ASCRS ♦ ASOA Symposium & Congress

Technicians & Nurses Program

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JCAHPO
JOINT COMMISSION ON ALLIED HEALTH PERSONNEL IN OPHTHALMOLOGY®

Colour Vision Testing

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JCAHPO ACE Meeting 2015
Las Vegas

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Objectives

- Basic review of colour vision
- Discuss colour vision testing with pseudoisochromatic plates
  - Ishihara plates
  - Hardy-Rand-Rittler plates
- Discuss colour vision testing with D-15
- Discuss colour vision with FM 100 Hue
- Apply colour vision testing in a case study

Colour Vision

•Dependant upon healthy cones

•Cones are thought to contain 3 different photosensitive pigments

- •Red
- •Green
- •Blue

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Why do we see in colour?

•To tell the difference between coloured berries

•To tell the good from rotten food

•To tell ripe from unripe food

•Mark Changizi, The Vision Revolution

- Subtle and not so subtle changes in skin colour (changes in blood oxygenation)
  - primates with colour vision have evolved to have bare patches on their bodies (face, rump, genitals)
  - 10% of all medical disorders list skin colour as a diagnostic sign

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Colour Vision

•Colour depends on

•Hue

- •The colour of an object
- •An object will have a particular hue because it reflects or transmits light of a certain wavelength

•Shades

- •Addition of black to a hue

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Colour Vision

•Colour depends on

•Saturation

- •Index of purity of a hue
- •The amount of white (highly saturated has little white)
- •Pink is less saturated than red

•Intensity

- •Brightness of a colour

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Colour Vision

- White objects
  - Reflect most light
- Black objects
  - Absorb most light

Colour Vision Defects

- Believed to arise from a deficiency or absence of one or more visual pigments
- Most common
  - Congenital
  - Red-green deficiency
  - X-linked recessive
  - 8% to 10% males
  - 0.4% females

Colour Vision Defects Inheritance

- Females - XX
- Males – XY
- X chromosome carries the defect (recessive)
- Female inherits it from her colour deficient father
  - Normal colour vision from the normal X
  - Carrier
  - Any of her sons that get the defective X will have the colour deficiency

Acquired Colour Vision Defects

- Secondary to disease or trauma
- Macular problems
  - Anything affecting the cones
- Optic nerve problems
  - TRO
  - Optic neuritis
- Chemical poisoning

Colour Vision Defects

Congenital	Acquired
•Bilateral	•Unilateral or bilateral
•Affects both eyes equally	•Can affect eyes differently
•Males>females	•Males=females
•Non-progressive	•Progressive
•No cure	•May go away when cause is removed

Colour Vision Defects Categories

- Trichromatism
- Dichromatism
- Monochromatism

Trichromatism

- Possess all 3 cone pigments
- Normal colour vision

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Anomolous Trichromatism

- Partial deficiency of one of the 3 cone pigments
  - Protanomaly
    - Red deficiency
    - Poor red-green discrimination
    - Poor blue-green discrimination

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Anomolous Trichromatism

- Partial deficiency of one of the 3 cone pigments
  - Deuteranomaly
    - Green deficiency
    - Poor green-purple discrimination
    - Poor red-purple discrimination

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Anomolous Trichromatism

- Partial deficiency of one of the 3 cone pigments
  - Tritanomaly
    - Blue deficiency
    - Poor blue-green discrimination
    - Poor yellow-green discrimination

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Dichromatism

- Complete deficiency of one cone pigment
  - Protanopia
    - Absent red cone pigment

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Protanopia

- Absent red cone pigment

Used with permission

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Dichromatism

- Complete deficiency of one cone pigment
  - Deuteranopia
    - Absent green cone pigment

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Deuteranopia

- Absent green cone pigment

Used with permission

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Dichromatism

- Complete deficiency of one cone pigment
  - Tritanopia
    - Absent blue cone pigment

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Tritanopia

- Absent blue cone pigment

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Monochromatism

- Only one cone pigment
- Require at least 2 different cone pigments to see any kind of colour
- Will see only shades of gray

