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Useful field of view of an indicator of accident risk: results from a college sample

Jeffrey James Schneider
Louisiana State University and Agricultural and Mechanical College, jschne4@lsu.edu

USEFUL FIELD OF VIEW AS AN INDICATOR OF ACCIDENT RISK: RESULTS FROM A COLLEGE SAMPLE

A Thesis

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Abstract

Driving is an important part of daily life in our society. Neurocognitive deficits acquired from a head injury can affect driving ability. Determining when it is safe for a person recovering from a head injury to return to the road can often be difficult. With the risk involved in an on-the-road driving evaluation, effective measures are needed to determine when patients are ready to be evaluated. Some neuropsychological measures have shown promise in this area. The Useful Field of View (UFOV) is one test that has been used successfully with older drivers to predict accident risk. Research has also been conducted examining the ability of the UFOV to predict the driving ability of patients recovering from traumatic brain injury (TBI). The ability of the UFOV to predict accident risk in samples of both non-injured and head-injured college students was examined. The UFOV was unable to predict crash involvement in the either the TBI or non-impaired subject group. The relationship of the UFOV with a number of neuropsychological measures was also explored. Possible implications of the findings and future directions are discussed.

Introduction

Driving is an essential component to independent living in our society. Components involved in driving include sensory, physical, cognitive, and behavioral factors. Any or all of these components can be affected by neurological injuries. Cognitive impairment resulting from brain injury can have a significant impact on the skills needed to successfully operate a motor vehicle (Schultheis & Chute, 2000). Limitations on driving caused by neurological injuries may cause significant difficulties in employment (Devany Serio & Devens, 1994; Kiernan & Brinkman, 1988), social integration and the ability to engage in activities outside the home (Dawson & Chipman, 1995). Therefore, determining when someone who has suffered a neurological injury can safely return to driving is an important step in the rehabilitation process.

Fifty to sixty percent of people with acquired brain injuries, including traumatic brain injury (TBI) and cerebrovascular accidents (CVA), return to driving (Pidikiti & Novack, 1991; van Zomeren, Brouwer, & Minderhoud, 1987). However, many of these people undergo no formal evaluation of driving ability prior to returning to the road. A study by Fisk, Schneider, and Novack (1998) found that over half (63%) of TBI survivors who returned to driving had not been professionally evaluated for driving competency, despite the fact that these individuals are in a higher risk category upon their return to the road.

Sivak, Olson, Kewman, Won, and Henson (1981) argue that if persons with brain damage suffer perceptual or cognitive impairment, and these skills are critical to effective driving, then compensating for the physical limitations imposed is not sufficient to lead to effective driving. Researchers have found relationships between neurocognitive impairments due to TBI and behavioral driving performance deficits that could lead to an increased level of risk for TBI survivors on the road. These impairments are in the areas of reaction time (Stokx & Gaillard, 1986), visuomotor ability (van Zomeren, Brouwer, Rothengatter, & Snoek, 1988), and perceptual/cognitive skills (Sivak et al., 1981).

The combination of increased risk and frequent lack of assessment points to a need for effective measures to evaluate the driving ability of people who have experienced neurological insults. Schultheis and Chute (2000) reviewed the current methods used to evaluate driving in head-injured populations. These include psychometric testing, computerized tasks, driving simulators, and behind-the-wheel evaluations. Psychometric tests (i.e., Trail Making Test, WAIS-III Digit Symbol) have the advantages of being able to identify residual deficits, safety, and low cost; however, they are limited by their questionable "real world" application, poor face validity, and lack of standardization. Computerized tasks (i.e., UFOV) allow for increased standardization of assessment and can enhance psychometric testing, but often have simplified graphics, limited user interaction, and questionable ecological validity. Driving simulators have increased face validity and can help in identifying practical skills which can affect driving; however, they are high in cost, have limited user interaction, lack normative information and standardization in their administration, and there is limited research on how driving simulator measures relate to actual driving performance. Behind-the-wheel evaluations have the advantage of allowing observation of "on-road" driving behavior, but are also high in cost and involve increased safety concerns.

An on-the-road test remains the best criterion for assessing driving ability (Fox, Bowden, & Smith, 1998). However, due to the risk involved in such an assessment, a screening procedure is needed to determine when a patient is ready for an on-the-road test. According to Korteling and Kaptein (1996), neuropsychological tests can be used to predict driving performance, but not to a degree sufficient to replace an open-road driving fitness assessment. Sivak et al. (1981) showed that tests that evaluate perceptual and cognitive skills were correlated with driving performance for persons with brain damage. Tests that have been shown to have predictive value for the ability to drive are reaction time tasks (Stokx & Gaillard, 1986), measures of processing speed (Schultheis, Garay, & DeLuca, 2001), the oral version of the Symbol Digit Modalities test (Gouvier et al., 1989), and Trail Making Test Part B (Mazer, Korner-Bitensky, & Sofer, 1998).

