A Recent Mild Traumatic Brain Injury Slows Drivers' Perception of Traffic Hazards

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Rationale

Individuals recovering from a mild traumatic brain injury (MTBI) may pose a road safety risk as cognitive deficits are a common consequence soon after such an injury[1,2]. However, no research has examined whether individuals recovering from a recent MTBI are safe to drive.

An important cognitive component of driving is drivers' hazard perception. It is defined as drivers' ability to search the road ahead for the rapid identification of potentially dangerous traffic situations[3]. Poorer hazard perception has been associated with higher crash rates in a number of studies[3-7]. Consequently, several Australian states and the United Kingdom now test hazard perception as part of their driver licensing programs.

Therefore, individuals recovering from a recent MTBI could be slower to identify traffic hazards; this could lead to an elevated crash risk in this group.

Aim

The aim of the present study was to address the lack of research on MTBI and driving by investigating the effect of a recent MTBI on drivers' hazard perception.

Method

Participants

- 42 patients with MTBI (6 female, 36 male) and 43 patients with minor orthopedic injuries (11 female, 32 male) were recruited from the emergency department of a large metropolitan hospital
  - Table 1 shows a summary of the sample's demographic and injury information
- General inclusion criteria:
  - Injured within 24 hours of testing
  - Aged 18 to 65 years
  - Driver's license
  - Blood alcohol concentration less than 0.05% at the time of recruitment (the same criterion as the legal driving limit in Australia)
  - Able to hear, read, and write for the purposes of testing
  - No previous neuropathology, severe psychiatric illness, or developmental disorder; absence of intentional self-harm; no illicit drug use in the last 72 hours; and not under police guard

Table 1. *Demographic and Injury Profiles for Mild Traumatic Brain Injury and Orthopedic Groups*

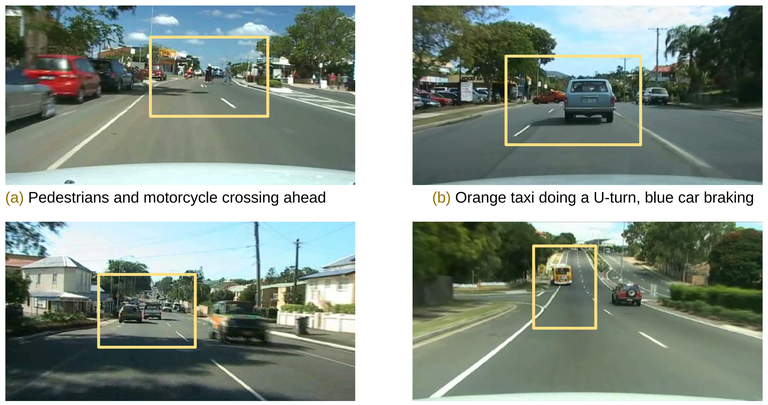
	MTBI (n = 42)		Orthopedic (n = 43)	
	M	*SD*	*M*	*SD*
Age (years)	25.38	7.54	28.71	8.14
GCS score	14.84	0.50	-	-
GOAT score	82.23	11.42	97.75	3.54
Loss of consciousness (minutes)	5.22	21.20	0	0
Blood alcohol concentration	0.009	0.018	0.001	0.007
Time since injury (hours)	10.23	5.22	7.38	7.01
Driving (years)	8.13	7.82	11.40	8.33
Education (years)	14.31	3.00	13.60	2.49
Number of previous head injuries	2.67	6.06	2.03	2.86

Note. Loss of consciousness, time since injury, and number of previous head injuries were self-reported. GCS = Glasgow Coma Scale[8]; GOAT = Galveston Orientation and Amnesia Test[9].

