Research Summary for Brain Injury Vision Symptom Survey: (BIVSS) COMPARISON DATA AND RASCH ANALYSIS

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ABSTRACT

The Brain Injury Vision Symptom Survey (BIVSS-28) is a 28-item scaled survey designed to query vision behaviors related to: clarity, comfort, diplopia, depth perception, dry-eye, peripheral vision, & reading with individuals who have suffered mild-to-moderate traumatic brain injury (TBI).

Anonymous BIVSS data were analyzed from 238 individuals (81 with TBI; 157 non-TBI). TBI results significantly differed from non-TBIs. A raw BIVSS-28 score of >31 was determined as discriminative of a significant visual problem for the 28-question survey. BIVSS-28 sensitivity & specificity were both 84%.

TBI completion success:
- 93.5% of TBI subjects able to complete at least 27 questions.

Non-TBI completion success:
- 100% of subjects able to complete all 28 questions.

Rasch analysis identified 10 of the 28-questions as either redundant or as misfit. ROC analysis was used to balance sensitivity (83%) and specificity (83%) for the reduced set of 18-questions. For the 18-question reduced set (BIVSS-18), a raw score of >18 was determined as discriminative of a significant vision problem.

Whereas Univariate Rasch Analysis assumes only a single factor, Factor Analysis of the 28-item responses suggested up to 5-underlying dimensions potentially.

SUBJECTS & METHODS

-Anonymous BIVSS-28 data were obtained from:
21 active duty soldiers with TBI, and 60 TBI patients who either participated in a support group or were patients of optometrists who attended the 2013 NORA or COVD meetings. Control subjects were 157 non-TBI (self-reported) optometry students who completed BIVSS questionnaires from two different classes. The controls included 86-1st year students (newly matriculated) and 71-3rd year students (1-week prior to NBEO examinations).

BIVSS questionnaire (28-item full-length)

Pacific University Institutional Review Board FWA: 00007392 | IRB: 00004173 Registered: 04/19/2013 Registration Expires: 04/19/2018

☐ I have had a medical diagnosis of brain injury (check box if true). My brain injury was: ____ years ago
☐ I suffered a brain injury without medical diagnosis (check box if true)
☐ I have NOT had a previous brain injury (check box if true)
your age _____ today's date: _____ your zip code: _____

Please check the most appropriate box, or circle the item number that best matches your observations. All information will be held in confidence. Thank you for your help!

SYMPTOM CHECKLIST — *Circle a number below:*

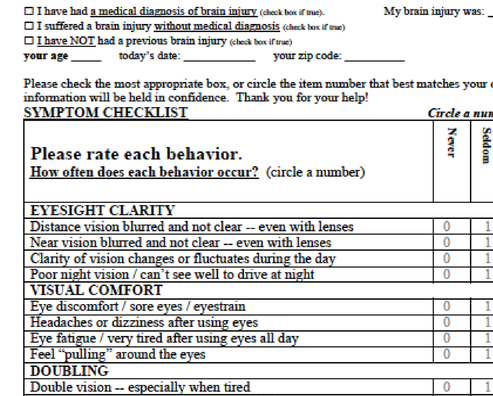
Please rate each behavior. How often does each behavior occur? (circle a number)	Never	Seldom	Occasionally	Frequently	Always
EYESIGHT CLARITY					
Distance vision blurred and not clear -- even with lenses	0	1	2	3	4
Near vision blurred and not clear -- even with lenses	0	1	2	3	4
Clarity of vision changes or fluctuates during the day	0	1	2	3	4
Poor night vision / can't see well to drive at night	0	1	2	3	4
VISUAL COMFORT					
Eye discomfort / sore eyes / eyestrain	0	1	2	3	4
Headaches or dizziness after using eyes	0	1	2	3	4
Eye fatigue / very tired after using eyes all day	0	1	2	3	4
Feel "pulling" around the eyes	0	1	2	3	4
DOUBLING					
Double vision -- especially when tired	0	1	2	3	4
Have to close or cover one eye to see clearly	0	1	2	3	4
Print moves in and out of focus when reading	0	1	2	3	4
LIGHT SENSITIVITY					
Normal indoor lighting is uncomfortable – too much glare	0	1	2	3	4
Outdoor light too bright – have to use sunglasses	0	1	2	3	4
Indoors fluorescent lighting is bothersome or annoying	0	1	2	3	4
DRY EYES					
Eyes feel "dry" and sting	0	1	2	3	4
"Stare" into space without blinking	0	1	2	3	4
Have to rub the eyes a lot	0	1	2	3	4
DEPTH PERCEPTION					
Clumsiness / misjudge where objects really are	0	1	2	3	4
Lack of confidence walking / missing steps / stumbling	0	1	2	3	4
Poor handwriting (spacing, size, legibility)	0	1	2	3	4
PERIPHERAL VISION					
Side vision distorted / objects move or change position	0	1	2	3	4
What looks straight ahead--isn't always straight ahead	0	1	2	3	4
Avoid crowds / can't tolerate "visually-busy" places	0	1	2	3	4
READING					
Short attention span / easily distracted when reading	0	1	2	3	4
Difficulty / slowness with reading and writing	0	1	2	3	4
Poor reading comprehension / can't remember what was read	0	1	2	3	4
Confusion of words / skip words during reading	0	1	2	3	4
Lose place / have to use finger not to lose place when reading	0	1	2	3	4

