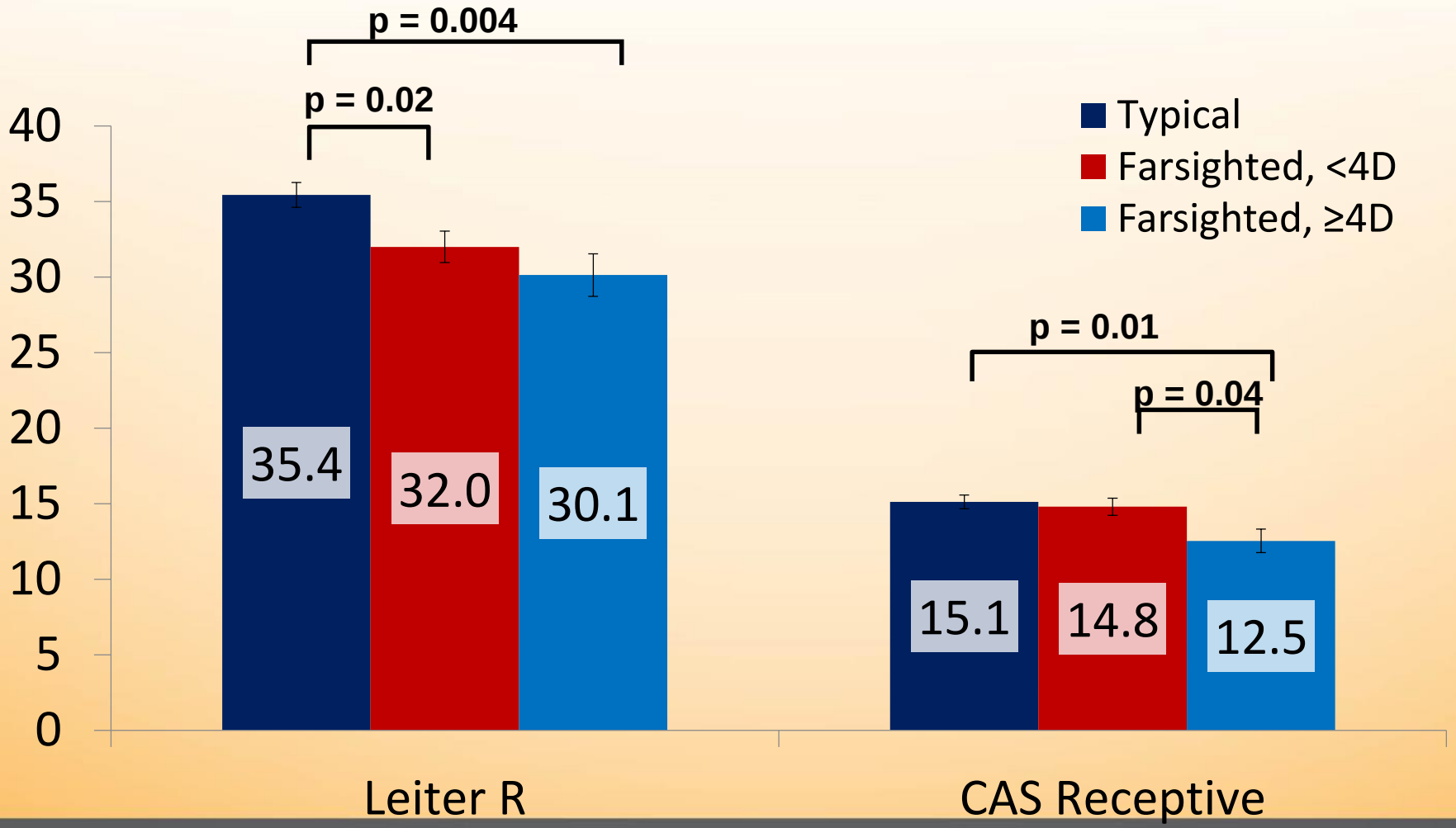
Literacy Score by Refractive Error & Stereoacuity



