Return to Driving After Traumatic Brain Injury

Tom Novack, Ph.D.

What's the Big Deal About Driving?

- Essential to independence in most areas of our country
- Necessary for employment in most areas
- An activity that was performed before injury
- Cognitive deficits associated with TBI can impair driving
- Recommendations concerning a return to driving should be in the purview of rehabilitation

Cognitive Abilities Impacting Driving Capacity

- Reaction time
- Attention skills (distractibility)
- Visual scanning
- Visuoperceptual skills
- Visuomotor ability
- Judgment

The Disabled Driver: An Unmet Challenge

Pidikiti RD, Novack TA. Archives of Physical Medicine and Rehabilitation 1991; 72: 109-111.

Guidelines for Return to Driving

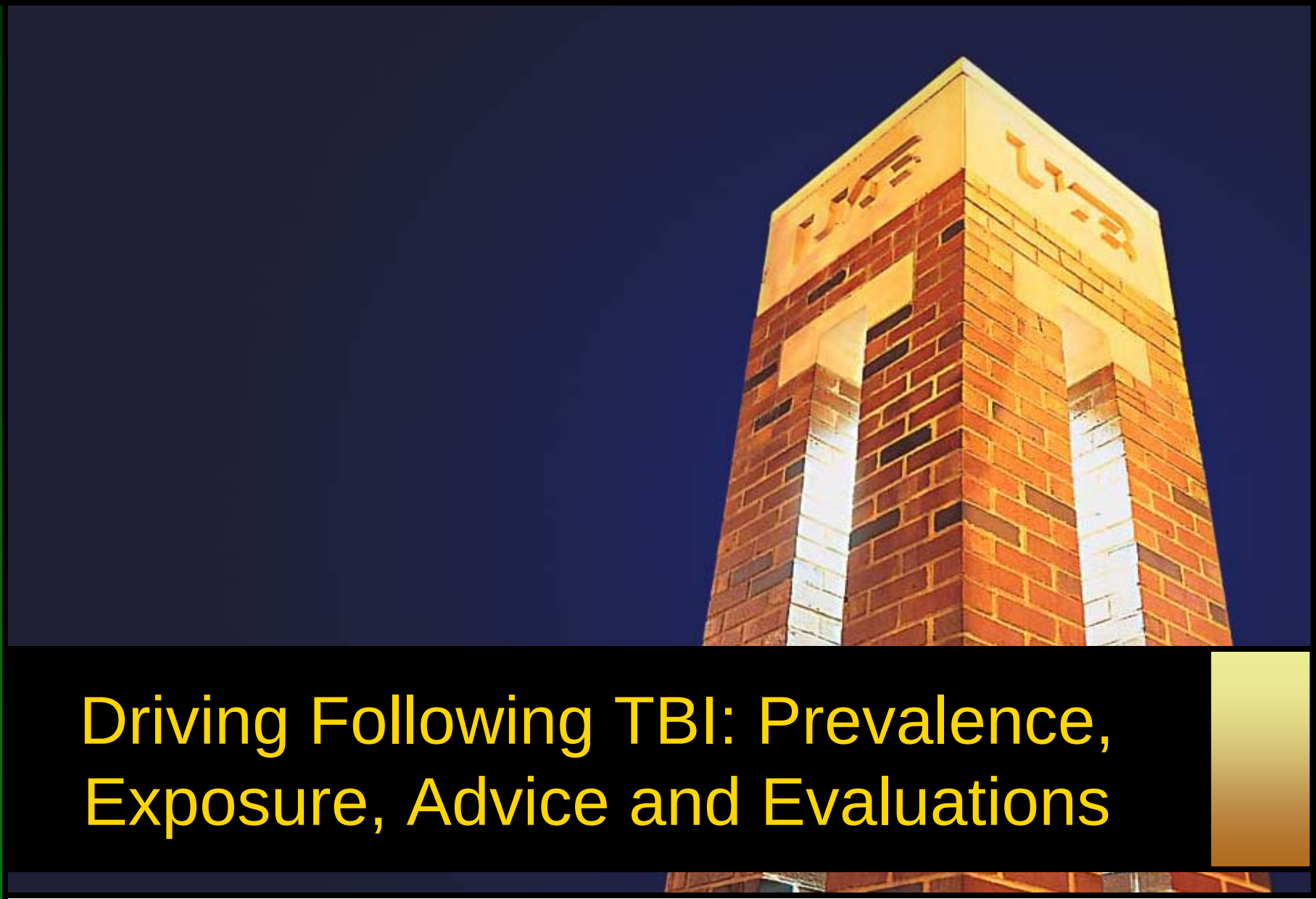
Pidikiti & Novack (1991)