One screening device used successfully with older drivers is the Useful Field of View (UFOV; Ball & Roenker, 1998), a computer-administered and computer-scored test of visual attention. This test, which assesses decline in visual sensory function, visual processing speed, and visual attention skills, has been found to be a significant predictor of crash involvement in older drivers (Owsley et al., 1998). The UFOV determines the visual field area (useful field of view) over which a driver can process rapidly presented visual information (Owsley et al., 1998). In a study comparing different predriver screening tasks used in an adaptive driving program for older patients, the UFOV, among a battery of sample neuropsychological tests used as potential predictors, was shown to be the best single predictor of the outcome on an on-road driving test (Myers, Ball, Kalina, Roth, & Goode, 2000).

The UFOV task is divided into three parts. Part 1, which measures central vision and processing speed, requires the examinee to identify a target object presented for varying lengths of time in the center of the computer's screen. Part 2, which measures divided attention, requires the examinee to identify a central target object as before and also to localize a simultaneously presented target object displayed in the periphery of the screen. Part 3, which measures selective attention, is similar to part 2, except that the target object displayed in the periphery is embedded in distracters, making the examinee's task more difficult. The results from these three subtests are used in combination to determine the UFOV Risk Level, which ranges from level 1(Very Low Risk) to level 5 (Very High Risk).

Research on the UFOV has expanded to include special populations other than older drivers. Schneider, Novack, Alderson, and Bush (2000) examined a sample of TBI patients who had sustained moderate to severe injuries and found that the UFOV provided meaningful information with respect to on-the-road driving performance as measured by both an observer and a certified driving evaluator. The UFOV has also been used as a measure of driving risk in research on cognitively impaired individuals with multiple sclerosis (Schultheis et al., 2001). Although there is a growing literature on the ability of the UFOV to predict driving ability and crash risk in special populations, few studies have examined the ability of the UFOV to predict crash involvement in normal populations as compared to special populations, or to assess its usefulness among previously head injured individuals who have made good functional recovery.

A population of non-injured and head-injured college students was evaluated for crash risk using a battery of neuropsychological measures commonly used in driving assessments, along with the UFOV. Crash status was determined by way of participants' self-reports of their involvement in motor vehicle accidents (MVA) and the number of traffic citations received in the past 2 years. It was hypothesized that:

1. Convergent validity for the UFOV will be demonstrated through its positive correlation with measures that have previously been shown to have value in predicting driving ability including the Trail Making Test Part B, the Symbol Digit Modalities Test, and measures of processing speed from the WAIS-III. Divergent validity will be demonstrated through the lack of correlation between the UFOV and the Shipley Institute of Living Scale, a verbally based scale used to predict IQ, but not driving ability.

2. The UFOV will reliably predict crash status in both the TBI and non-impaired subject groups, but with greater predictive power in the TBI group due to the higher level of impairment in visual processing and attention skills expected in the TBI subjects. This finding will further demonstrate the sensitivity of the UFOV to the deficits in visual sensory function, processing speed, and attention that are often present in individuals with a history of head injury.

3. The UFOV Risk Level will be the best single predictor of crash status in the TBI group, consistent with prior research on older drivers showing the UFOV to be the best single predictor of driving ability among a battery of neuropsychological tests (Myers et al., 2000). This result will provide evidence for the utility of the UFOV as a screening measure for determining when people with head injuries may be ready to participate in a formal on-the-road driving evaluation.

Methods

Participants

Participants were 80 predominantly White college undergraduates (see Table 1) selected from a larger sample of students at Louisiana State University. They participated in the research to earn extra credit for their psychology coursework. Participants were divided into two groups: students with a self-reported history of head injury (TBI Group; *N* = 40) and those with no history of neurological insult (Control Group; *N* = 40). A sample size of 40 was selected for the TBI group through a review of the previous literature on research involving the use of the UFOV with special populations (Goode et al., 1998; Myers et al., 2000; Owsley et al., 1998; Schneider et al., 2000; Schultheis et al., 2001). The sample sizes used in these studies was around 40 or less, with the exception of the studies by Goode and Owsley, who collaborated with the authors of the UFOV in its development, evaluation, validation, and standardization (Ball & Roenker, 1998).

