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1 **Development of the 25-item Cardiff Visual Ability**
2 **Questionnaire for Children (CVAQC)**

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38 **Key words:** Children and young people, Visual impairment, Questionnaire,
39 Rasch analysis, Intraclass correlation coefficient

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1 **Abstract**

2 **Aims:** To develop and validate a short questionnaire to assess self reported
3 visual ability in children and young people with a visual impairment.

4 **Methods:** A list of 121 items was generated from 13 focus groups with
5 children and young people with and without a visual impairment. A long 89
6 item questionnaire was piloted with 45 visually impaired children and young
7 people using face to face interviews. Rasch analysis was used to analyze the
8 response category function and to facilitate item removal ensuring a valid
9 unidimensional scale. The validity and reliability of the short questionnaire
10 were assessed on a group of 109 visually impaired children (58.7% boys;
11 median age, 13 years) using Rasch analysis and intraclass correlation
12 coefficient (ICC).

13 **Results:** The final 25-item questionnaire has good validity and reliability as
14 demonstrated by a person separation index of 2.28 and reliability coefficient of
15 0.84. The items are well targeted to the subjects with a mean difference of -
16 0.40 logit between item and person means and ICC of 0.89 demonstrate a
17 good temporal stability.

18 **Conclusion:** The CVAQC is a short, psychometrically robust, self reported
19 instrument which works to form a unidimensional scale for the assessment of
20 the visual ability in children and young people with a visual impairment.

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1 **Introduction**

2 Visual impairment early in life has profound implications in terms of reduced
3 educational, recreational and social experience in children.(1, 2) Even though
4 childhood visual impairment is less common than in adults, the associated life
5 long burden of disability is more significant in terms of number of 'blind years'
6 experience by children in their life time.(3) The extent to which visual
7 impairment limits a child's ability varies. So, it is important to measure the
8 individual's perception of their visual ability in order to understand what effect,
9 if any, interventions have on a child's functioning. In terms of low vision
10 rehabilitation, as in adults, there is a need to promote cost effective paediatric
11 low vision rehabilitation service delivery.(4) Therefore, an assessment tool is
12 needed to capture the individual self reported difficulty in performing the
13 activities that drive children's daily living and the change in difficulty
14 performing these activities after rehabilitation.(4, 5)

15 There are three questionnaires described in the literature that are aimed at
16 determining the impact of visual impairment in children. One of these is only
17 for children of 7 years and under and is aimed at determining parent's
18 perceptions of treatment for the impairing conditions (Children's Visual
19 Function Questionnaire or CVFQ).(6) One was developed with children in
20 India and so is most suited to measuring the activities of children in
21 developing countries (LV Prasad-Functional Vision Questionnaire or LVP-
22 VFQ).(7) The psychometric properties of the third, which used input from
23 specialist instructors (such as teachers, occupational therapists and
24 orientation and mobility instructors), parents and children have not been
25 described (Impact of Visual Impairment on Children or IVI-C).(8) Therefore, as

1 yet there is not a validated tool available to assess the difficulty in performing
2 the activities in children's daily lives in developed countries.

3 The measurement of quality of life and visual ability is considered as an
4 essential aspect to measure treatment and rehabilitative outcomes in eye
5 care.(4, 7) However in the past, carers and/or professionals have been asked
6 to answer on children's behalf i.e. by proxy.(6, 9) It is well documented in both
7 the adult and paediatric literature that information provided by proxy-
8 respondents is not equivalent to that reported by the patient.(9, 10) There are
9 circumstances when children are too young, too cognitively impaired, too ill or
10 fatigued to complete a paediatric questionnaire, and reliable and valid parent
11 proxy-reported instruments are appropriate in such cases.(9) The proxy
12 method may also be useful for people with multiple disabilities. Ideally,
13 information on children's opinions, attitude, and behaviour should be collected
14 directly from children, if they are cognitively able to answer the questions.(11)
15 Studies have shown that paediatric questionnaires work well if vague and
16 ambiguous wording is avoided and the number of response options is limited
17 to decrease the burden on child's visual or auditory memory.(12) Children as
18 young as 5 years old can reliably complete questionnaire when given the
19 opportunity to do so with an age-appropriate instrument.(13)

20 There is need to determine 1) the participation of children and young people
21 with a visual impairment in society and 2) change in ability outcomes following
22 interventions. The current project focussed on the second that is to design a
23 tool, which would enable change in ability to do activities that are important to
24 them to be measured.