- 35 states required voluntary re-evaluation following a disabling injury
- 15 states authorized reporting of impaired drivers, but only 7 required such reporting
- Clerks in licensing bureaus were not aware of reporting guidelines

Guidelines for Return to Driving

Pidikiti & Novack (1991)

- Of 35 people surveyed following TBI, none had been re-evaluated although 60% had returned to driving
- Of 100 rehabilitation centers surveyed only 36 provided on-site driver training and assessment



Driving Following TBI: Prevalence, Exposure, Advice and Evaluations

Fisk GD, Schneider JJ, Novack TA. Brain Injury 1998; 12: 683-695.

Driving After TBI

Fisk, Schneider, & Novack (1998)

- Survey of 384 TBI survivors treated at SRC from 1990-1995
- 83 respondents (21.6%)
- Average duration of 3.3 years since injury
- Average age of 33 (range 16 – 81)
- 69% male
- 74% had experienced severe TBI based on GCS score (when available)

Driving After TBI

- 60% returned to driving after TBI
- Most of these (64%) were driving 7 days a week
- Distances driven varied widely
- Correlation with rehab FIM scores and GCS scores was insignificant

Driving After TBI

- 82% received advice about returning to driving from family members or health care providers
- 63% of those driving received no evaluation of driving abilities after the TBI

Useful Field of View After Traumatic Brain Injury

Fisk GD, Novack TA, Mennemeier M, Roenker D. Journal of Head Trauma Rehabilitation 2002; 17: 16-25.

Evaluating Driving Capacity

- On-the-road assessment
- Simulator assessment
- Cognitive assessment
- Medical assessment
- No assessment

Cognitive Assessment

- Dementia screening
- Neuropsychological tests
- Useful Field of View (UFOV) test

Useful Field of View (UFOV)

- Concept of useful field of view
- Change in useful field of view with age
- Impact of change on driving (Ball, Owsley, Sloane)
- Would the same relationship exist in cases of acquired brain disorder, such as TBI?

UFOV

- Processing speed
  - Identify stimuli (car or truck outline) in the center of a computer display (16 –325 msec)
- Divided attention
  - Simultaneously identify stimuli in the center of the display as well as the location of a peripheral stimulus (8 radial spokes)
- Selective attention
  - Same as previous test but peripheral stimuli are embedded in distracters (small triangles)

Risk Categories

- Very Low (< 23% restriction in field of view)
- Low (23 – 39% restriction)
- Low to Moderate (40 – 59% restriction)
- Moderate to High (60 – 75% restriction)
- Very High (> 75% restriction)

UFOV Performance After TBI

Fisk, Novack, Mennemeier, & Roenker (2002)

- Compared 23 TBI survivors with 18 normal controls
- Average of 13 months post-injury
- Median PTA of 1 to 7 days
- 70% of TBI cases and 100% of controls at the Very Low Risk level
- TBI subjects performed poorly on the divided and selective attention subtests
- Significant correlation (r = -.603) with Part B of the TMT, but no other neuropsychological tests

UFOV Performance and Driving Ability Following TBI

Novack TA, Baños JH, Alderson AL, Schneider JJ, Week W, Blandkenship J, Salisbury D. Brain Injury 2006, 20: 455-461.

Procedure

- Referred to VRS for on-the-road driving evaluation
- Visual assessment completed
- Brake reaction time
- Depth perception
- Trail Making Test A & B
- UFOV Test
- On-the-road assessment with driving evaluator and data collector
- Feedback from the driving evaluator

The Sophisticated Apparatus

UFOV Visual Attention Analyzer, Model 2000

Driving Outcome Measures

- Global Rating of Performance—completed by driving evaluator
- Driving Assessment Scale—completed by data collector

Global Rating of Performance

0 Should not be driving under any conditions

1 Able to drive under optimal conditions, such as good weather, low traffic, familiar routes, daylight hours

2 Able to drive under moderately difficult conditions, but should avoid driving in extremely heavy traffic, in bad weather, and on congested unfamiliar roads

3 Able to drive in any conditions

Driver Assessment Scale (0,1,2)

