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Utility of an Occupational Therapy Driving Intervention for a Combat Veteran

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MeSH TERMS

- automobile driving
- combat disorders
- evaluation studies
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- veterans

Many combat veterans are injured in motor vehicle crashes shortly after returning to civilian life, yet little evidence exists on effective driving interventions. In this single-subject design study, we compared clinical test results and driving errors in a returning combat veteran before and after an occupational therapy driving intervention. A certified driving rehabilitation specialist administered baseline clinical and simulated driving assessments; conducted three intervention sessions that discussed driving errors, retrained visual search skills, and invited commentary on driving; and administered a postintervention evaluation in conditions resembling those at baseline. Clinical test results were similar pre- and postintervention. Baseline versus postintervention driving errors were as follows: lane maintenance, 23 versus 7; vehicle positioning, 5 versus 1; signaling, 2 versus 0; speed regulation, 1 versus 1; visual scanning, 1 versus 0; and gap acceptance, 1 versus 0. Although the intervention appeared efficacious for this participant, threats to validity must be recognized and controlled for in a follow-up study.

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Between 2002 and 2012, more than 1.5 million U.S. soldiers returned to the United States after active duty in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF; U.S. Department of Veterans Affairs [VA], 2012a). As of March 2013, more than 50,000 U.S. soldiers had been wounded serving in OEF–OIF (U.S. Department of Defense, 2013). Blast-induced wounds are the prevailing injury type, and posttraumatic stress disorder (PTSD) is the prevalent disorder (Quality Enhancement Research Initiative, 2012; U.S. Department of Defense, 2013). Both conditions result in cognitive, physical, and behavioral impairments affecting the driving ability of combat veterans (Classen et al., 2011; Lew, Amick, Kraft, Stein, & Cifu, 2010).

Motor vehicle crashes (MVCs) are a leading cause of injury and death for combat veterans, and OEF–OIF veterans have a 75% higher chance of dying from an MVC than the overall population (Lew et al., 2010, 2011). Even returning combat veterans without medical conditions are at risk because of the combat driving tactics they learned in the war zone and continue to execute on civilian roads (Lew et al., 2010). Even though these factors compromise the safety of the veterans and of other road users, little evidence currently exists on driving interventions for returning combat veterans.

Polytraumatic Injuries

Most OEF–OIF wounds are caused by improvised explosive devices, landmines, and other blast devices (Clark, Bair, Buckenmaier, Girona, & Walker, 2007). Often these wounds are polytraumatic, involving multiple body organs or systems (Quality Enhancement Research Initiative, 2012). Orthopedic and

soft-tissue wounds predominate, followed by hearing problems and eye injuries (Clark et al., 2007). Although the exact numbers are not known, Clark and colleagues (2007) indicated the scope of polytrauma by reporting that of 1,565 surgeries performed on 297 severely injured OEF–OIF combat veterans who were medically evacuated to the Walter Reed Army Medical Center, 1,078 (69%) were orthopedic related (amputation; external and internal fixations; joint exploration, fixation, manipulation, reconstruction, or replacement; bone grafting; hardware removal; ligament repair) and 579 (37%) were soft-tissue related. Such bodily injuries may influence the driving ability of veterans.

Posttraumatic Stress Disorder

Of the 834,467 returning combat veterans who obtained VA health care between 2002 and 2012, approximately 31% were diagnosed with PTSD (VA, 2012a, 2012b). A person with PTSD has either observed or experienced a dangerous event and consequently presents with anxiety in harmless situations (National Institute of Mental Health, 2012). Lew and colleagues (2011) found that OEF–OIF combat veterans with PTSD had the most significant driving impairments and the most severe driving difficulties compared with combat veterans without PTSD.