1 The aim of this study was to develop a short, self-reported questionnaire
2 capable of measuring the visual ability of children and young people in
3 developed countries to take part in activities that matter. This questionnaire is
4 named the Cardiff Visual Ability Questionnaire for Children (CVAQC).

5

6 **Methods**

7 **Item selection**

8 To ensure content validity, 121 items were initially identified on the basis of
9 thirteen focus groups discussions (the details of the focus group study will be
10 published separately). Seven focus groups included visually impaired (VI)
11 children and six normally sighted (NS) children. All participants were aged
12 between 5 and 18 years, and there were 4 to 8 individuals in each group. The
13 inclusion criteria for VI were; children who can access print, able to converse
14 in English and with no other physical, sensory or severe cognitive impairment.
15 The question “route” had open ended questions on the activities children and
16 young people like doing, are interested in or struggle with at home, in school,
17 in the playground, with friends and socially.

18

19 Subsequently, the items generated were reviewed by the authors to look for
20 repeated ideas which represented item redundancy. Thirty two redundant
21 items were removed on this basis and so the 121 items were reduced to 89
22 items. The 89 items were then read to eight normally sighted children (aged
23 5-11) to identify item ambiguity and preferences for positive or negative
24 valencing of items. All children preferred negatively valenced items i.e. ‘how
25 difficult’ rather than ‘how easy’. Items which the children identified as

1 ambiguous or difficult to understand were rephrased. The 89 item
2 questionnaire had six response categories (*“Very easy”, “Easy”, “A little bit*
3 *difficult”, “Difficult”, “Very difficult” and “Impossible or can’t do because of my*
4 *eye sight”*) and a seventh response (*Do not do for other reason/s*) which was
5 scored as missing data.

6

7 **Piloting the 89 item questionnaire**

8 The questionnaire was piloted on a group of 49 VI children. The children were
9 identified and recruited from primary (5 to 11 years) comprehensive (12 to 18
10 years) schools, a special school for VI young people, Gwent Visual
11 Impairment Service, a football team for VI children based in South Wales and
12 Gwent Actionnaires (a community based organisation for sporting and
13 recreational opportunities for visually impaired children) . The Qualified
14 Teachers for the Visually Impaired (QTVI), the head of Gwent VI service, the
15 head of Gwent Actionnaires and the head coach of the football team were
16 involved in recruiting and obtaining written consents from all the children and
17 their legal guardians for participants below 16 years. Inclusion criteria were
18 same as that of the focus groups study. Exclusion criteria were severe visual
19 impairment (preventing access to print) and inability to communicate verbally.

20

21 All the participants were given a matching card with the response categories
22 to help them remember the response options. A different matching card with
23 smiley faces representing the six category options was also provided to those
24 who were either young or cognitively less able. Each interview was completed
25 within 20 minutes and question ordering was varied to control for a fatigue

1 effect. Habitual binocular visual acuity and contrast sensitivity were measured
2 on all participants using a Log MAR letter chart and Pelli Robson contrast
3 sensitivity chart respectively. A letter matching card was used for those
4 children who could not read.

5

6 Rasch analysis was undertaken according to the Andrich rating scale model
7 using Winsteps version 3.85.1.(14) Firstly, Rasch analysis was used to
8 identify the optimum number of response categories which participants could
9 discriminate reliably between. Secondly, Rasch analysis fit statistics were
10 used to identify any items which did not contribute to the underlying
11 unidimensional scale and therefore should be removed i.e. items which do not
12 contribute to the scale.(15) This process reduced six response categories to
13 four and 89 items to 25.