Table 1. Sample Demographics

	Total		TBI		Control	
Characteristic	N	%	N	%	N	%
Sex						
Male	32	40.0	16	40.0	16	40.0
Female	48	60.0	24	60.0	24	60.0
Race						
Caucasian	68	85.0	34	85.0	34	85.0
African-American	10	12.5	5	12.5	5	12.5
Hispanic	2	2.5	1	2.5	1	2.5
Education						
Freshman	4	5.0	1	2.5	3	7.5
Sophomore	13	16.3	6	15.0	7	17.5
Junior	25	31.3	13	32.5	12	30.0
Senior	38	47.5	20	50.0	18	45.0

The criterion for placement in the TBI group was self-report of a head injury of any severity that resulted in at least a momentary loss of consciousness (LOC), a standard in excess of the definition of mild TBI set forth by the American Congress of Rehabilitation Medicine (ACRM; Kay et al., 1993), which requires at least one of the following four criteria for a mild TBI: (1) any period of loss of consciousness; (2) any loss of memory for events immediately before or after the accident; (3) any alteration in mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused); and/or (4) focal neurological deficit(s) that may or may not be transient. Additionally, individuals were only included in the TBI group if they experienced their head injury at some point in time prior to the two-year period that was being surveyed for receipt of traffic tickets and accident involvement. Individuals who experienced a TBI during, but not prior, to the two-year study period were excluded.

Participants were recruited for the study during classroom visits by the experimenter. Students were asked to fill out a general health questionnaire that was used to screen for history of past head injuries. They received extra credit in their courses for completion of the health survey. On the survey students were able to indicate their consent to be contacted for participation in an additional extra-credit research project. From a subject pool of 538 students, 70 met the criteria for head injury status (13%). Of those screened, 66 students with history of head injury gave their initial consent to be contacted for additional research. During recruitment for the UFOV study, this number was narrowed to the final sample size of 40 due to individuals either deciding not to seek extra credit through this study or not fully meeting the exclusion criteria.

TBI subjects were collected first in the study. Control subjects were selected from a sample of 405 students without history of head injury who consented to be contacted for additional research. Controls were selected to match the TBI group as closely as possible for age, gender, and race. In cases where more than one eligible control subject was a possible match for a TBI subject, all eligible controls were assigned a number and a drawing was held to randomly determine the control subject that was selected for the study. The mean age for members of the TBI group was 21.95 years (*SD* = 4.07) compared to 21.98 years (*SD* = 3.97) for the control group. Additional demographics are provided in Table 1. The TBI and control groups did not differ significantly on any of the demographic variables.

Materials

Trail Making Test, Parts A and B. This test, from the Halstead Reitan Battery (Reitan & Davison, 1974), is used to assess speed of visual search, attention, sequencing, mental flexibility, and motor function (Spreen & Strauss, 1998). The reliability of this instrument has been demonstrated to be acceptable (Lezak, 1995). Additionally, this task provides an opportunity to observe one's ability to deal with multiple stimuli, a skill that is important in driving (Goode et al., 1998). Scores of interest were time required for completion; standard scores were based on age and grade level.

WAIS-III Processing Speed. Two subtests from the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III, Wechsler, 1997) comprise the processing speed index. The first of these, the Digit Symbol Coding subtest, involves visual attention and concentration. This task is a symbol substitution procedure that provides individuals with a key pairing a series of numbers with different nonsense symbols. The respondents are then required to fill in blank spaces with the symbol that is paired with the number above the blank space as quickly as possible (Lezak, 1995). Motor persistence, sustained attention, response speed, and visuomotor coordination are important for performance on this test (Lezak, 1995). The other subtest, Symbol Search, involves visual scanning and discrimination of stimuli. This task requires the respondent to scan each line of symbols for the presence or absence of designated targets, which differ from line to line (Groth-Marnat, Gallagher, Hale, & Kaplan, 2000). Abilities assessed by this task include speed of visual search, speed of information processing, visual acuity, spatial visualization, planning, and visual-motor coordination (Groth-Marnat et al., 2000). Age-based scaled scores were recorded for each subtest, along with the overall processing speed standard score.

Symbol Digit Modalities Test (SDMT). The SDMT (Smith, 1982) is similar to the WAIS-III Digit Symbol Coding subtest in its substitution format, but the format is altered such that nine meaningless symbols are presented in the top row of the key, each associated with a number on the bottom row (Ponsford, 2000). The respondent is then required to reproduce the number associated with each symbol, either orally or in writing, during the test phase. The SDMT is used to assess visual scanning, tracking, and motoric speed (Spreen & Strauss, 1998). The oral format can be particularly useful in detecting attentional problems related to tracking, inattentiveness to details, or inappreciation of orientation changes (Lezak, 1995), and has previously been shown to have predictive value for driving ability (Gouvier et al., 1989). The oral version of the

SDMT was administered to participants in this study and standard scores based on age norms were recorded.