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Colour Vision Tests

- Psuedoisochromatic plates
  - Ishihara Plates
  - Hardy-Rand Rittler Plates
- Farnworth Munsell D-15
- FM 100 Hue

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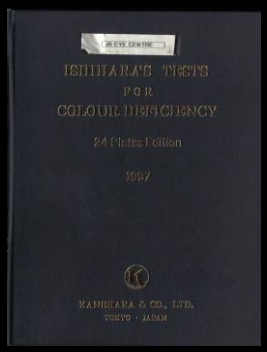
Ishihara Plates

- Plates composed of coloured dots, differing in shade and hue, that form numbers and patterns that are not visible with color vision defects
- Provides assessment of congenital defects
- Different versions



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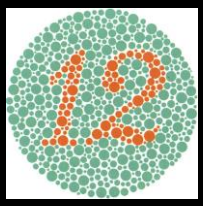
Ishihara Plates

Plate 1



Red-green defect	Total colour deficiency
12	12

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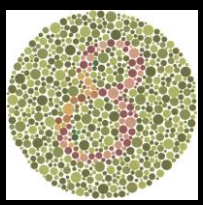
Ishihara Plates

Plate 2



Red-green defect	Total colour deficiency
3	-

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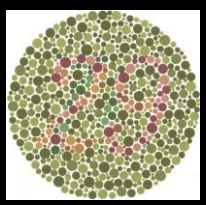
Ishihara Plates

Plate 3



Red-green defect	Total colour deficiency
70	-

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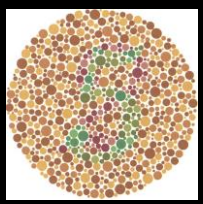
Ishihara Plates

Plate 4



Red-green defect	Total colour deficiency
2	-

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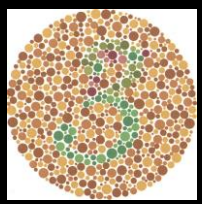
Ishihara Plates

Plate 5



Red-green defect	Total colour deficiency
5	-

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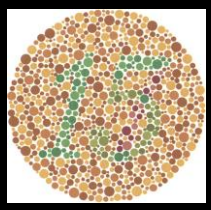
Ishihara Plates

Plate 6



Red-green defect	Total colour deficiency
17	-

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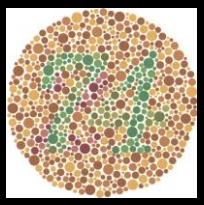
Ishihara Plates

Plate 7



Red-green defect	Total colour deficiency
21	-

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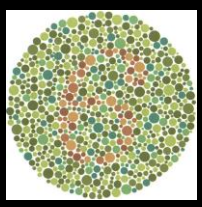
Ishihara Plates

Plate 8



Red-green defect	Total colour deficiency
-	-

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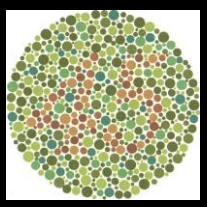
Ishihara Plates

Plate 9



Red-green defect	Total colour deficiency
-	-

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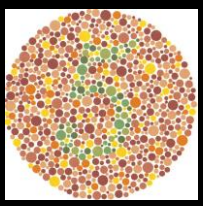
Ishihara Plates

Plate 10



Red-green defect	Total colour deficiency
-	-

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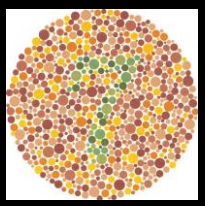
Ishihara Plates

Plate 11



Red-green defect	Total colour deficiency
-	-

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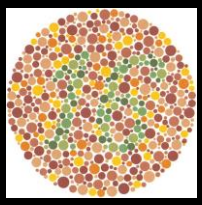
Ishihara Plates

•Plate 12



Red-green defect	Total colour deficiency
-	-

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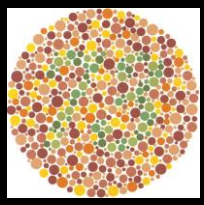
Ishihara Plates

Plate 13



Red-green defect	Total colour deficiency
-	-

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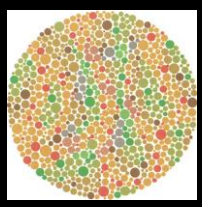
Ishihara Plates