14

15 **Assessment of the validity and the reliability of the 25-item CVAQC**

16 The 25-item CVAQC was again administered in face to face interviews to a
17 separate group of visually impaired children and young people aged 5 to 18
18 years. Once again, the participants were recruited by QTVIs, the head of
19 Visual Impairment Service, the head of special school for VI young people
20 and the head of Gwent Actionnaires. Inclusion and exclusion criteria were the
21 same as in the focus groups study and the pilot study. Informed written
22 consent was obtained from parents and the participants. The interviews were
23 carried out on an appointment basis in the participants' schools. Habitual
24 binocular visual acuity and contrast sensitivity were also measured.

25

1 The reliability and validity of the 25-item CVAQC was measured using person
2 and item reliability estimates. The stability of the measure was evaluated by
3 assessing its test-retest reliability. This was measured using a group of 39
4 participants (test-retest time, 2 to 3 weeks), with the intraclass correlation
5 (ICC).(16) This data was also used to confirm the validity of collapsing
6 categories.

7

8 The Differential item functioning (DIF) shows whether the items have
9 significantly different meaning for the different groups within the study
10 population, despite possessing equal level of underlying trait (i.e. visual
11 ability) being measured. (17) DIF was assessed for primary (<11 years)
12 versus secondary (>12 years). DIF is small or absent if the difference in item
13 measure is <0.50 Logit, minimal if 0.50 to 1.00 Logit and notable if >1.00
14 Logit. (18)

15

16 All the procedures adhered to the tenets of the Declaration of Helsinki and
17 ethical approval was obtained separately for the focus groups, pilot and the
18 main study for validity assessment from the School Human Research Ethical
19 Committee at Cardiff University.

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1 **Results:**

2 **The 89-items questionnaire**

3 The 89-item questionnaire was administered in face to face interviews to 49
4 visually impaired children and young people. Four questionnaires were
5 excluded from analysis because more than 33% of the questions were
6 incomplete and were considered unreliable.(19) Therefore, 45 questionnaires
7 (67% boys; median age 13 years; range, 5-18 years) were included for the
8 final analysis. Habitual binocular visual acuity ranged from Log MAR 0.30
9 (6/12) to 1.64 (6/240) and logarithmic contrast sensitivity of 1.85 to 0.05.

10

11 ***Response scale analysis***

12 Category diagnostic statistics identified that all the six response categories
13 were ordered, indicating that each category had a distinct probability of being
14 selected (Fig 1a). However, during the interview, it was evident that
15 participants struggled to remember all the six categories. Furthermore, the
16 end category "impossible" was only selected in 2% of total answers. An
17 underutilized category compromises the precision of threshold estimates;
18 therefore category 6 was merged with category 5 (very difficult).(20)

19

20 Category 3 (a little bit difficult) and 4 (difficult) were separated by less than
21 half the recommended normal separation value of 1.4 logit.(17) In terms of
22 average patient measures these two categories occupy a limited range of the
23 scale for maximum probability of selection.(21) Therefore, categories 3 and 4
24 were also merged together. The combined four response category option
25 improved structure calibration and category utilization (Figure 1b).(20) The

1 new four response categories were worded as *Very easy, Easy, Difficult and*
2 *Very difficult.*

3

4 ***Person and item estimates***

5 In Figure 2 the spread of each item calibration is visualized compared with
6 the range of person ability estimates. Winsteps provides statistics to describe
7 the precision of these estimates. The root mean square error (RMSE) over all
8 the items is 0.27. The high item separation reliability coefficient 3.13 of the
9 items indicates the stability of the item estimates. Winsteps also provides a
10 statistic called the person separation reliability coefficient which describes the
11 reliability of person ordering and is similar to the conventional Cronbach
12 alpha coefficient. It is 0.94 for this sample. The person separation ratio
13 (signal-to-noise ratio) was 3.90, which is greater than the recommended
14 value of 2.(15)