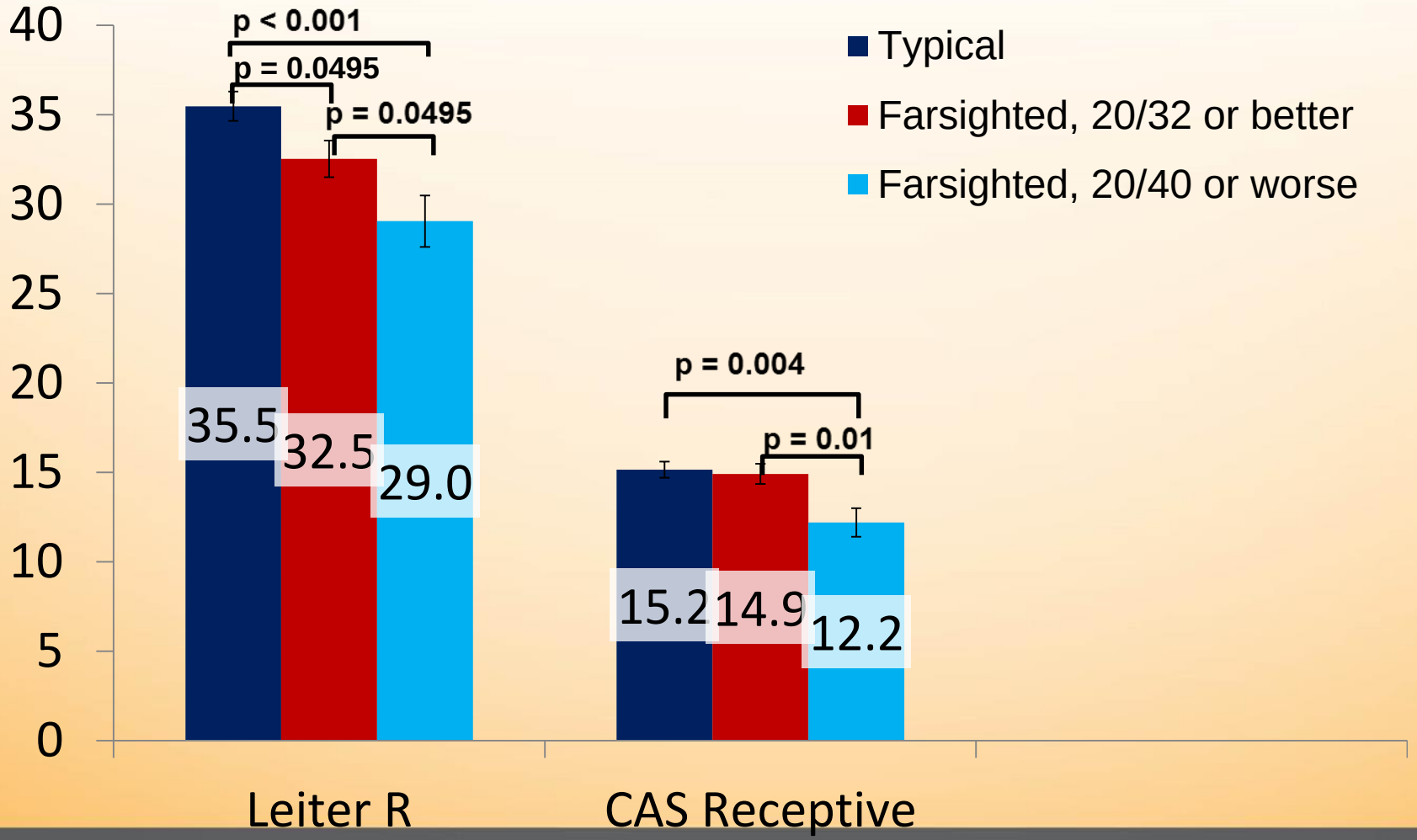
Attention Scores by Refractive Error



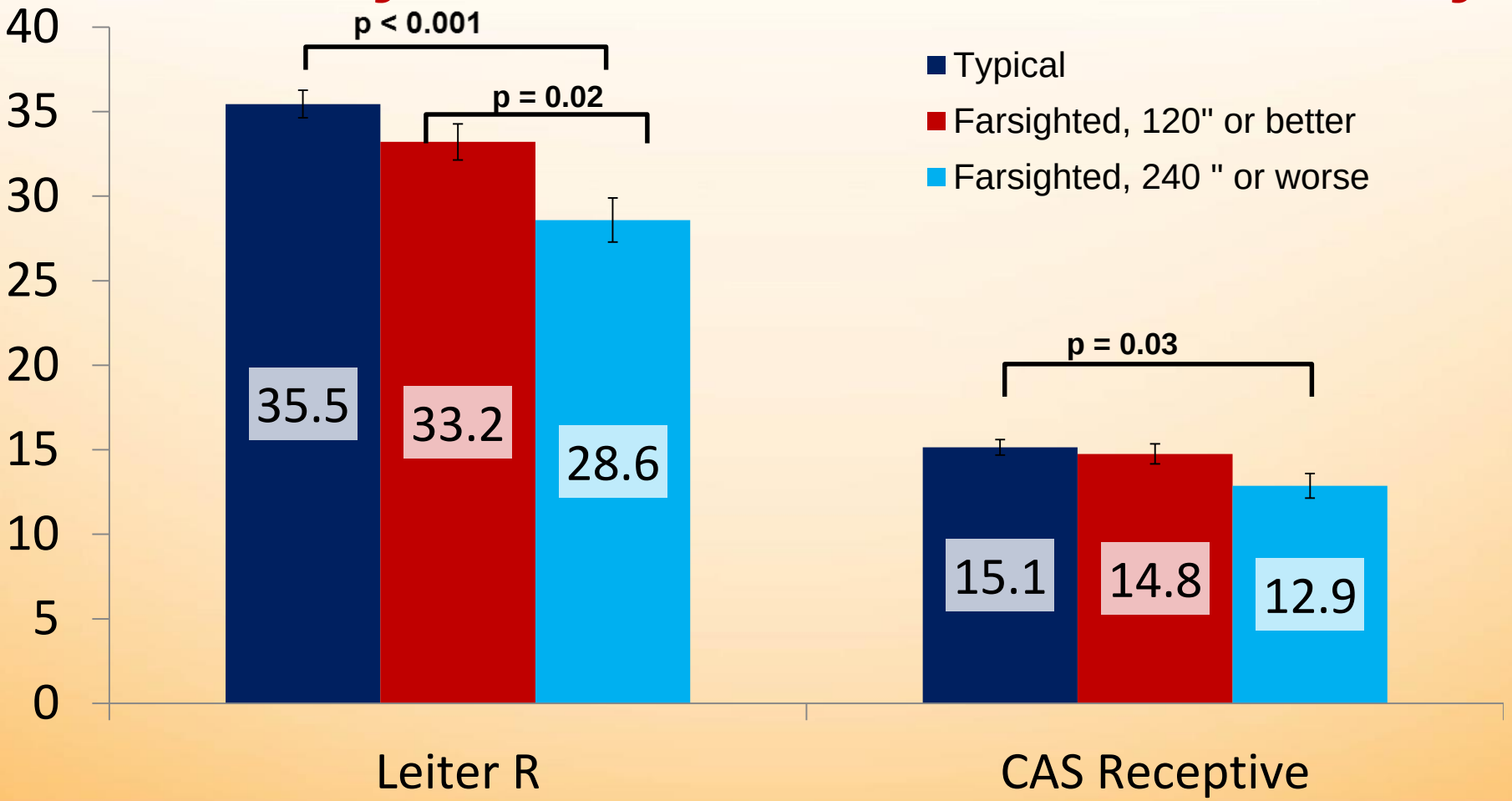
Attention Scores by Refractive Error



Attention by Refractive Error & Near Acuity



Attention by Refractive Error & Stereoacuity



Proportion with ≥ 1 reduced near visual skills

– near visual acuity, stereoacuity, focusing ability (accommodation)

- Typical Refractive Error (Emmetropes) 17%
- Moderate to High Farsighted (Hyperopes) 64%
- $p<0.001$