Shipley Institute of Living Scale (ILS). The Shipley ILS (Shipley, 1940; Zachary, 1986) is a short self-administered scale containing both vocabulary and verbal abstraction items. The vocabulary portion of the test is designed to represent the level of well-established learning and skills that are relatively resistant to brain damage, while the abstraction items test concept formation, which is vulnerable to many kinds of brain damage (Lezak, 1995). A comparison between the vocabulary and abstraction scores can yield a ratio indicating whether mental deterioration is present (Zachary, 1986). This ratio is the Conceptualization Quotient (CQ), or “index of impairment.” The Shipley ILS is often used as a screening test for brain dysfunction and can also provide for prediction of WAIS-R Full Scale IQ scores (Lezak, 1995). The CQ was recorded along with the WAIS-R IQ estimate.

Useful Field of View (UFOV). Visual attention was assessed using the Useful Field of View (UFOV) test (Ball & Roenker, 1998). This test is a computer-based measure that uses three subtests in combination to determine a driver’s risk of accident involvement. A thorough description of this measure is given by Goode et al. (1998):

> In the first subtest, designed to assess speed of visual processing, the participant [is] required to identify a target of varying duration presented in a fixation box. The target [is] the silhouette of a car or truck. The second subtest, designed to assess the ability to divide attention, require[s] the localization of a simultaneously presented peripheral target (a silhouette of a car) in addition to the identification of the central target. The peripheral target appear[s] unpredictably at … different peripheral locations along 8 radial spokes (4 cardinal and 4 oblique)…. The duration of the display [is] varied to measure speed of processing for this divided attention task. The third subtest, designed to assess selective attention abilities, [is] the same as the second task with the exception that the peripheral target [is] embedded in distracters (triangles). Performance on the UFOV is then expressed as a function of three variables: the minimum

> target duration required to perform the central discrimination task (Subtest 1), the ability to divide attention between central and peripheral tasks successfully (Subtest 2), and the ability to filter out distracting stimuli (Subtest 3). (p. 430-431)

The respondent performs the UFOV from a viewing distance of about 24 inches from the computer screen. Upon completion of the test, the raw score for each subtest is given in milliseconds. Combinations of various raw scores from each subtest are used to arrive at one of five categories of risk (UFOV Risk Level), with Level 1 being the lowest risk. The raw score from each subtest and the overall UFOV Risk Level was recorded.

Crash Status. Accident involvement and number of traffic citations received during the past two years was measured with a self-report survey (see Appendix) given to the participants. A differential weighting system was used to assign risk scores to respondents. In this system, traffic citations were worth 1 point, and accidents were worth 2 points (O'Jile, 1998). Respondents were divided into 3 categories based on their total points: Group 1 (Low Risk) was composed of subjects with 0 points; Group 2 (Moderate Risk) was composed of subjects with 1-2 points; and Group 3 (High Risk) was composed of subjects with 3 or more points.

Procedure

Data collection took place at the Psychological Services Center, Louisiana State University. Data was collected by the experimenter or by an undergraduate research assistant trained by the experimenter on administration of the measures used in the study. After the participants arrived, informed consent was obtained for inclusion in the study. Once consent was given, the participants were asked to complete the accident and ticket survey. The data collector then administered the three subtests of the UFOV and the battery of neuropsychological tests. A fixed order of presentation was used to hold any possible sequence effects constant. The Trail Making Test was given first, followed by the Digit Symbol Coding and Symbol Search subtests from the WAIS-III, and the Symbol Digit Modalities Test. Finally, the Shipley Institute of Living Scale was administered.

Results

The TBI group was evaluated for cause and severity of injury. The most frequently reported cause of injury was sporting accidents (*N* = 13 or 32.5%), with falls (*N* = 9 or 22.5%) and motor vehicle accidents (*N* = 8 or 20%) coming next. Five subjects (12.5%) reported receiving head injuries from blunt traumas, and 5 subjects (12.5%) failed to report the cause of their injuries. In terms of severity, using a criterion of loss of consciousness, most subjects (*N* = 36 or 90%) reported receiving mild injuries (loss of consciousness less than one hour), Using post-traumatic amnesia (PTA) as a criterion yielded similar results, with 77.5% of TBI subjects (*N* = 31) reporting very mild injuries (PTA less than 10 minutes; see Table 2). Additionally, TBI subjects were seen an average of 7.13 years (*SD* = 5.08) after their injury. These results, taken together with the similar test results to the control group and the fact that all participants were currently enrolled in college, support the notion that most participants had received mild injuries.