15

16 ***Item reduction***

17 To improve measurement validity, Rasch analysis was used to identify items
18 which misfit the Rasch model. Removal of items was principally driven by fit
19 statistics (infit and outfit), which estimates the extent to which responses show
20 adherence and compatibility with the Rasch model expectations.(22) Items
21 fitting perfectly to the unidimensional scale have an expected infit or outfit
22 statistic of 1 and their value can range from zero to infinity.(23, 24) The
23 standard cut-off range is from 0.7 to 1.3.(14) Items were considered for
24 removal from the scale which fulfilled the highest number of candidate criteria
25 in order of priority as proposed by Pesudovs (2003) (15, 19, 24); 1: infit mean

1 square outside 0.80 to 1.20, 2: outfit mean square outside 0.70 to 1.30, 3:
2 item with mean furthest from the subject mean, 4: high proportion of missing
3 data (> 50%), 5: ceiling effect (>50% in end category) and 6: skew and
4 kurtosis outside -2.00 to + 2.00.

5
6 Skew (symmetry of a distribution) and kurtosis (peakedness or flatness of a
7 distribution) values indicate the measurement of normality of a data
8 distribution. If the skew and kurtosis values of items are outside the normal
9 range then those items do not contribute to the unidimensionality of the scale.
10 Hence, the items should be removed.

11
12 Items were removed until the scale provided good fit values, with no significant
13 missing data or ceiling effect and good person separation (>2.00). This
14 procedure reduced the scale to 37 items. During the interview, it was
15 observed that many of the participants either lost their interest or got bored
16 after 24 or 25 questions. Therefore, the number of items was reduced to 24
17 items by further modifying Pesudovs's criteria. The three added criteria were:
18 1:Missing data (>25%), 2:High item redundancy i.e. 3 or more items at the
19 same level on persons items map which signifies items having the same level
20 of difficulty and measure and 3: redundant items furthest from the subject
21 mean

22
23 To ascertain that the final instrument covered all the important areas guided
24 by the focus groups, the authors reviewed the items and focus group results
25 again. As a result, item 3 "*chatting with your friends*," which was removed

1 before due to high kurtosis value (>2.00) was brought back into the scale. The
2 remaining 25 items instrument had good measurement precision denoted by
3 high person and item separation reliability coefficients, 0.82 and 0.94
4 respectively and the real person and item separation, 2.10 and 4.11
5 respectively. The 25 items were regrouped according to the face validity into
6 7 subscales (identified in Table 1).

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- 1 **Table 1:** Descriptive statistics, Rasch fit statistics and rating of difficulty for the 25-
 2 item, 4 –response category questionnaire (*Very easy, easy, difficult and very*
 3 *difficult*). Items with highest negative item measure are the most difficult items.