- Accelerates smoothly
- Maintains speed
- Follows a safe distance
- Uses turn signals
- Stays in lane
- Signals lane change
- Checks blindspot in lane change
- Maintains speed in lane change
- Cuts off other drivers
- Brakes smoothly
- Positions appropriately when stopped
- Comes to a complete stop
- Interprets traffic signals
- Attends to traffic signs
- Other drivers irritated
- Aware of pedestrians
- Yields right-of-way
- Visually scans at appropriate times
- Parks in designated spaces
- Back up 100 feet
- Follows instructions
- Distractibility
- Uses good judgment
- Instructor uses brake
- Instructor takes steering wheel

Sample Characteristics

- N = 60
- 38 male, 22 female
- Average age of 33 (16 to 68)
- Average of 12.7 years of education (7 to 20)
- Average of 17.5 months since injury (2 months to 19 years)
- GCS score (n = 28), 71% severe, 18% moderate

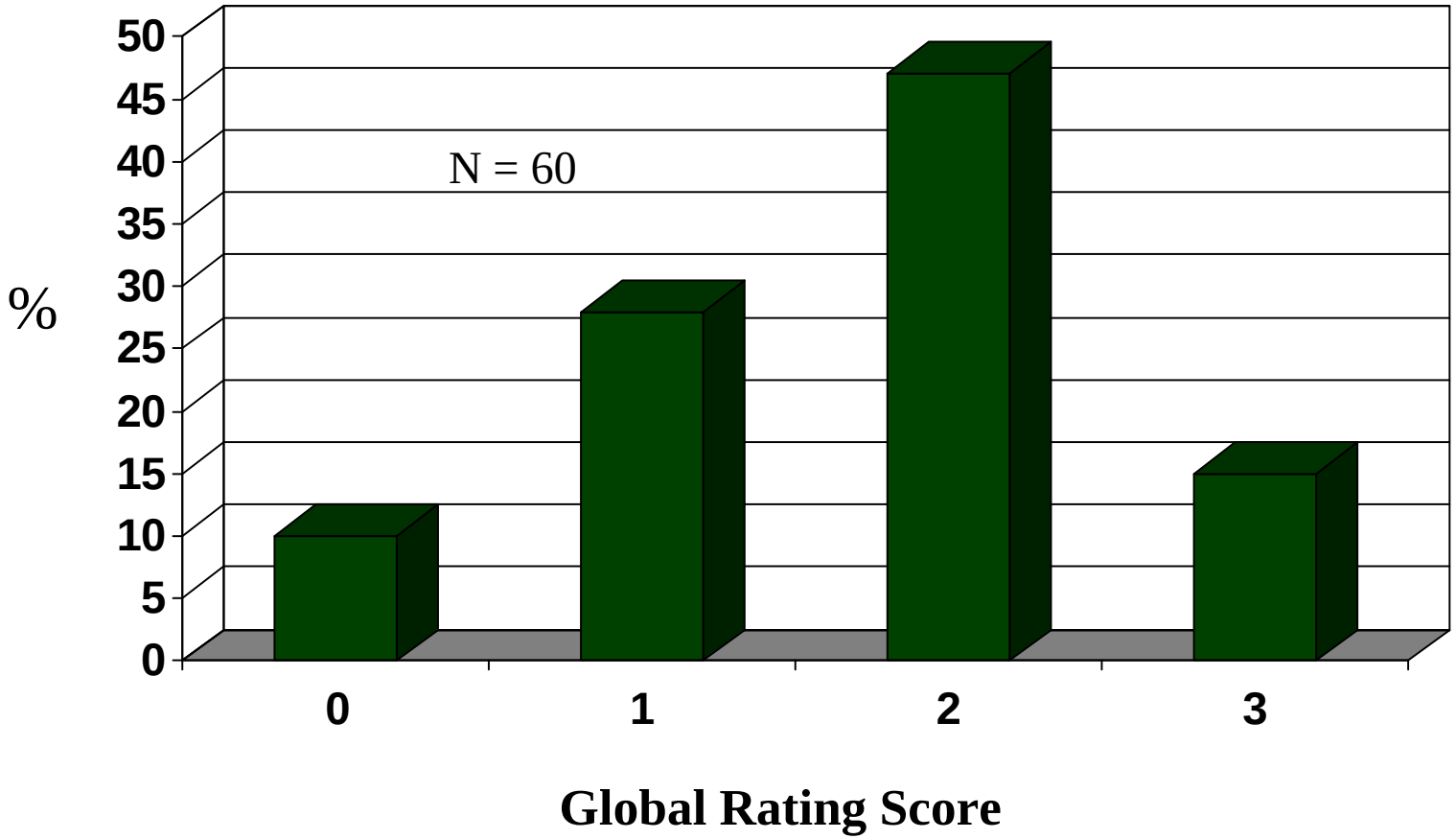
UFOV Results

- 44 (73%) of the subjects were in the Very Low Risk category
- 14 (23%) of the subjects were in the Low Risk category
- 1 subject was in the Low to Moderate Risk category
- 1 subject was in the Moderate to High Risk category