Battle-Mind Driving Tactics

According to Lew et al. (2010), deployed service members are taught “battle-mind” driving tactics to survive in war, and many retain that mindset postdeployment. Speeding, changing lanes suddenly, and avoiding certain objects (e.g., swerving around trash bags) are some of the tactics warranted in combat but potentially dangerous on civilian roads (Lew et al., 2010). Thus, even returning combat veterans without medical conditions can be unsafe drivers, but more empirical support for battle-mind driving is necessary to make this claim. One way to assess risky driving behaviors is through simulated driving assessments.

Simulated Driving Assessments

Several methods are used to assess driving performance. On-road driving assessments are deemed the most accurate predictor of driving performance, but driving simulators are a valuable alternative when on-road assessment is not possible, feasible, or safe (Classen et al., 2011). Simulators use modern technology to give the illusion of driving an actual vehicle, and examinees can make driving errors without damaging property or risking lives (Shechtman

et al., 2007). Also, situations displayed on the simulator can be controlled and repeated, which allows all participants in a study to undergo the same assessment or intervention, yielding more reliable results compared with situations in which certain factors cannot be controlled (Stern & Schold Davis, 2006).

Shechtman, Classen, Awadzi, and Mann (2009) compared driving errors made on the road with those made on a driving simulator among community-dwelling older and younger adults to validate simulator use for assessment and training. All 39 participants drove on the road and later on the simulator. The researchers examined seven driving errors for both vehicles: speed regulation, lane maintenance, signaling, adjustment to stimuli, vehicle positioning, gap acceptance, and visual scanning. Although the number of driving errors differed, the most common errors made in the simulator were also made on the road, suggesting that relative validity (vs. absolute validity) exists between simulator and on-road driving performance.

Driving Performance of Combat Veterans With Mild Traumatic Brain Injury and PTSD

Classen et al. (2011) conducted a pilot study using driving simulators to determine driving error differences between OEF–OIF veterans and healthy control participants. Eighteen participants were combat veterans diagnosed with mild traumatic brain injury (mTBI) and PTSD, and 20 were healthy control participants. The veterans made more errors, particularly adjustment to stimuli and overspeeding, compared with the control group. If driving performance on the simulator reflects and predicts driving performance on the road, it may be assumed that the veterans would make these same driving errors on the road, contributing to the risk of injury or death. The reasons for these errors were uncertain, however. Although the combat veteran described in this study did not have mTBI, he did have PTSD, which has been shown to affect driving performance (Lew et al., 2011).

Rationale, Significance, and Purpose of the Study

Medical conditions and battle-mind driving tactics compromise the driving ability of combat veterans, yet little is known about the efficacy of driving interventions for combat veterans. The aim of this study was to determine whether an occupational therapy driving intervention improved the driving ability of an OIF combat veteran

who had an orthopedic injury and PTSD by comparing clinical test results and driving errors made on a simulator before and after the intervention. Driving errors included errors of lane maintenance (side-to-side positioning of the vehicle), vehicle positioning (front and back positioning of the vehicle in relation to other vehicles, objects, and pavement markings), vehicle scanning (apt examination of the environment), speed regulation (observance of speed limits), adjustment to stimuli (apt responses to driving situations), gap acceptance (safe crossing in front of oncoming traffic), and signaling (proper use of turn signals; Justiss, Mann, Stav, & Velozo, 2006). The aims were to verify whether the intervention changed the number of driving errors and mitigated the types of errors made. Because the intervention included client education and coaching, tailored guidance, visual search training, and a narrated drive, including correction of driving errors, we anticipated that the intervention would reduce the number and types of driving errors made by the combat veteran.

Method

Research Design

This study used a single-subject design with three phases: a baseline pretest, an intervention with three 1-hr training sessions, and a posttest conducted in conditions similar to baseline. Single-subject designs present helpful feedback about an intervention's progress while establishing the value of the intervention (Portney & Watkins, 2000). Limitations of these designs include limited generalizability of the results and inability to conclude that the treatment caused change (Portney & Watkins, 2000). The University of Florida institutional review board approved the study, and the combat veteran provided informed consent before participating.