Plate 14



Red-green defect	Total colour deficiency
5	-

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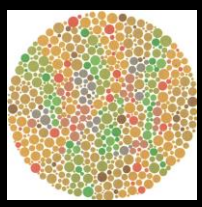
Ishihara Plates

Plate 15



Red-green defect	Total colour deficiency
45	-

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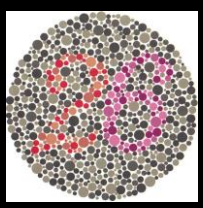
Ishihara Plates

Plate 16



Protan (red)		Deutan (green)	
strong	mild	strong	mild
6	(2)6	2	2(6)

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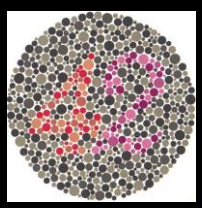
Ishihara Plates

Plate 17



Protan (red)		Deutan (green)	
strong	mild	strong	mild
2	(4)2	4	4(2)

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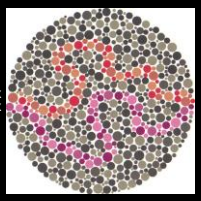
Ishihara Plates

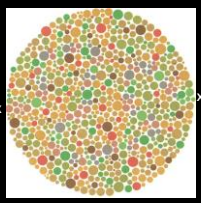
Plate 18



Protan (red)		Deutan (green)	
strong	mild	strong	mild
Purple	Purple (red)	Red	Red (purple)

Ishihara Plates

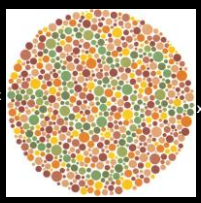
Plate 19



Normal	Red – green defect	Total colour deficiency
-	Trace along a line	-

Ishihara Plates

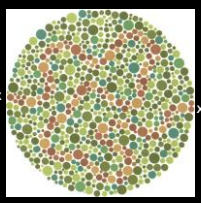
Plate 20



Normal	Red – green defect	Total colour deficiency
Trace bluish-green line	-	-

Ishihara Plates

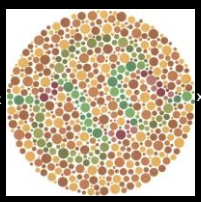
Plate 21



Normal	Red – green defect	Total colour deficiency
Trace orange line	-	-

Ishihara Plates

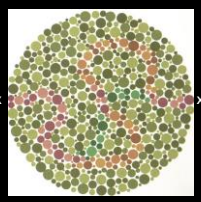
Plate 22



Normal	Red – green defect	Total colour deficiency
Trace greenish line	Trace greenish line with the purple	-

Ishihara Plates

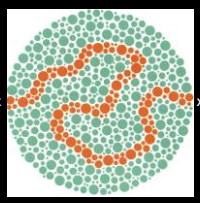
Plate 23



Normal	Red – green defect	Total colour deficiency
Trace purple and orange line	Trace purple and bluish green line	-

Ishihara Plates

Plate 24



Normal	Red – green defect	Total colour deficiency
Trace orange line	Trace orange line	Trace orange line

Ishihara Plates

•Testing: Monocular? Binocular?

•Review colour vision defects (briefly and basically)

Congenital	Acquired
•Bilateral •Affects both eyes equally •Males>females •Non-progressive •No cure	•Unilateral or bilateral •Can affect eyes differently •Males=females •Progressive •May go away when cause is removed

Ishihara Plates

•Testing: Monocular? Binocular?