Items	Skew	Kurtosis	MnSq Infit (ZSTD)	MnSq Outfit (ZSTD)	Item measure (SE)
Because of your eye sight and with your glasses or low vision aids of you use them how difficult do you find...					
Subscale 1 :Education					
1. your maths lessons?	0.412	0.137	0.93(-0.50)	0.94(-0.40)	0.33(0.14)
2. your science lessons?	0.117	-0.167	0.78(-1.80)	0.79(-1.70)	-0.25(0.14)
3. your geography lessons?	0.173	-0.497	0.98(-0.10)	0.96(-0.20)	-0.86(0.17)
4. your language lessons?	0.388	-0.054	1.08(0.60)	1.09(0.70)	0.06(0.14)
Subscale 2: Near vision					
5. reading textbooks and work sheets that are given in your school?	0.237	-0.435	1.02(0.20)	0.99(0.00)	-0.19(0.13)
6. reading the smallest print in your text book?	-1.062	0.299	1.25(1.80)	1.23(1.50)	-2.18(1.50)
7. drawing, colouring or painting?	0.538	-0.355	1.19(1.40)	1.17(1.30)	0.77(0.14)
8. reading text messages on your mobile phone?	0.325	-0.470	1.17(1.20)	1.15(1.00)	0.10(1.50)
9. reading restaurant menus?	0.172	-0.782	0.95(-0.30)	0.99(0.00)	-0.79(0.15)
Subscale 3: Distance vision					
10. reading the board in your class room?	0.004	-1.002	1.41(3.00)	1.38(2.80)	-0.76(0.13)
11. watching television?	0.895	0.574	1.02(0.20)	1.00(0.10)	1.30(0.16)
12. watching a film at the cinema?	1.273	1.156	1.22(1.50)	1.12(0.80)	1.45(0.16)
Subscale 4: Getting around					
13. going out alone in the daylight?	0.278	-0.283	1.03(0.30)	1.04(0.40)	0.42(0.14)
14. walking in a crowded place?	-0.296	-0.306	0.76(-2.10)	0.77(-2.00)	-0.78(0.13)
15. using public transport (bus/train)?	0.148	-0.410	0.80(-1.40)	0.81(-1.30)	-0.02(0.15)
16. reading bus/train time table on a screen at a station?	-0.923	0.277	0.91(-0.50)	0.86(-0.80)	-1.90(0.17)
Subscale 5: Social Interaction					
17. chatting with your friends?	0.998	1.033	1.02(0.20)	0.95(-0.30)	1.69(0.17)
18. recognising faces or identifying your friends at arms length?	0.577	0.461	0.76(-1.90)	0.75(-2.00)	0.70(0.14)
19. seeing your friend in a playground?	-0.976	0.032	0.78(-2.00)	0.80(-1.70)	-1.06(0.13)
Subscale 6: Entertainment					
20. playing video games e.g. a playstation?	0.343	-0.784	0.84(-1.20)	0.83(-1.20)	1.04(0.16)
21. playing computer games?	0.588	0.104	0.86(-1.00)	0.83(-1.20)	0.49(0.15)
22. using IPOD/ MP3/MP4 to listen to music?	0.436	0.083	1.03(0.30)	1.03(0.30)	0.65(0.15)
Subscale 7: Sports					
23. swimming?	0.697	-0.004	1.15(1.00)	1.08(0.60)	0.76(0.15)
24. taking part in athletics?	0.382	-0.510	0.98(-0.10)	0.96(-0.30)	-0.15(0.14)
25. playing ball games?	-0.204	-0.678	1.18(1.40)	1.19(1.50)	-0.81(0.14)

1 ***Assessment of the validity and the reliability of the 25-item CVAQC***

2 The shortened CVAQC was completed by an additional 110 visually impaired
3 children and young people (58.2% boys; median age, 13; range 5-18 years).
4 Participants habitual binocular visual acuity ranged from Log MAR 0.1 (6/7.5)
5 to 1.90 (6/480) and contrast sensitivity from Log contrast sensitivity 2.00 to
6 0.05. The average length of time for each appointment was 10 minutes. This
7 included collecting personal details, measuring visual acuity and contrast
8 sensitivity, reading the instructions and asking the 25 questions.

9

10 Questionnaires are invalidated if they had more than 33% missing data. This
11 applied to only one subject, who was aged 5. The subject was excluded from
12 the analysis leaving 109 questionnaires.

13

14 Rasch analysis identified that all 25 items had good fit statistics denoted by
15 infit and outfit values <1.5 as recommended by Linacre (14) and skew and
16 kurtosis values within normal limits (Table 1). The items were well targeted to
17 the subjects with a mean difference of -0.40 Logits (Figure 3). Items located
18 at the top of the map, e.g., Q17 *“chatting with your friends,”* discriminate
19 between those people who are less able. Conversely, items located at the
20 bottom of the map, e.g., Q16 *“reading a bus or train time table on a screen at*
21 *a station,”* is high level ability discriminating items (Figure 3).

22

23 The shorter instrument also has high measurement precision (person
24 separation 2.28, reliability 0.84 and item separation 6.20, and reliability 0.97).

25 The results also confirmed ordered structure threshold calibration and good

1 utilization of the four categories. In other words, the four category solution
2 allows reliable discrimination of visual ability in children.