IIIVSS_06/12 version

ANOVA, Rasch Analysis, non-parametric, & logistic regression were used to analyze questionnaire results.

RESULTS

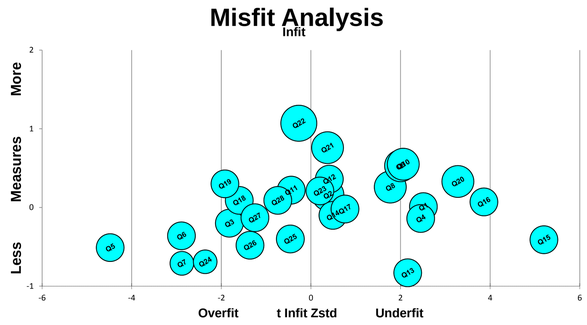
Raw Score Sums of 28 BIVSS Questions



- Boxes represent the 25th to 75th percentiles. Bars in the center are the medians.
- Little overlap between TBI patients (soldiers and non-soldiers) and normal non-TBI optometry students.
- Overall non-parametric Kruskal Wallis comparison of 4 distributions was significant, p<.001.
- 3rd years had a significantly different distributions than the 1st year optometry students (p=.035, Wilcoxon), but the median test was not significant between the two groups (p=.10).

RESULTS (cont)

Misfit Analysis



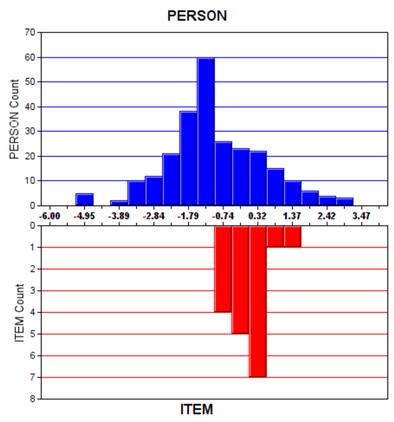
Rasch Analysis

- The 28 item scale had a person separation score 3.35 with reliability =.92 and item separation 5.72 with reliability = .97.
- 10 items were removed from the original scale that exceeded a stricter standardized z > 2 to reveal a single dimension scale with item separation = 6.50 and a person separation of 2.94.

Final 18 questions

- *Clarity of vision changes/fluctuates during day*
- *Eye discomfort / sore eyes / eyestrain*
- *Headaches or dizziness after using eyes*
- *Eye fatigue / very tired after using eyes all day*
- *Feel "pulling" around the eyes*
- *Print moves in and out of focus when reading*
- *Normal indoor lighting is uncomfortable – too much glare*
- *Indoor fluorescent light bothersome/annoying*
- *Clumsiness / misjudge where objects really are*
- *Lack of confidence walking / missing steps / stumbling*
- *Side vision distorted / objects move/change position*
- *What looks straight ahead--isn't always straight ahead*
- *Avoid crowds/can't tolerate "visually-busy"*
- *Short attention span / easily distracted reading*
- *Difficulty / slowness with reading and writing*
- *Poor reading comprehension / can't remember what was read*
- *Confusion of words / skip words during reading*
- *Lose place / have to use finger not to lose place when reading*