•Acquired (TRO, chemical poisoning, etc)
- Monocular

•Congenital
- Binocular

Ishihara Plates Scoring

•Scoring

•Give 1 point for each correct number

•Total number correct out of the total number of plates

•15/15

•9/15

Ishihara Plates Scoring

•Scoring

•Score using plate # 1 or not

•Since everyone should see it

•0/14 is equivalent to 1/15

Ishihara Plates Scoring

•Scoring (using 15 plates in the book)

•9 or less plates are read correctly = colour deficiency

•Track which numbers are missed
- Determine if red/green defect is present

Ishihara Plates

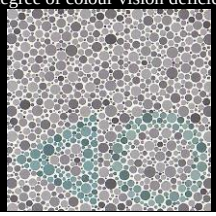
- Adequate lighting
  - Daylight or best artificial light
- Held at 75 cm
- Tilted to 90° to the line of vision
- Should answer within 3 seconds
- Do not touch colour plates
- Keep book closed when not in use

Hardy-Rand-Rittler plates

- No longer manufactured
- Pseudoisochromatic plates
  - Plates for detecting protans
  - Plates for detecting deutans
  - Plates for detecting tritans

Hardy-Rand-Rittler plates

- Neutral gray background
- Coloured circles, crosses, and triangles
  - Presented in higher and lower saturations
  - Detect the degree of colour vision deficiency



Hardy-Rand-Rittler plates

- Colour vision deficiency can be graded
  - Mild, moderate, severe
- Can differentiate Red-Green and Yellow-Blue defects
- Impossible to memorize (unlike Ishihara)
  - Identify not only what shape is seen but also in what quadrant it is in
  - Could rotate the plate to make even more combinations
- Detailed instructions included in the book

Farnsworth-Munsell D-15

- Series of 15 coloured caps
- Differentiate between
  - Protan
  - Deutan
  - Tritan
- Will not pick up subtle defects
  - Anamolous trichromat

Farnsworth-Munsell D-15

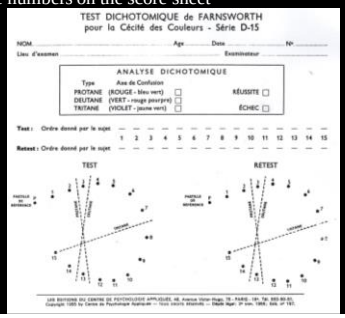
- Mix up caps and place them on table
- Have the patient arrange the caps in order for the anchor (both eyes open)
- 2 minute limit
  - Not enforced

Farnsworth-Munsell D-15

•Flip box over and record on the score sheet the order of the caps

Farnsworth-Munsell D-15

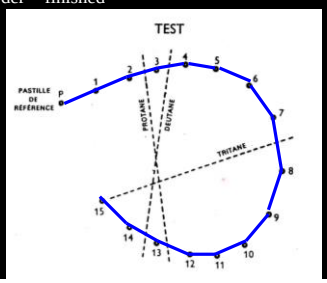
•Connect the numbers on the score sheet



Farnsworth-Munsell D-15

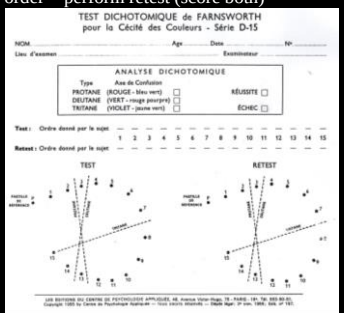
•Normal vision = numbers in order (1-15)

•If all in order = finished



Farnsworth-Munsell D-15

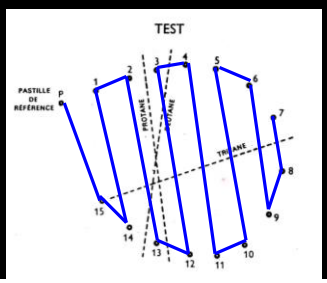
•If any out of order = perform retest (score both)



Farnsworth-Munsell D-15

•Defect corresponds with the line to which it is parallel

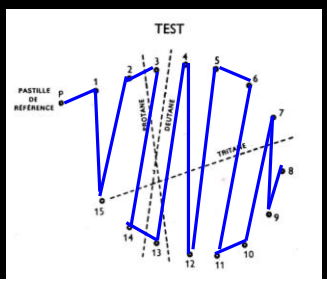
Protan



Farnsworth-Munsell D-15

•Defect corresponds with the line to which it is parallel

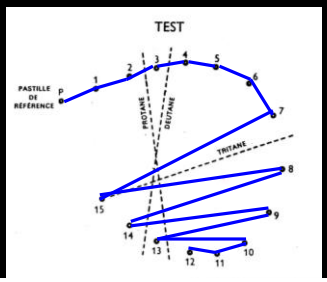
Deutan



Farnsworth-Munsell D-15

•Defect corresponds with the line to which it is parallel

Tritan



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Farnsworth-Munsell 100-Hue

•Tests colour discrimination

•Separate people with normal colour vision into

- •Superior colour discrimination
- •Average colour discrimination
- •Low colour discrimination