Participant Selection

To recruit the participant for this study, members of the research team (Classen, Canonizado, and Winter), including an occupational therapist (Monahan) who is also a certified driving rehabilitation specialist (OT-CDRS), presented study information to the clinical and research staff of various VA clinics in north Florida, followed up with flyers and telephone calls, participated in veteran-oriented community events, and used word-of-mouth referral. The participant in this study was considered eligible on the basis of the following inclusion criteria: service in OEF or OIF, presence of a mTBI or orthopedic injury with PTSD, participation in driving before onset of the medical condition, possession of a valid driver's

license, residence in the community, ability to partake in a driving evaluation, and score of at least 24 of 30 points on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975).

Instruments

Clinical Measures. The OT-CDRS measured the participant's visual abilities with the Optec[®] 2500 Visual Analyzer (Stereo Optical, Inc., Chicago), visual attention and processing speed with the Useful Field of View[®] (UFOV; Ball & Owsley, 1993), general cognitive abilities with the MMSE, set shifting with the Trail-Making Test Part B (TMT; Reitan, 1958), and ability to move the right foot between the accelerator and the brake with the foot tap test (FTT; Stav, Justiss, McCarthy, Mann, & Lanford, 2008) and right lower-extremity range of motion (ROM; Marottoli, Cooney, Wagner, Doucette, & Tinetti, 1994).

Simulated Driving Tests. After baseline clinical test administration, the participant drove two 7-min acclimation drives to adjust to the Drive Safety DS-250r[™] mobile driving simulator (DriveSafety, Inc., Murray, UT), displayed in Figure 1. The Simulator Sickness Questionnaire (Kennedy, Lane, Berbaum, & Lilienthal, 1993) was given during the drives to assess any reported simulator sickness. The pretest involved a 6-min rural/suburban drive scenario consisting of 10 straight drives and 3 turns and a 10-min city/highway drive scenario consisting of 14 straight drives and 4 turns.

Response triggers were programmed into each drive scenario to potentially elicit a reaction from the combat veteran. Nine triggers were programmed into the rural/suburban drive, and 10 triggers were programmed into the city/highway drive. These triggers included trash, disabled



Figure 1. The DriveSafety DS-250r[™] Driving Simulator with three 20-in. panels for a 65° field of view, engineered into the cargo area of a 2010 Dodge Caravan.

Source: Photo courtesy of S. Classen.

vehicles, dead animals, unexpected maneuvers from other road users, loud helicopter sounds, and a motorcycle backfiring. For each scenario, the OT-CDRS recorded the number and type of driving error the combat veteran made. The type of driving error and verbal responses from the participant's reaction to the response triggers were also recorded. The entire battery of clinical and simulated driving assessments administered by the OT-CDRS took about 3 hr to administer.

Intervention and Procedures

The combat veteran received the pretest, intervention, and posttest within 1 wk. In Session 1 of the intervention, the OT-CDRS, who was also the interventionist, reviewed with the combat veteran the driving errors and strategies for mitigating errors (e.g., highlighted risks involved in driving in a civilian area according to the battlefield mindset). In Session 2, which focused on visual search training for critical cues, the OT-CDRS used a visual search skills CD (Monahan, 2009) showing U.S. roadways, cities, and intersections. Using the pictures in the CD, the combat veteran first identified war cues he would have attended to in Iraq and then identified roadway cues critical for civilian roads. In Session 3, the combat veteran provided verbal commentary on critical roadway cues he learned in Session 2 while driving the simulator. Each session lasted about 1 hr.

Session 2 of the intervention was manualized, and the procedure for Sessions 1 and 3, which were based on coaching techniques, was established. The fidelity of the intervention was characterized by adherence (i.e., program component delivery as prescribed), exposure of the participant (i.e., amount of program content received by the participant), quality of the delivery (i.e., intervention provided by a trained OT-CDRS), participant's responsiveness (i.e., engagement of the participant as indicated by participating in all of the sessions), and program differentiation (i.e., unique features of the intervention; Dane & Schneider, 1998). The OT-CDRS administered the posttest in conditions similar to baseline testing using the Optec 2500 and UFOV, right lower-extremity ROM, FTT, MMSE, and TMT. The combat veteran drove the same rural/suburban and city/highway drives, and the OT-CDRS recorded the driving errors. The combat veteran was compensated with \$150 for participating in the study.