Rasch analysis item & person distributions



- The 18 item questionnaire had a person separation of 3.08, reliability =.9 and an item separation of 6.86, reliability = .98.
- The Rasch analysis revealed a single dimension scale comprised of 18 items.
- Rasch analysis assumes questions/items fall along the dimension. The red histogram shows the distribution of questions on this dimension.
- The blue histogram shows the distribution of people across the dimension. People on the left have few symptoms and people on the right have more severe symptoms.
- The scale is centered at the middle of the item distribution.
- The area where red and blue distributions overlap shows the highest point of scale discrimination.
- The scale does not discriminate between people with lower levels of symptoms.

Logistic Model

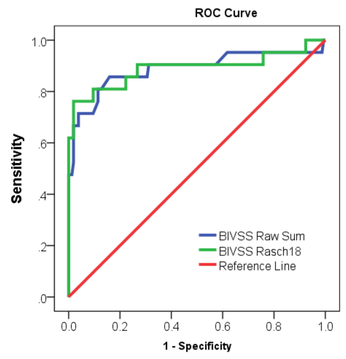
- Predicting TBI as a function of the 18 item Rasch scale with logistic regression.

	B	S.E.
Rasch	.19	.024
Constant	3.074	.516

- p(TBI) = .5 = -Constant/B
  = -3.074/.19= -16.2
- Rasch 18 item scale cutoff for TBI > 16.2
- The Rasch model was able to correctly assign 88% of the people to the correct categories.
- BIVSS Raw sum cutoff for TBI > -(-5.79)/.11 3 > 51 and correctly categorized 94% of TBIs.

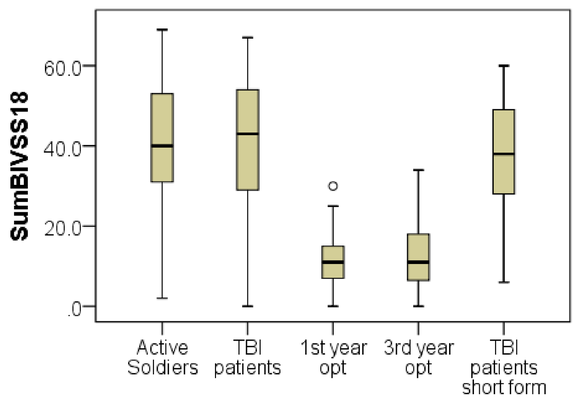
RESULTS (cont)

Relationship between the Rasch measure and the raw sum of the 18 question scale



- ROC curve illustrates that Rasch and Total Sum of Raw Scores, yields virtually identical results.
- Balancing both sensitivity and specificity to approximately 83% is accomplished with >18-point total sum cutoff for the BIVSS-18 version.
- The BIVSS-28 item scale has matching 84% sensitivity and specificity with a cutoff score >31.
- There is little to gain using the longer scale when the difference is between TBI & non-TBI subjects.

Group Comparison for Total Sum of BIVSS



18 Item test

- The overall Kruskal Wallis non-parametric test was significant (p<.001).
- The Wilcoxon (distributions) test was not significant between optometry groups (p=.13).
- The mean for the 3rd years was not significantly different from the first year optometry students (13.0, 6.3SD, 11.2, 6.3SD respectively, t=1.54, p=.13), Effect size = .24 SD, a small effect.

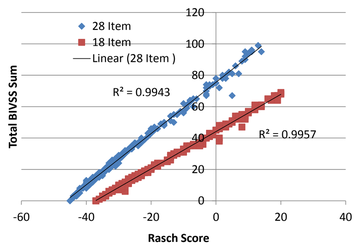
28 Item test

- The overall Kruskal Wallis non-parametric test was significant (p<.001).
- The Wilcoxon was significant between optometry students (p=.03).
- The mean for the 3rd years was higher than the first year optometry students (23.0, 12.8SD, 18.2, 9.4 SD respectively, t=2.69, p=.008), Effect size = .43 SD, a small to medium effect.
- The 28 item test was better at differentiating normal groups with heightened stress.