3

4 Test-retest was good when tested on 39 participants (61.5% male; median
5 age 12 years); ICC of 0.89 for persons (95% CI: 0.80 - 0.94) and 0.94 for
6 items (95% CI, 0.87 – 0.97). None of the 25 items showed notable DIF by
7 age. Four items showed minimal DIF by age: “item 10, reading the board”
8 (0.92), “item 12, watching film ” (0.59), “item 21, playing computer games
9 (0.54), “Q25 playing ball games” (0.60). Reading the board (item 10) and
10 playing ball games (item 25) were rated difficult by older participants (>12
11 years) where as watching film (item 12) and playing computer games (item
12 21) were rated difficult by younger participants (<11 years) relative to other
13 tasks.

14

15 **Discussion**

16 The 25-item CVAQC is a valid and a reliable instrument which was developed
17 using Rasch analysis to ensure good content validity, construct validity and
18 temporal stability. The item selection was based on the information provided
19 by the focus groups with children and young people. This means that the
20 instrument is highly relevant to this population focusing on the most important
21 activities both in and out of school.

22

23 Offering the clearest type of response options produces the best quality in
24 questionnaire research with children. Hence, category collapsing was carried
25 out in such a way that the resulting scale becomes “sensible.” (25) The four

1 response categories are likely to be a good compromise between stability and
2 response burden. The reanalysis of the data with four response options
3 increased the person and item reliability and the targeting of 89 items to
4 subjects. Further testing the four response category options with an additional
5 109 subjects and 39 test-retest subjects showed good utilization of all the
6 categories. It confirms that four response category options to measure visual
7 ability in children are consistent and optimum. The response scale collapsing
8 and item reduction also brought the two means close enough to signify
9 improved item targeting.

10

11 The initial 89-item version was too long, signifying a huge respondent burden.

12 Items were removed using standard criteria primarily based on infit and outfit

13 Rasch statistics proposed by Pesudovs 2003.(15, 19, 22, 24) Unlike

14 Pesudov's criteria of 50% missing data, items with more than 25% missing

15 data and high redundancy were also removed to reach the final 25-item

16 questionnaire. It is not necessary to delete, all misfitting items or items not

17 satisfying the Pseudov's criteria but reducing the number while retaining good

18 measurement properties is key in questionnaire development.(22) In

19 instrument development, the minimum number of items needed are used to

20 measure a domain. while maintaining acceptable reliability and separation

21 ratio to ensure test quality.(24) Therefore the removal of items was stopped

22 when the separation ratio was nearing an unacceptable value (i.e < 2.00).

23

24 The 25-item instrument administered to 109 subjects showed that items

25 3,9,10, 14 and 25 (Figure 3) measured the same level of visual ability. Few of

26 these items could be removed to shorten the instrument and decrease the

1 administration time and response burden. However, when the 25-item
 2 instrument can be administered in a reasonable time period valuable
 3 information would be lost if significant items were eliminated.(4)

4
 5 Table 2: Comparing the features of the CVAQC with the other three
 6 questionnaires

Description	CVAQC	IVI-C(8)	LVP-VFQ(7)	CVFQ(6)
Age range	5-18 years	8-18 years	8-18 years	Up to 7 years
Basis of items development	Focus groups with children (VI and normally sighted)	Focus groups with VI children, parents, teachers and support providers	Literature review and focus groups with VI children, parents and support providers	Clinical experience and literature review
Population most suited to	Children in developed countries		Children in developing countries	
Self reported/Proxy	Self-reported	Not published	Self-reported	Proxy
Psychometric properties	Rasch analysis	Not published	Rasch analysis	Rasch analysis not used
Concept being measured	Visual ability	Vision related Quality of Life	Visual function	Vision related Quality of Life

7
 8 The parent proxy-report like CVFQ which was designed for use with children
 9 up to 7 years can be useful when children are unable or unwilling to provide
 10 self report. However, CVFQ was developed to assess competence,
 11 personality, family impact and treatment difficulty imposed by specific eye
 12 diseases rather than an overall visual ability measurement.(26) The CVAQC
 13 on the other hand, is designed to examine visual ability in terms of the
 14 children's perceived ability to perform vision specific tasks, such as using
 15 mobile phones and reading menus. It is suitable for the assessment of
 16 interventions such as the provision of low vision aids. The two types of
 17 instrument may be complementary, each appropriate for a particular purpose.