Table 2. Reports of Post-Traumatic Amnesia (PTA) by TBI Subjects

Length of PTA	Severity	N	%
<10 min.	Very Mild	31	77.5
10-60 min.	Mild	5	12.5
1-24 hr.	Moderate	3	7.5
1-7 days	Severe	1	2.5

Scores on the UFOV for this sample were restricted to the Very Low Risk designation, with all of the members of both the control and TBI groups falling in this range. This represents a floor effect for the UFOV in evaluating crash risk for individuals with mild TBI or without neurological injuries. Table 3 contains the mean scores for the TBI and control groups on all of the administered tests, as well as standard deviations, t-test values, and effect sizes. A directional independent samples t-test showed that the two groups did not differ significantly on any of the measures (all *p* > .05). The TBI group was evaluated separately to see if injury severity had any influence on test scores. The moderate and severe injury groups were combined for this analysis due to the low number of subjects in each of those groups. A one-way ANOVA showed that scores on the administered measures did not differ significantly among the very mild, mild, and moderate to severe head injury groups (all *p* >.05).

Table 3. Descriptive Statistics for UFOV and Neuropsychological Tests

	TBI		Control		t-test[a]	d
Measure	M	(SD)	M	(SD)	(df = 78)	
UFOV Part 1 (ms)	16	0	16	0	b	
UFOV Part 2 (ms)	19.95	-11.95	17.38	-4.19	-1.282	.32
UFOV Part 3 (ms)	63.4	-27.3	67.18	-40.45	0.489	.11
UFOV Risk Level	1	0	1	0	b	
Trails A (t-score)	49.85	-8.04	49.38	-10	-0.234	.05
Trails B (t-score)	51.83	-11.08	51.18	-11.16	-0.261	.06
Digit Symbol	11.78	-2.66	10.93	-2.16	-1.566	.35
Symbol Search	11.78	-2.45	11.35	-1.99	-0.85	.19
Processing Speed	109.7	-13.37	106.1	-10.48	-1.341	.30
SDMT	93.5	-10.32	92.3	-11.12	-0.5	.11
Shipley CQ	105.08	-8.51	102.35	-13.23	-1.096	.25
Shipley WAIS-R IQ	106.78	-6.48	106.45	-6.74	-0.22	.05

a. all p > .05 (one-tailed)
b. t-score could not be computed because the SD of both groups were 0.

To examine the first hypothesis, Pearson product-moment correlation coefficients were used to determine the relationship between each UFOV subtest score and the neuropsychological measures. Correlations could not be calculated for the overall UFOV Risk Level or for UFOV Part 1 since these variables had only one value. For the control group, the raw score on part 2 of the UFOV was significantly correlated with the

Trails B t-score, $r = -.503$, $p = .001$; and the Shipley IQ estimate, $r = -.346$, $p = .029$. UFOV Part 3 was significantly correlated with the Trails B t-score, $r = -.417$, $p = .008$; the Shipley CQ, $r = -.403$, $p = .010$; and the Shipley IQ estimate, $r = -.517$, $p = .001$. For the TBI group, UFOV Part 3 was significantly correlated with the Digit Symbol subtest from the WAIS-III, $r = -.376$, $p = .017$. UFOV Part 2 was not significantly correlated with any of the neuropsychological measures for the TBI group.

Each of the head injury severity groups was also evaluated independently. For subjects with very mild TBI, UFOV Part 2 was not correlated with any the measures and UFOV Part 3 was correlated with the WAIS-III Digit Symbol subtest, $r = -.428$, $p = .016$; and the WAIS-III Processing Speed Index, $r = -.364$, $p = .044$. In the mild TBI and moderate to severe TBI groups, correlations could not be calculated for UFOV Part 2 as this variable had only one value. UFOV Part 3 was not significantly correlated with any of the measures for either the mild or moderate to severe TBI groups.

Figure 1 shows the mean number of self-reported tickets and accidents over the past two years for subjects in the TBI and control groups. While there was a general trend towards a higher number of tickets and accidents among the TBI subjects, this difference was only significant for number of reported accidents. Results of directional independent samples t-tests showed that the mean number of reported tickets for TBI subjects ($M = .65$) was not significantly higher than for control subjects ($M = .50$), $t\ (78) = -.758$, $p = .226$, $d = .17$ (one-tailed); while the mean number of accidents reported by TBI subjects ($M = .60$) was significantly higher than the mean number of accidents reported by control subjects ($M = .33$), $t\ (78) = -1.853$, $p = .034$, $d = .41$(one-tailed).