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Farnsworth-Munsell 100-Hue

•Four wooden cases

•93 coloured caps

- •85 removable
- •2 caps in each box are fixed and repeated

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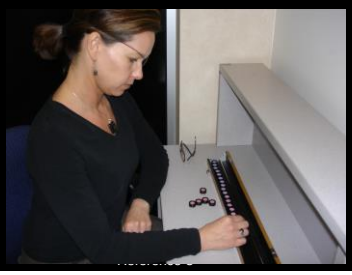
Farnsworth-Munsell 100-Hue

•Perform each eye separately

•Natural daylight or equivalent



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Farnsworth-Munsell 100-Hue

Procedure

•The object of the test is to arrange the caps in order according to colour. Transfer the caps in to the panel so they form a regular colour series between the 2 caps. It should take you about 2 minutes per panel. However, accuracy is more important than speed. Arrange them as best as you can…but do not dawdle.

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Farnsworth-Munsell 100-Hue

Recording Data

•Record the order of the caps

-- -- -- 18 22 16 17 19 -- --

13 14 15 ~~16~~ ~~17~~ ~~18~~ ~~19~~ ~~20~~ 21 22

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Farnsworth-Munsell 100-Hue

Scoring

- Essentially counting errors
- Score for each cap is the sum of the difference between the number of the cap and the number of the caps adjacent to it

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Farnsworth-Munsell 100-Hue

RECORDED ORDER	13	14	15	18	22	16	17	19

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Farnsworth-Munsell 100-Hue

RECORDED ORDER	13	14	15	18	22	16	17	19
DIFFERENCE b/w CAPS	1	1	3	4	6	1	2	

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Farnsworth-Munsell 100-Hue

RECORDED ORDER	13	14	15	18	22	16	17	19
DIFFERENCE b/w CAPS	1	1	3	4	6	1	2	
SCORE FOR CAP	2	4	7	10	7	3		

Therefore, cap number 14 has an error score of 2 (1+1)

2 is the lowest possible score

Cap 22 has an error score of 10 (4+6)

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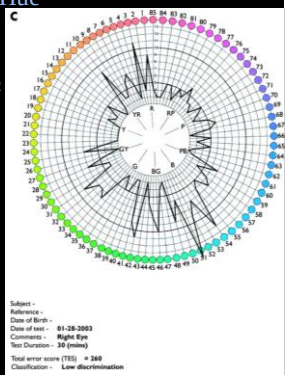
Farnsworth-Munsell 100-Hue

- Inner circle corresponds to the number of caps
- First circle represents a score error of 2
- Mark each error score on the radial line
- Connect the points
- Total error = sum the errors on each radial line counting the inner circle as zero
- Re-test as required



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Farnsworth-Munsell 100-Hue

Results

- Superior colour discrimination
  - Total error score of 0 to 16
  - 0 to 4 transpositions
- Average colour discrimination
  - Total error score of 20 to 100
- Low colour discrimination
  - Total error score of greater than 100

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Case Study

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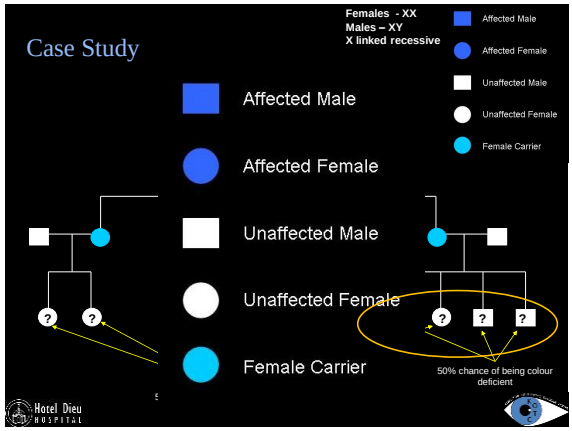
Case Study