UFOV Results

- For analysis purposes the UFOV scores were dichotomized into:
  - Very Low Risk (n = 44)
  - Low to High Risk (n = 16)

Driving Results
Global Rating Score



Driving Results
Driver Assessment Scale

- Maximum possible score of 50
- Mean score = 43
- Standard deviation = 7
- Minimum = 13
- Maximum = 50

Driving and UFOV Results

- Based on chi^2 analysis, subjects falling in the Very Low Risk category were more likely to receive a higher Global Rating of driving performance than those in the Low to High Risk range ($chi^2 = 14.65$, $p < .01$)
- Based on ANOVA, subjects in the Very Low Risk category received higher scores on the DAS than those in the Low to High Risk range (average 44.6 and 37.7, $F(1,58) = 14.8$, $p < .001$)

Linear Regression Modeling

- Predicting the Global Rating and DAS scores
- Predictors included age, gender, standardized scores on Parts A & B of the Trail Making Test, brake reaction time, depth perception score, and UFOV risk level (dichotomized)

Linear Regression Modeling

- Global Rating Score
  - Predictors accounted for 52% of the variance
  - Significant predictors in the equation included age, Trails B score, depth perception score, and UFOV risk level

Linear Regression Modeling

- Driver Assessment Scale score
  - The predictors accounted for 37% of the variance
  - Significant predictors in the equation included age and UFOV risk level

UFOV Subtests

- Comparing those who passed the driving test versus those who did not using ANOVA, there was no difference in performance on the first subtest, but a significant difference on the divided and selective attention subtests
- Using correlational analyses, similar results were obtained with the DAS score

Conclusions

- Subjects with TBI performed well on the UFOV overall
- This likely reflects a selection bias for the subjects
- This is similar to the results obtained by Fisk, Novack, Mennemeier, & Roenker (2002)

Conclusions

- Considering the limited range of performance on the UFOV, it is impressive that there is still a significant relationship with on-the-road driving performance, as assessed with two instruments
- The more difficult subtests (divided and selective attention) appear to have the strongest relationship to driving performance