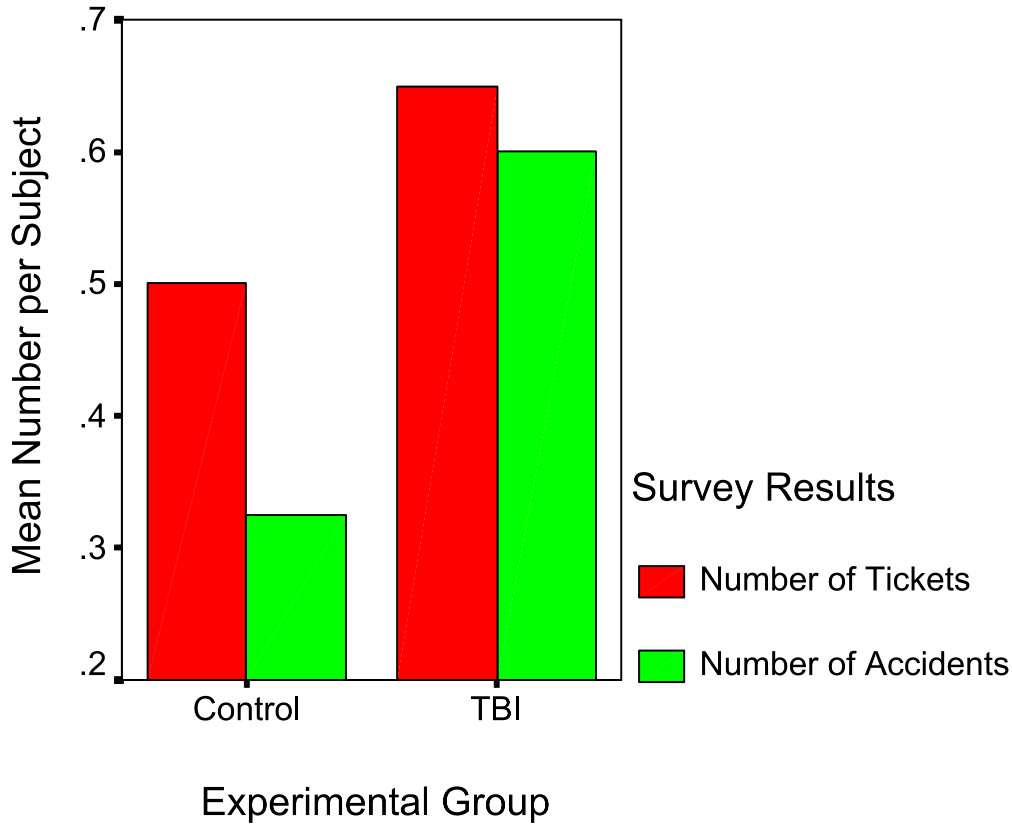

Figure 1. Mean number of tickets and accidents reported by subjects in the TBI and control groups over the last two years.

Due to the difference in number of reported tickets and accidents, there was also a trend towards placement of a higher number of individuals from the TBI group into the high-risk category for crash status (see Figure 2). Results from a directional independent samples t-test showed that the mean risk group placement for subjects in the TBI group (*M* =1.93, *SD* = .76) was significantly higher than mean risk group placement for subjects in the control group (*M* = 1.65, *SD* = .70), $t\ (78) = -1.678$, $p = .049$, $d = .38$ (one-tailed).