1 The LVP-VFQ is aimed at assessing general visual functioning with items
2 such as walking home at night, locating a ball and threading a needle. It was
3 developed with children in India and hence will be the instrument for use with
4 children in developing countries (Table 2). The CVAQC in other hand has
5 robust psychometric properties when compared with LVP-VFQ. The good
6 separation indices of the CVAQC make it more discriminating than LVP-VFQ.
7 Similarly, good fit statistics of all the 25 items of CVAQC indicate that it has
8 less noise while measuring visual ability. In addition the CVAQC measures
9 visual ability in terms of activities important to the children. The LVP-VFQ,
10 while appropriate as a measure of functional vision in the developing world
11 may be less applicable to children in developed countries such as the UK.

12
13 All the participants in the focus groups and the pilot study were 'white British'.
14 Two out of 110 pupils in the validity and reliability study were from ethnic
15 minority groups, Asian Pakistani and Black African. The small number of
16 children from ethnic minority groups in this study reflects the low prevalence
17 of ethnic minority groups in Wales (2.1% of total population in Wales are non
18 white). (27) We do not know the socioeconomic background of the
19 participants but all the participants were studying in state funded primary and
20 comprehensive schools and all the children with a VI in each school, Visual
21 Impairment Service, football team for visually impaired and Gwent
22 Actionnaires were recruited and none declined. There were three children with
23 multiple disabilities (2 with cerebral palsy and 1 Aspergers syndrome) in the
24 pilot study. In the validation and reliability study, four children had multiple
25 disabilities (1 with Down's syndrome, 2 with Say Field Coldwell syndrome and
26 1 with Stickler syndrome). There was no problem administering the

1 questionnaire to any participants as they were all able to communicate
2 verbally in English.

3

4 Every effort was made to include younger children through out the study, for
5 example separate focus groups were conducted with younger children (5-7
6 years) during the development of the questionnaire. There was no any
7 concern about the missing data across the study population (i.e. only those
8 with low missing data <25% were included). There was no evidence of
9 notable differential item functioning between primary and secondary school
10 participants. However, the sample size for younger children (<7 years) was
11 too small to separately assess DIF, reliability and validity of the tool in this age
12 group. This is an area that needs further investigation.

13

14 In conclusion, the 25-item CVAQC is a reliable and a valid measure of visual
15 ability in visually impaired children and young people. Because it uses items
16 representing activities important to children across the age range, it may
17 prove useful to those wishing to characterise the nature and degree of the
18 difficulties that visually impaired children experience in everyday life.

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1 **Figures Legends**

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4 **Figure 1a:** Category probability curves for the six response categories. Cat. 1
5 = Very easy, Cat. 2 = Easy, Cat. 3 = A little bit difficult, Cat. 4 = Difficult, Cat. 5
6 = Very difficult and Cat.6 = Impossible.

7

8 **Figure 1b:** Category probability curves showing the operation of the four
9 response option (after category 6 was merged with category 5 and category 3
10 with 4). Cat. 1 = Very easy, Cat. 2 = Easy, Cat. 3 = Difficult and Cat. 4 = Very
11 difficult.

12

13

14 **Figure 2:** Person visual ability and item difficulty map or scale for the 89-item
15 and 4 categories CVAQC. The subjects are represented by “x” on left of the
16 scale and items (questions) are represented by Q followed by the item
17 number on the right of the scale. The more difficult items are placed near the
18 bottom of the scale. The more visually able subjects are near the bottom of
19 the scale and less visually able are at the top. M = mean, S = 1 standard
20 deviation from the mean, T = 2 standard deviations from the mean. The M, S
21 and T are shown for the children and the items i.e. on either side of the
22 dashed line.

23

24 **Figure 3:** Person item map for 25-item and 4 categories CVAQC. Items are
25 denoted by Q followed by item number shown on right. Two people are
26 represented by “#” on left of the dashed line. The sample population shows
27 excellent targeting of items to subjects i.e. the subjects and the questions
28 overlap well on the scale. The M, S and T are shown for the children and the
29 items i.e. on either side of the dashed line.