Farsighted vs. Typical Refractive Error

- **Significantly lower early literacy and attention scores**
- **Early literacy:**
  - **Greatest deficits in print knowledge**
    - ***Print awareness***
    - ***Ability to identify letters, written words***
    - ***Ability to identify letters associated with particular sounds***
  - **Similar performance for phonological awareness**
    - ***Ability to drop and blend specific sounds in everyday words***

- **Greatest deficits in early literacy & attention in farsighted with reduced near visual function:**
  - **Near visual acuity 20/40 or worse**
  - **Stereoacuity 240” or worse**
- **Farsighted children with better near visual function performed similarly to those with typical refractive error**
  - **Better near visual acuity & better stereoacuity**

- **Test items -large, high contrast**
  - **Not a problem 'seeing' the pictures & letters**
- **Supports prior research showing relationship between farsightedness & reading & attention**
- **Moderate farsightedness may cause difficulty with:**
  - **Access to print, sustained focus (Intermittent blur), learning letters & their associations**

- **Differences are meaningful**
  - **Deficits in early literacy highly predictive of poor reading in later years**
    - Juel, Cunningham & Stanovich, Francis et al, Torgesen & Burgess, McNamara et al, Adlof et al
  - **Magnitude that warrants intervention in educational settings to maximize future reading performance**
    - Lonigan et al.
  - ***'What Works Clearinghouse' ≥+0.25 effect size "substantively important"***

Does correction improve early literacy skills?

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ELF
Early Literacy & Farsightedness

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Research to Impact – Improving Vision to Learn- Screening for Visual Problems in Childhood

Mae Millicent Winfrey Peterseim, MD
Medical University of South Carolina

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MUSC
STORM EYE INSTITUTE

Mae Millicent Peterseim MD
Storm Eye Institute / Medical University of South Carolina
Professor, Pratt Endowed Chair
Pediatric Ophthalmology

No conflict of interest

No financial interest

Pleased to be part of this distinguished panel

We all have our stories:

Children who are missed

- 8 yo amblyopia –

  " I thought everyone had a bad eye"

  heartbreaking

- 9 yo "autistic" child with high hyperopia–

  didn't pay attention because he needed glasses!

While we all have our individual patient stories, it takes

- Research to impact
- Research to provide the big picture
- Research to instruct how to improve care

Research to Impact in Pediatric Vision Care

Improvements last few decades for my patients

Amblyopia – easier treatment

- Reduced patching from days to 4 or 2 hours or drop in eye to improve vision

Strabismus surgery – better techniques

- Straighter eyes- better binocular vision

Research to Impact in Pediatric Vision Care

Retinopathy of Prematurity–Revolution!

Reduced blindness from 1 in 10 to 1 in 500

Now “Very Unusual”

Due to

- National Screening Guidelines
- Improved Treatment Due to Research

Research to Impact in Pediatric Vision Care

Tremendous impact of research to improve vision and lives

Thank you!

Research to Impact in Pediatric Vision Care

- Vision screening
- Detects children who are at risk and should receive comprehensive exam
- Research in development and evaluation of better ways to screen
- National Screening Guidelines
- Next few decades I want “Revolution”-
- Want “Very Unusual” for child to have undetected vision problem

Vision screening - What are we looking for?

Ophthalmic disorder	Frequency
Congenital cataract	0.06%
Congenital glaucoma	0.01%
Retinoblastoma	0.005%
Strabismus	4%
Amblyopia	2-4%
Refractive errors (age 5-17)	9-28%

Children don't know

Vision Impacts Learning and Life

- Visual deficiencies affect school performance
- High hyperopia associated with lower reading skills
- Amblyopia most common cause of visual impairment among children
- Amblyopia most common cause of monocular visual impairment among young and middle-aged adults
- Amblyopia associated with lower rates of college graduation, limits occupation choice
- Strabismus associated with adverse effects relationships, education and success in finding employment

These conditions are treatable

Vision screening finds at-risk children

to refer for care and treatment

Collaboration between MUSC and ABVI

MUSC
STORM EYE INSTITUTE

Association for the Blind & Visually Impaired Charleston

<u>Combining Automated Vision Screening With On-site Examinations in 23 Schools:</u>