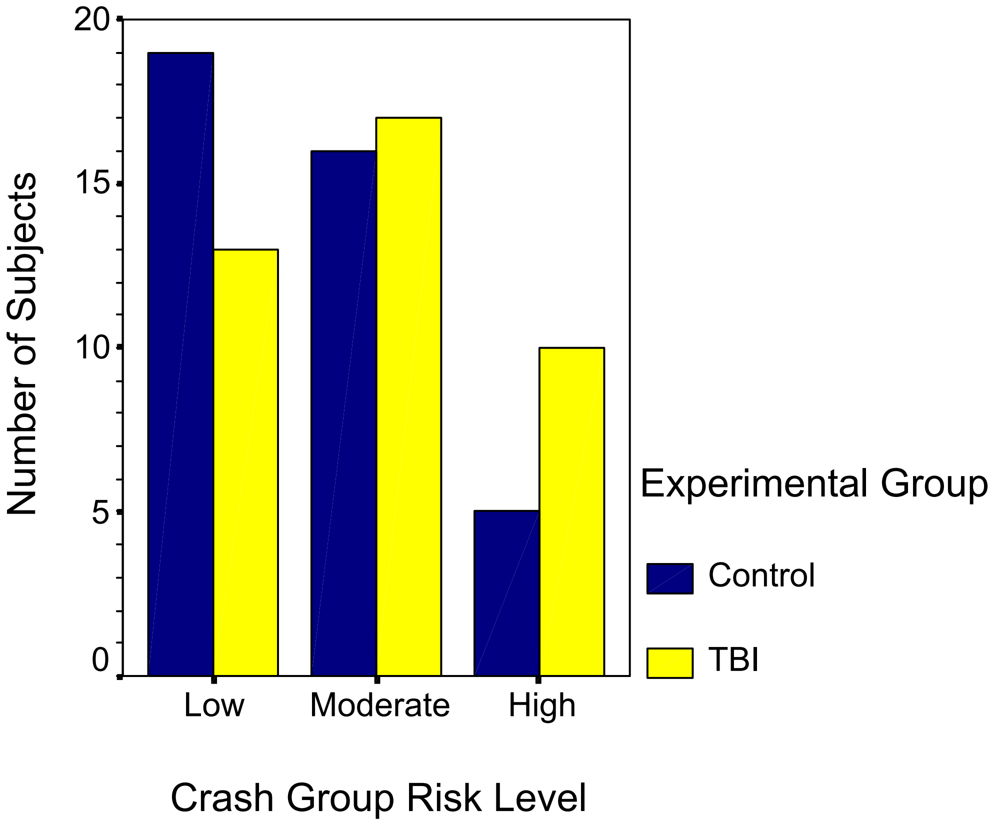

Figure 2. Number of subjects from the TBI and control groups in each crash group, based on self-reported number of tickets and accidents over the last two years.

To test the second hypothesis, Spearman rho correlation coefficients were used to examine the relationship between the UFOV and the subjects' crash group placement. UFOV Risk Level could not be used for this analysis since the variable had only one value, so results from the most difficult subtest, UFOV Part 3, were used instead. The scores on UFOV Part 3 were not significantly correlated with crash group for subjects in either the TBI (r = .172, p = .289) or control groups (r = .013, p = .935). Additionally, the scores on UFOV Part 3 were not significantly correlated with crash group for the very mild (r = .185, p = .319), mild (r < .001, p = 1.000), or moderate to severe TBI subjects (r = .866, p = .333). As none of the correlations were significant, no further analysis was performed.

The third hypothesis was examined using multiple regression analysis, stepwise method, to identify which variables among the UFOV and neuropsychological tests were the best predictors of crash group status and which were redundant. For the control group, none of the predictor variables were entered into the analysis due to lack of correlation with the dependent variable. For the TBI group, the only predictor variable entered into the analysis was Shipley CQ, accounting for 11.5% of the variance in crash group status. The TBI groups were sorted according to injury severity and no predictor variables were entered into the regression analysis for any of these groups.

Discussion

The overall prevalence of self-reported head injury in the present study was 13%, which is slightly lower than that reported by previous investigators (Ryan, O'Jile, Gouvier, Parks-Levy, & Betz, 1996; Segalowitz, Lawson, & Berge, 1993). Ryan et al. found a prevalence of 23% in a previous survey of 800 undergraduate students at Louisiana State University, and Segalowitz et al. found a prevalence of over 30% in a survey of 3,025 individuals from the general population. The findings in the present study for cause and severity of injury were consistent with those reported by Ryan et al.

Some convergent validity was demonstrated for the UFOV through its correlation with part B of the Trail Making Test in the control group. This result may be due to the processing and attention components that these measures share as important factors in performance on them. The ability of respondents to interpret stimuli quickly and accurately is fundamental to performance on these tasks. However, this correlation was not present in the TBI group, which stands in contrast to the results of research on a population of TBI patients with moderate to severe injuries that provided evidence for the use of both the UFOV and Trail Making Test, Part B in predicting on-the-road driving ability (Novack, Schneider, Weed, Blankenship, & Baños, 2003). The UFOV was also correlated with the WAIS-III Digit Symbol subtest in the TBI group, perhaps due to the processing speed components shared by the tests.