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3rd generation offspring from youngest daughter

Male - 9 years old

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3rd generation offspring from youngest daughter

Male - 9 years old

correctly identified 4 half numbers

55 instead of 57
17 instead of 15
21 instead of 71
27 instead of 97

→ IHCP 0/16

23 → Suggestive for deuteranopia

42

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3rd generation offspring from youngest daughter

Male - 9 years old

ICHP: deuteranopia

Anecdotal: normal / abnormal

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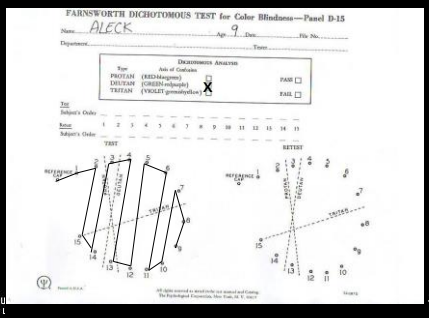
3rd generation offspring from youngest daughter

Male - 9 years old



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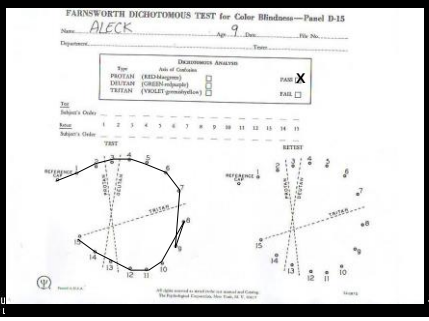

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Anecdotal: normal / abnormal

D-15: normal

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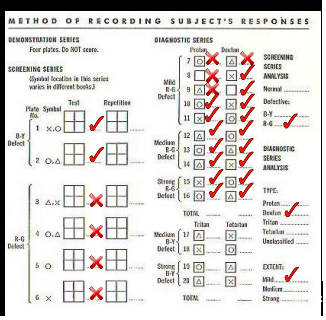
H-R-R Plates

Could not identify plates
3-6 = R-G defect

More checks under
deutan = deutan

No further errors = mild



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ICHP: deuteranopia

Anecdotal: normal / abnormal

D-15: normal

H-R-R: mild deutan

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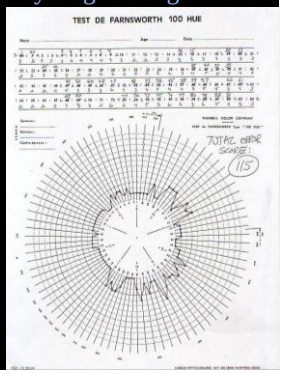
Male - 9 years old

100 Hue

Low colour discrimination



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3rd generation offspring from youngest daughter

Male - 9 years old

ICHP: deuteranopia

Anecdotal: normal / abnormal

D-15: normal

H-R-R: mild deutan

100 Hue : low colour discrimination

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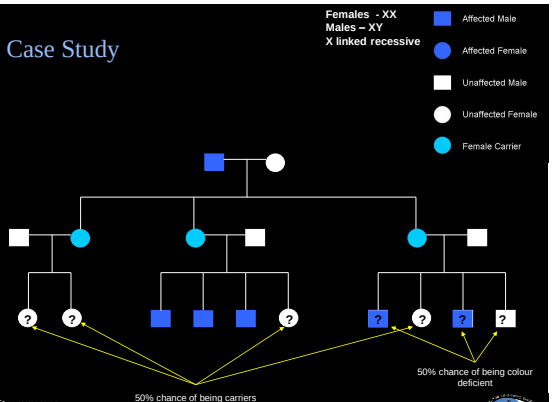
Case Study



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"This is REO the cat. He is blue"

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Colour Vision Testing

Craig Simms
BSc, COMT, CDOS, ROUB

Chief Ophthalmic Medical Technologist
Program Coordinator, KOTC
Kingston, Ontario

JCAHPO ACE Meeting 2015
Las Vegas

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