- Specific inclusion criteria for the MTBI group:
  - Diagnosis of closed head injury
  - Glasgow Coma Scale[8] score of 13 to 15 upon admission to hospital
- Specific inclusion criteria for the orthopedic group:
  - Trauma to a limb, but without the injury resulting from rapid acceleration or deceleration forces, and without having concurrently sustained a head injury

Hazard Perception Test

- The test was run on a laptop with a participant in bed or seated in a private bay awaiting treatment in the emergency department
- A participant viewed videos of genuine traffic scenes filmed from the driver's point of view
- The participant was required to use a computer mouse to click on any road users causing a 'traffic conflict' as early as possible
  - Traffic conflicts were defined as situations in which a collision (or near collision) between the 'driver' and another road user would eventually occur
  - All the traffic conflicts shown were genuine incidents taken from filming around Brisbane, Australia during daytime driving
  - See Figure 1 for examples of traffic conflicts presented during the test
- The test presented 24 unambiguous traffic conflicts in 22 minutes
- Main measure: A participant's mean response time to the traffic conflicts
- Psychometric properties: The test's validity has been established by its ability to find an experienced (low crash risk) vs. novice driver (high crash risk) difference[10]. The test had good reliability, Cronbach's α = 0.89



(a) Pedestrians and motorcycle crossing ahead

(b) Orange taxi doing a U-turn, blue car braking

(c) White car waiting to turn right, traffic swerves around to the left

(d) Bus pulls in to bus-stop, partially blocks lane

Figure 1. Example scenes from the Hazard Perception Test (yellow boxes indicate correct response areas)

Testing protocol

- The Hazard Perception Test was administered first
- The participants then also completed a Spatial Reaction Time Task, pain and emotionality scales, Short-Form Depression Anxiety Stress Scales, Digit Symbol Substitution, a semi-structured interview re: injury (including items comprising the Galveston Orientation and Amnesia Test[9]), Driver Behavior Questionnaire, driver questionnaire, recovery questionnaire, National Adult Reading Test, and LogMAR Visual Acuity Test
- Testing lasted about 40 minutes per participant, but testing was terminated early if emergency department staff wanted to treat a participant

Results

Significant group difference on the Hazard Perception Test

- Participants with MTBI were significantly slower to detect traffic conflicts in the Hazard Perception Test compared with participants with minor orthopedic injuries, $t(83) = -2.21$, $p = 0.03$ (two-tailed), $d = 0.48$.
  - Table 2 shows response times for the groups
- The observed 0.45 second difference between groups' response times is equivalent to 7.50 m braking distance difference if driving at 60 km per hour (about 37 miles per hour)

Table 2. *Hazard Perception Test Response Times for Mild Traumatic Brain Injury and Orthopedic Groups*

	MTBI		Orthopedic	
	M	*SD*	*M*	*SD*
Response time to hazards (seconds)	4.24	0.90	3.79	0.99

Discounting the effect of potential confounds

- Examined whether other variables could account for the group difference on the Hazard Perception Test, given the quasi-experimental nature of this study
- Excluding participants (n = 6) injured in road traffic collisions, i.e. where poor hazard perception could have *caused* the injury, did not change the group difference
- When variables were significantly correlated with the Hazard Perception Test response time or when groups differed on a variable, examined if that variable could mediate the group difference on the Hazard Perception Test
  - Procedure: Preacher and Hayes'[11] accelerated bootstrap procedure for indirect effects with 5,000 re-samples
  - Variables: Spatial reaction time, blood alcohol concentration, digit symbols correct, age, hours of sleep in last 24 hours, self-reported driving errors, driving experience in years, and National Adult Reading Test errors
  - Results: No significant mediation effects at the 95% confidence level
  - A third variable was unlikely to account for the group difference on the Hazard Perception Test

Conclusions

This study provides the first indication that within the acute stage post-injury, MTBI can be associated with impairment in a crash-related component of driving. Participants with MTBI were significantly slower to detect traffic conflicts than participants with minor orthopedic injuries within 24 hours of injury. The practical implication is that patients with MTBI should perhaps be advised to refrain from driving for at least the first 24 hours after injury.

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