The UFOV was correlated with the Conceptualization Quotient and IQ estimate from the Shipley Institute of Living Scale in the control group, but not in the TBI group. The correlation with the Shipley IQ estimate in the control group was unexpected due to the broader range of skills that fall under the umbrella of intelligence. The UFOV is not meant to predict such a global concept, but simply visual attention skills and fitness to drive. However, the lack of correlation between the UFOV and the Shipley in the TBI group was expected and may provide evidence of divergent validity for the UFOV

The UFOV was unable to predict crash status in the TBI or control groups for participants in this study. However, none of the neuropsychological measures that have previously been shown to have predictive value for driving ability were able to predict crash status for the participants in this study either. The only measure that showed a statistically significant degree of predictive value in the TBI group was the Shipley CQ, which accounted for 11.5% of the variance in crash status. When the TBI group was sorted by injury severity, none of the administered measures showed predictive value for driving ability in any head injury group. None of the measures had any significant predictive value for the control group.

These results may be due to the relative lack of impairment shown by members of the TBI group. These subjects were on average 7 years past their injury date, had received very mild injuries in most cases, and obtained scores on the administered neuropsychological measures that were in the average range and equivalent to those obtained by the control group. Subjects evaluated closer to the dates of their injuries and subjects with more severe levels of injury would likely show more deficits in their performance on the neuropsychological tests, as well as on the UFOV.

Another possibility is that under the right circumstances, such as stress or fatigue, deficits would appear in the TBI group that were not observed in the present study. A study by Hanna-Pladdy, Berry, Bennett, Phillips, and Gouvier (2001) found that mild TBI patients reported symptoms at a level consistent with controls initially during testing, but displayed significant increases in postconcussive symptoms compared to controls after engaging in cognitively challenging tasks over an extended period. It is possible that if exposed to similar types of strain and fatigue, the TBI subjects in the present study could have shown deficits.

Still another possibility is that the dependent variable used to measure driving ability in this study was inappropriate for that purpose. A more accurate dependent variable might be observations of subjects' on-the-road driving performance. However, changing the dependent variable would not change the level of performance on the other assessment measures given. The TBI subjects would still have performed at a high level, consistent with controls, and this would likely have resulted in similar findings.

The UFOV was not sensitive to the influence of brain damage in a high functioning population with very mild levels of injury, perhaps setting a lower threshold on the use of the test in the assessment of people with head injuries. However, this does not imply that the UFOV is not sensitive to brain damage in lower functioning or more severely injured populations, such as those in rehabilitation after sustaining a moderate or severe head injury. With these populations, the UFOV may serve as a quick, efficient screening measure to determine when people with TBI are ready for a formal driving evaluation. Using this measure with these more severe groups may reduce some of the time spent in determining driving status and could get some TBI patients back on the road sooner after their injury. However, this should not be done without sufficient caution in interpreting the results, or without referral of the patient to a formal on-the-road driving evaluation when warranted. The safety of the patient and other drivers should remain the top priority of the clinician when making driving status recommendations, even at the cost of a delay in returning to driving.

Future research should continue to examine the use of the UFOV to assist in evaluating the driving status of patients who have suffered head injuries. Further clarification of the sensitivity of the UFOV to different types and severities of brain dysfunction would help clinicians decide when and if the UFOV is an appropriate tool to use with a particular patient. Assessment of patients should be made at a point closer to the time of injury to see if people who will have the capacity to drive can be identified earlier in recovery.

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Appendix

Accident and Ticket Survey (after O'Jile, 1998)

Subject's Name: ________________________ Date of Study: ____________________

Date of Birth: _______________ Age: _____ Gender: ______ Education: ________

1. Are you currently driving? _____ If no, when did you stop, and why? ________

   ____

2. How many years have you driven? ____
3. How many miles do you drive in an average week? __________________________
4. Do you restrict your driving (day driving only, only in the neighborhood, avoid rush hour, etc.)? ____
5. Do you drive at, below, or above the speed limit? ___________________________
6. Have you received any tickets (moving violations only) over the last two years? List dates (month and year) ____

   ____

   ____

7. Have you been involved in any car accidents while driving for the last two years? Please list them, no matter how minor. Please list dates (month and year). Please note how severe (i.e., anyone hurt, more than $1,000 damage, etc.). Were they reported to the police? ____

   ____

   ____

   ____

8. What medications are you taking? ____
9. Do you use alcohol and how much? ____
10. Any additional comments concerning your driving? ___________________________

    ____

Vita

The author is a native of Atlanta, Georgia and completed his secondary education at Tucker High School, graduating in 1994. He received a bachelor of science in psychology from Birmingham-Southern College in 1998. He was elected to numerous honorary societies while at Birmingham-Southern College, including Psi Chi and Phi Beta Kappa. He is currently a graduate student in the doctoral program of the Department of Psychology at Louisiana State University, and will earn his master's degree in December 2002.