Consideration of questions not included in the Rasch Primary Dimension

- Backward conditional stepwise logistic regression revealed 8 of the 10 questions contributed independently to discriminating between 1st and 3rd year students.
- A non-parametric median test between 1st and 3rd year was significant for the sum of all 10 questions (p<.006) and for the sum of the 8 significant questions (p<.005).
- Items that were significant predictors of optometry class:
  - *Distance vision blurred not clear -- even with lenses*
  - *Near vision blurred not clear -- even with lenses*
  - *Poor night vision/can't see well drive at night (p=.076)*
  - *Double vision -- especially when tired*
  - *Eyes feel "dry" and sting*
  - *"Stare" into space without blinking*
  - *Have to rub the eyes a lot*
  - *Poor handwriting (spacing, size, legibility)*
- Not significant:
  - *Have to close or cover one eye to see clearly*
  - *Outdoor light too bright – have to use sunglasses*
- The rejected questions are multidimensional and do a better job discriminating at the lower end of the symptom scale.

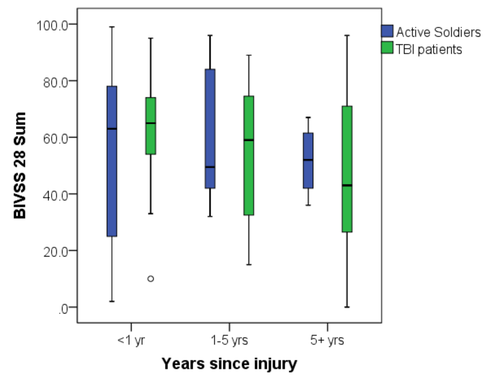
BIVSS Total Sum of Raw Scores is linearly related to the Rasch Scores



- The Rasch and Total Raw Sum are linearly related and can be used interchangeably.
- The total raw score is easier to compute, but an Excel scoring algorithm worksheet is available on request.

RESULTS (cont)

BIVSS score as a function of years since injury



- BIVSS scores were evaluated in a number of ways and none revealed a significant effect.
- There was no significant relationship between total BIVSS score or Rasch score for the 18 or 28-item scales whether or not one adjusted for age.
- Similarly categorizing the age to reveal a nonlinear relationship was also not significant. ANOVA-evaluation of relationship by group yielded no significant group differences, years since injury, or an interaction.

CONCLUSIONS

Nearly all individuals who had sustained mild-to-moderate TBI were able to self-complete the BIVSS questionnaire.

There was significant mean score separation between TBI & non-TBI groups (on both 28 & 18-item versions).
- No differences between soldier vs. non-soldier TBI groups.
- No differences between 1st vs. 3rd year non-TBI optometry students on the 18-item BIVSS; but the student groups differed on 28-item BIVSS questionnaire scores.
  - 8/10 questions on the BIVSS-28, but not included on the abbreviated BIVSS-18, contributed to discriminating 1st vs. 3rd year non-TBI optometry student groups.

BIVSS raw scores mirror Rasch computed scores, so use of raw scores may be clinically appropriate.

Specificity = 83% / sensitivity = 83%
The 18-item version is better at discrimination with higher total scores, but less so with lower raw score totals.
- Most likely to miss TBIs with low-level symptoms.

The cutoff scores (indicating a significant vision problem) were 31 & 18 (for the full 28-item BIVSS & the 18-item reduced set, respectively).

Rasch analysis assumes that a single dimension drives the responses to all of the questions. Factor analysis of the 28-item BIVSS results suggested multiple underlying factors may have contributed.
- To confirm, a larger BIVSS TBI database is needed.

BIVSS scores appear to trend downward as a function of time since the brain injury, but the relationship is not significant.

Future research with the BIVSS is planned.

DISCLAIMER

- The BIVSS appears to have a very clear association with TBI, but it is not diagnostic. There are other vision problems that may score high on the BIVSS.
- We use the sum of the BIVSS as a convenient scoring method for clinicians after including questions based on Rasch analysis.

ACKNOWLEDGEMENTS

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