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12 Competing Interest: None declared



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14 Dr. J. Margaret Woodhouse

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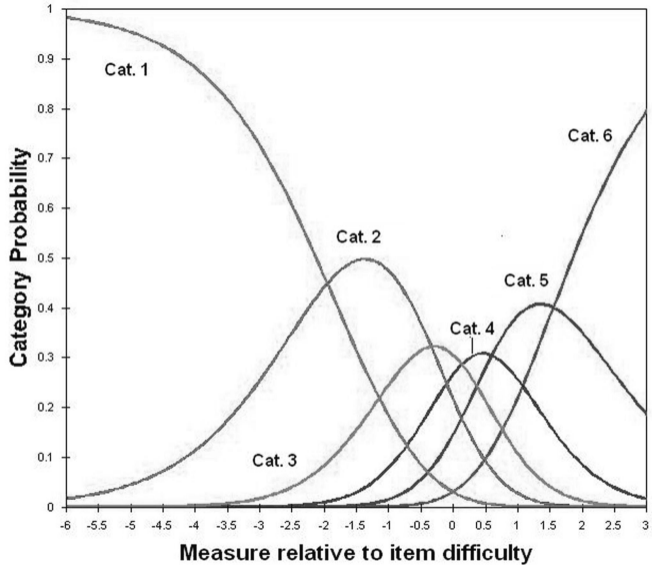
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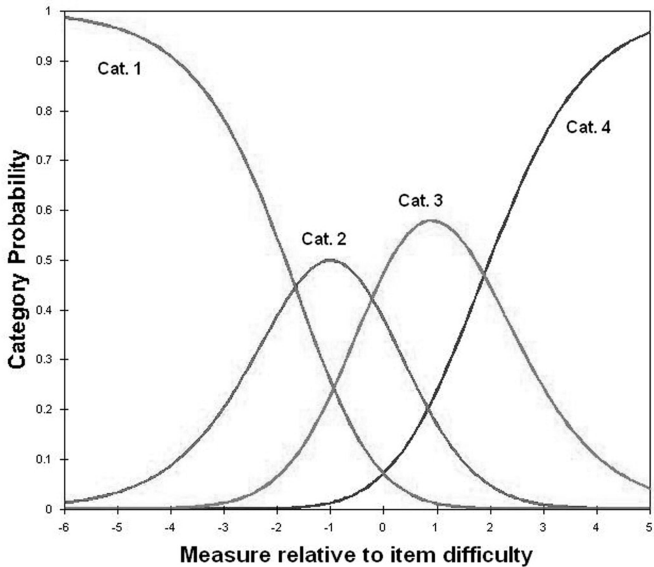
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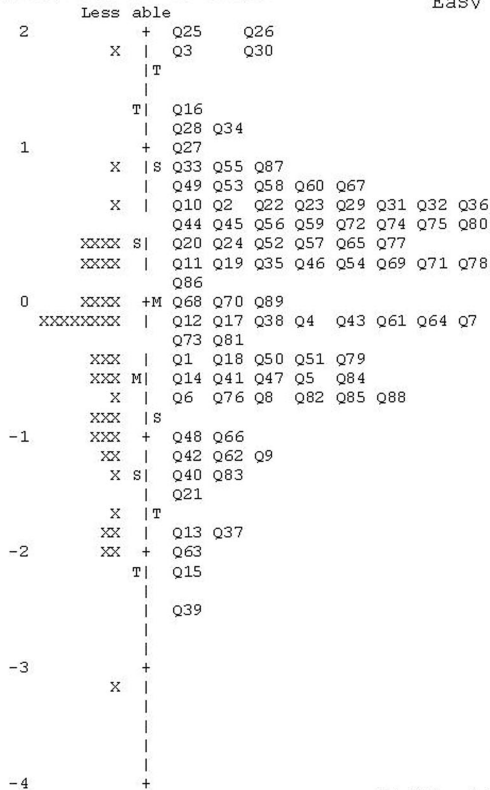
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PERSONS MAP OF 89 ITEMS

Easy items



Difficult items

PERSONS MAP OF 25 ITEMS