<u>ReFocus on Children Program 2012 to 2013</u>

Program screens >2000 children/year
Provides exam and glasses if needed at school
Provides glasses for 200 children/year
Teacher survey

Teachers overwhelmingly "Glasses help!" Positive impact in the classroom

- reduction in squinting and overall better vision
- improvement in academic progress
- increase in the children's focus during lessons
- increase in participation and classroom interaction
- improvement in student's confidence and behavior

Research in Vision Screening

- New technology:
- Instrument-based screening devices
  - Include photoscreeners, photorefractors, others
  - “Take a picture” and pass/refer for exam
  - Quick and child-friendly
  - Marketed pediatricians, community groups

Research at MUSC/Storm Eye Institute

- We have performed independent evaluations of vision screening devices
- We compare results of the device to results of doctor examination
- Ensure device refers children appropriately
- Adequate sensitivity - not miss children

Criteria for Referral
American Association for Pediatric Ophthalmology and Strabismus Recommended Amblyopia Risk Factor Targets

REFRACTIVE RISK FACTOR TARGETS				
Age, months	Astigmatism	Hyperopia	Anisometropia	Myopia
12-30	>2.0 diopters	>4.5 diopters	>2.5 diopters	>-3.5 diopters
31-48	>2.0 diopters	>4.0 diopters	>2.0 diopters	>-3.0 diopters
>48	>1.5 diopters	>3.0 dipters	>1.5 diopters	>-1.5 diopters

NONREFRACTIVE RISK FACTOR TARGETS	
All ages	Media opacity >1 mm Manifest strabismus >8 prism diopters in primary position

Research at MUSC/Storm Eye Institute

Confirm usefulness of photoscreeners/screening devices

Published sensitivity and validation studies

Vision Screening Research: Instrument screening works

American Academy of Pediatrics

CLINICAL REPORT
Guidance for the Clinician in Rendering Pediatric Care
Procedures for the Evaluation of the Visual System by Pediatricians

AMERICAN ASSOCIATION FOR PEDIATRIC OPHTHALMOLOGY AND STRABISMUS
AMERICAN ACADEMY OF OPHTHALMOLOGY
Joint Policy Statement
PEDIATRICS Volume 137, number 1, January 2016

Uniform support

AAP, AAO, AAPOS, NCCVEH, NASN

Include photoscreening/instrument-based screeners

Age specific recommendations

THE AMERICAN ACADEMY OF PEDIATRICS

AAO
EyeSmart™

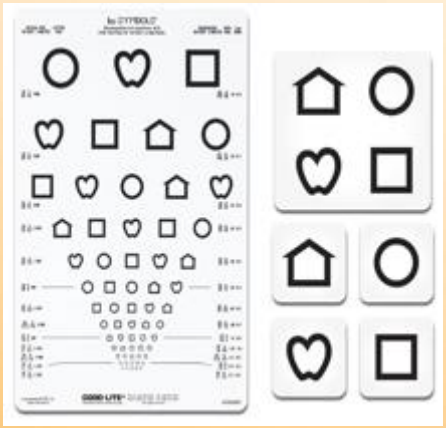
aapos
American Association for Pediatric Ophthalmology and Strabismus

NATIONAL CENTER
for Children's Vision & Eye Health
AT PREVENT BLINDNESS

NASN
National Association of School Nurses

Accomplishments that Improve Childhood Vision Screening

- Research determine best techniques for impact
- National age-specific recommendations doctors and schools
  - Use of photoscreening/ instrument screeners
  - Methods and charts for threshold acuity



Accomplishments that Improve Childhood Vision Screening

- CPT codes for vision screening
  - 99173, 99174, 99177
- Category I codes, meaning they have demonstrated clinical efficacy and are expected to be used widely by health care providers
- Encourage reimbursement for screening

Moving Forward

- Encourage adoption of recommendations
- Expand access to care and treatment
- Continue research to provide “big picture” to improve care

Moving Forward

Expect, in next few decades, a

Vision Screening Revolution!

Say that an undetected vision problem in childhood is “Very Unusual”

Goal to provide all children best vision for learning and life

Prevent Blindness®

Bringing Americans to Eye Care