Data Collection and Analysis

Data from all tests were first manually recorded on hard-copy forms by the OT-CDRS and then entered into

PASW Statistics 20 (IBM Corporation, Armonk, NY) for analysis by a trained research assistant. The simulator sickness data were entered into Microsoft Excel but are not further discussed in this article because no differences appeared before, during, or after the ride. All data were analyzed with descriptive statistics using PASW Statistics 20.

Results

Participant Description and History

We evaluated a 31-yr-old postdeployed OIF combat veteran with a left leg compound fracture and PTSD. He was White, had a high school education, and reported his marital status as divorced. He held a valid driver's license. In 2005, during his service and single deployment to Iraq, he drove trucks, and he returned to the United States in 2006. He was in a motorcycle crash in 2012, resulting in multiple fractures of the left tibia and fibula. He was clinically diagnosed with PTSD and a sleep disorder after deployment. He reported taking two drugs for well-managed bipolar disorder.

Clinical Measures

Vision, Attention, and Processing Speed. The Optec 2500 revealed intact color discrimination, peripheral fields, visual acuity, depth perception, and phorias for both eyes. The combat veteran scored 16.70 ms on UFOV Test 1 and 16.70 ms on UFOV Test 2 at pretest and posttest. On Test 3, he scored 63.40 ms at pretest and 60.00 ms at posttest (Table 1). Scores that fall within 0–30 ms for UFOV Test 1 indicate normal processing speed, 0–100 ms for Test 2 indicate normal divided attention, and 0–350 ms for Test 3 indicate normal selective attention (Visual Awareness, 2002).

Cognition. The combat veteran scored 30 points on the MMSE. A score ≤ 24 denotes cognitive decline (Crizzle, Classen, Bédard, Lanford, & Winter, 2012). He took 83 s (cutoff = 180 s) to complete the TMT Part B. Finishing the TMT Part B in < 85 s signifies no deficits in set shifting (i.e., intact ability to divide attention to accommodate multiple stimuli; Reitan, 1958; Tombaugh, 2004).

Motor and Physical Coordination. The combat veteran took 5.31 s preintervention and 5.07 s postintervention to complete the FTT. Finishing in less than 7.92 s is within the normal range, signifying normal ability to move the right leg between the accelerator and the brake when driving (Marottoli et al., 1994). The combat veteran's right knee and ankle ROM were both assessed as within functional limits.

Table 1. Pre- and Postintervention Clinical Test Results

Test	Cutpoints or Ranges	Preintervention Results	Postintervention Results
Mini-Mental State Examination	<26/30 points	30 points	30 points
Trail Making Test Part B	>180 s	83.00 s	83.00 s
Useful Field of View Test 1	>500 ms	16.70 ms	16.70 ms
Useful Field of View Test 2	>500 ms	16.70 ms	16.70 ms
Useful Field of View Test 3	>500 ms	63.40 ms	60.00 ms
Foot tap test	<7.92 s	5.31 s	5.07 s
Right lower-extremity range of motion	Functional for use of accelerator and brake	Intact	Intact

Driving Errors

Baseline Preintervention Driving Errors. The combat veteran made 33 driving errors of six types (Table 2). Interestingly, the three lane maintenance errors involved trash-provoked response triggers; the combat veteran gave the trash wide berth.

During Session 1, the combat veteran explained that he was trained as a soldier to avoid trash on the road and would always give trash wide berth if there was no oncoming traffic. In Session 2, he identified potential hiding places of gunmen as cues he searched for in Iraq, including a ditch, a rooftop, and a large sign. He explained that he could not detect both military and civilian critical cues concurrently and suspected that was the reason for his driving errors.