Conclusions

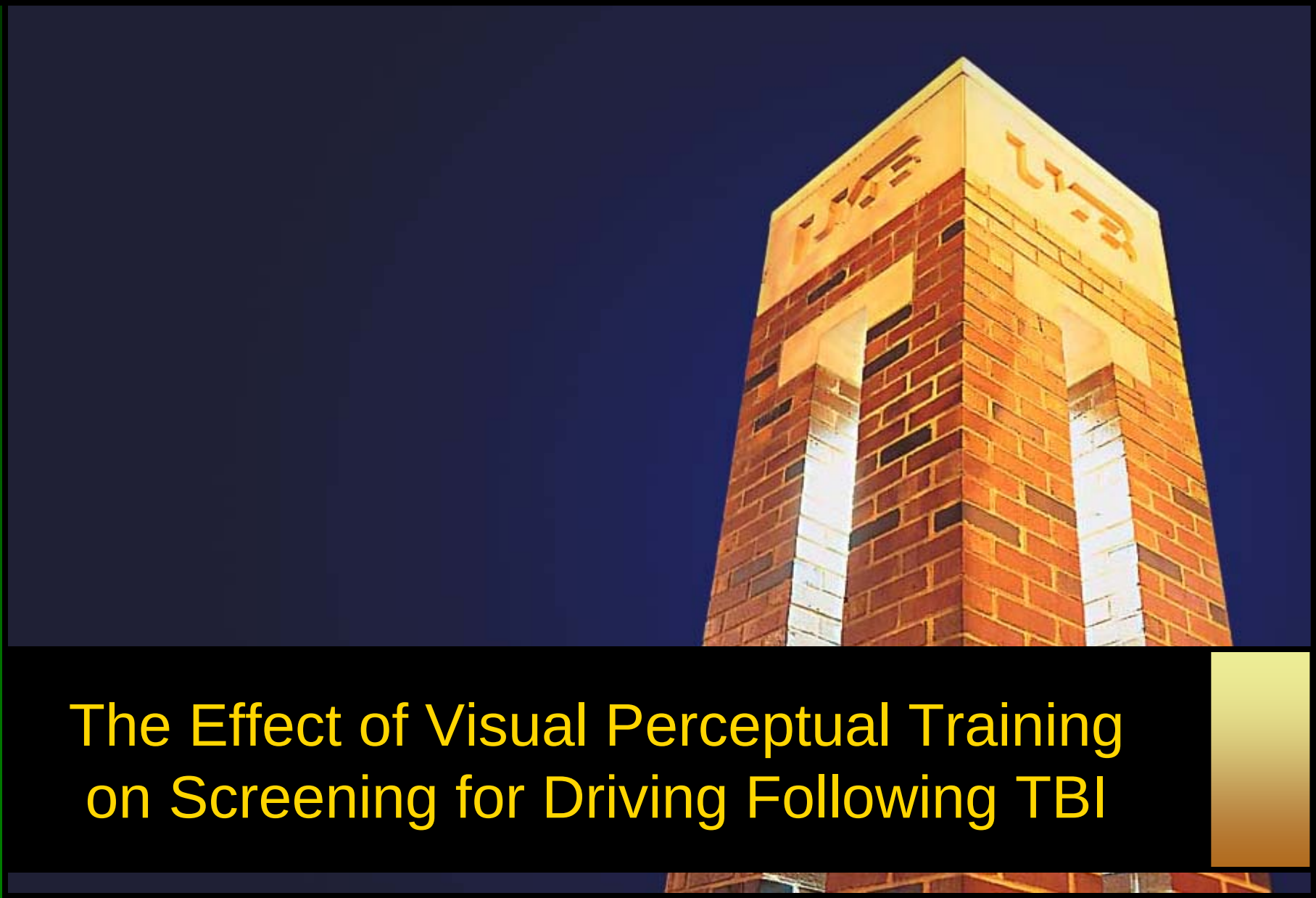
- The influence of age on driving performance in this study may be a reflection of a sampling bias
  - Younger people may have a stronger need and desire to drive than older people
  - Younger people may be more likely to be referred for driving evaluation
  - Older people referred for driving evaluation may have less severe injuries and better recovery than younger referrals

Conclusions

- Part B of the Trail Making Test is a steady performer in predicting driving performance
  - Executive abilities
  - Equivalent to the UFOV?
    - Quantity of information collected
    - Consistency of performance prediction

Conclusions

- This study supports the use of the UFOV as a screening measure to determine readiness to participate in an on-the-road driving evaluation
- It would be helpful to have UFOV ratings over time during recovery after TBI to determine the natural course of recovery
- Driving habits and events, such as crashes, also need to be examined



The Effect of Visual Perceptual Training on Screening for Driving Following TBI

Tom Novack and Karlene Ball

Remediation of Visual Perceptual Deficits

- Visual perceptual speed can be increased in older individuals using a computer based training program
- The training can take place at home
- This translates to improved performance on the UFOV test and on-the-road driving
- Would such a program also be effective during recovery from TBI?

Remediation Program

- Insight™, developed by Posit Science
- Involves 4 games
  - Bird Safari—Locate specific birds in peripheral vision
  - Road Tour—Central target identification with peripheral stimuli (most similar to UFOV)
  - Jewel Diver—Tracking multiple hidden targets
  - Sweep Seeker—Discrimination of visual sweeps

Procedure

- Identify deficits during acute rehabilitation
- Assign to control or treatment groups randomly (N = 40 in each group)
- Treatment group is asked to use the remediation program 30 minutes a day on a laptop computer at home
- Weekly phone contact to ask about use of program and video games in general

Procedure

- Follow-up in 6 weeks
  - UFOV test
  - Driving Simulator
  - Brief cognitive testing
- Phone interview at 6, 12, 18, and 24 months post-injury focusing on return to driving

Ancillary Studies

- Examination of the TBI Model System national database of 6,000+ cases
- Adding questions regarding driving to interviews for Alabama enrollees at 1, 2, 5, and 10 years post-injury
  - Frequency of driving
  - Distance
  - Reason for driving
  - Negative events (crashes, tickets)

Results

- See you back here is 4 years!

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