Postintervention Driving Errors. The participant made 9 errors of three types (Table 2). He made no signaling, visual scanning, gap acceptance, or adjustment-to-stimuli errors and no driving errors in response to the triggers (trash, disabled vehicles, dead animals, unexpected maneuvers from road users, loud helicopter sounds, and a backfiring motorcycle).

Discussion

This single-subject design study aimed to determine whether an occupational therapy driving intervention improved the driving ability of an OIF veteran with an orthopedic injury and PTSD by comparing pre- and postintervention clinical and driving test results. The veteran received the intervention 7 yr after returning from Iraq and 1 yr after involvement in an MVC. The participant's orthopedic injury, which made him eligible for the study, was a consequence of the MVC sustained during civilian life. As such, the MVC and resultant injuries may have affected his driving ability differently than the injuries of other OEF–OIF veterans with driving performance issues.

According to UFOV results, the participant's processing speed, divided attention, and selective attention were within normal limits. The improved score on UFOV

Test 3 postintervention may indicate a possible learning effect during the intervention. This effect is perhaps attributable to the visual search training, which cultivated selective attention skills by training the participant to attend to critical cues and disregard irrelevant ones. No differences were found in the pre- and posttest results of the motor assessments, perhaps because the participant's motor performance was stable before participation.

For the driving tests, the combat veteran most commonly erred in lane maintenance and vehicle positioning. Both involve apt positioning of the vehicle in relation to other vehicles, objects, and pavement markings in the driver's surroundings. The combat veteran's progress on these skills demonstrated his greater ability to focus on the task at hand while appropriately managing the battle-mind triggers (e.g., searching for snipers). The emphasis on honing his visual search skills redirected the participant's focus from combat tactics to civilian cues, thus helping him more appropriately assess his driving environment. This finding suggests the utility of the visual search training and of the intervention overall.

Evading trash bags was a battle-mind driving tactic the combat veteran used in Iraq and continued to use in civilian life. Postintervention test results revealed that he no longer avoided the trash bags, suggesting that he overcame his combat mindset and improved the appropriateness of

Table 2. Pre- and Postintervention Driving Errors

Driving Error Type	Preintervention	Postintervention
Lane maintenance	23	7
Vehicle positioning	5	1
Signaling	2	0
Speed regulation	1	1
Visual scanning	1	0
Gap acceptance	1	0
Adjustment to stimuli	0	0
Yielding	0	0
Total	33	9

Note. Some driving errors are expected even among volunteer participants without medical conditions; normal ranges will be unavailable until completion of work in progress.

his search skills to the demands of civilian driving. Signaling provides other roadway users with information about the driver's next actions. Because the combat veteran made no signaling errors at posttest, we concluded that the intervention also helped him appropriately improve his on-road communication skills and recognition of the need to inform other road users of his intended actions.

Limitations and Future Research

The results, although they support the occupational therapy driving intervention, have limited internal and external validity. First, we are not certain whether other events occurred in the combat veteran's life during the intervention period that could have affected his progress. Second, the results are generalizable only to this combat veteran's experience and not to combat veterans as a population. Although the driving simulator allowed reproducible and consistent assessment and intervention and thereby permitted a practical comparison of driving errors pre- and postintervention, replication of effects in other combat veterans may be a future research strategy to control for the limited external validity (Portney & Watkins, 2000, p. 235). Our future research is aimed at testing more combat veterans in a randomized controlled study with an experimental and control arm. As such, we expect more rigorous findings and results to validate (or not) the occupational therapy driving intervention.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- A combat veteran reduced the number and types of driving errors made on a driving simulator after an occupational therapy driving intervention that included discussion of driving errors, retraining in visual search skills, and commentary on driving.
- The intervention potentially improved the selective attention of the combat veteran, but this finding needs further validation.
- A high-fidelity driving simulator can be used as an assessment tool to identify driving errors and as a treatment tool to remediate driving errors for combat veterans. ▲

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