Relation Between Subjective Fogginess and Neuropsychological Testing Following Concussion

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Abstract

The purpose of this study was to examine the relation between the subjective report of feeling foggy at one-week post concussion and acute neuropsychological outcome. The outcome variables were derived from a computerized neuropsychological screening battery (ImPACT). Participants were 110 high school students who sustained a sports-related concussion and were evaluated 5-10 days post injury (mean = 6.8 days). Athletes were divided into two groups on the basis of self-reported fogginess. The first group reported no fogginess (n = 91), whereas the second group reported experiencing some degree of fogginess (n = 19) on a 6-point scale. The athletes with persistent fogginess experienced a large number of other post-concussion symptoms, compared to the athletes with no reported fogginess. In addition, the athletes with persistent fogginess had significantly slower reaction times, reduced memory performance, and slower processing speed. Thus, athletes with any degree of self-reported fogginess at one-week post injury are likely to have persistent adverse effects from their concussions in multiple domains.

Introduction

When assessing athletes who have recently sustained a concussion, a variety of somatic and cognitive symptoms are spontaneously reported. These symptoms often include problems with headache, dizziness, photophobia, memory, and concentration. Other descriptions of cognitive change include “feeling one step removed from my surroundings” or “feeling like I’m in a fog”. One author (MG) frequently heard these descriptions during his dissertation research with British Columbia Junior Hockey League players. Another author (MRL) heard these complaints with such regularity in both amateur and professional athletes that the symptom “fogginess” was incorporated into his Postconcussion Scale that was developed through work with the Pittsburgh Steelers in the early 1990’s.

The purpose of this study was to examine the relation between feeling mentally foggy at one-week post injury and neuropsychological outcome. The outcome variables were derived from a computerized neuropsychological screening battery called ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing). A postconcussion symptom scale and three composite scores for reaction time, processing speed, and memory were used. It was hypothesized that high school athletes with self-reported fogginess would report more concussion symptoms, in general, than athletes who did not experience fogginess. Moreover, concussed athletes with persistent fogginess would perform more poorly on the neuropsychological composite scores than athletes without persistent fogginess.

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Methods

Participants

Participants in this study were 110 high school athletes who sustained a sports-related concussion during the 2000 and 2001 athletic seasons. All athletes participated in the Sports Medicine Concussion Program at the University of Pittsburgh Medical Center. Athletes were included from high schools within the states of Pennsylvania, Michigan, Illinois, Oregon, and Maine.

The average age of the sample was 15.8 years (SD = 1.2), and 84.5% were male. The majority of athletes were football players (63.6%). Other represented sports included basketball (12.7%), soccer (11.8%), hockey (3.6%), lacrosse (2.7%), softball (1.8%), track (.9%), volleyball (.9%), and wrestling (.9%). Half of the subjects (50.9%) reported at least one previous concussion, 33.6% reported that this was their first concussion, and 15.5% had missing data on this variable.

Protocol and Outcome Measures

Dependent measures were collected through the administration of ImPACT, a computerized neuropsychological test battery, designed specifically for sports-related concussion. The test battery consists of seven individual cognitive test modules. Composite scores in the areas of memory, reaction time, and processing speed are computed by standardized formulas derived from the results of the seven individual cognitive tasks. In addition, the battery includes the Postconcussion Scale (Lovell & Collins, 1998) that is now being utilized throughout both amateur and professional sports. This Likert scale consists of 19 symptoms commonly associated with concussion (e.g., headache, dizziness, sleep deficits, nausea, feeling slowed down, etc.) that are graded from 0 (asymptomatic) to 6 (severely symptomatic). A more detailed description of the computerized test battery has been described in detail previously (Maroon et al., 2000).

Initial assessment of concussion was made by a certified athletic trainer or physician who was present at the time of injury. Concussion was diagnosed based on one or more of the following criteria as identified by on-field, court, rink examination: 1) any observable alteration in mental status or consciousness; 2) the presence of loss of consciousness and/or presence of anterograde amnesia (difficulty in forming new memory after trauma) or retrograde amnesia (difficulty in recalling events during period immediately preceding trauma); 3) evidence of a constellation of post-concussion symptoms, such as cognitive “fogginess”, nausea/vomiting, dizziness, balance problems, visual changes, presence of post-traumatic headache, etc following a collision involving the head or body. All athletes were evaluated via computerized neuropsychological testing 5-10 days post diagnosis of concussion (mean = 6.8 days).

Formation of Outcome Groups

Concussed athletes were divided into two groups on the basis of self-reported fogginess at the time of the post-injury neuropsychological evaluation. The first group reported no fogginess at this follow-up interval (n = 91), whereas the second group reported experiencing fogginess (n = 19). Concussed athletes were included in the persistent fogginess group if they endorsed any degree of fogginess on the Post-Concussion Symptom Scale. Fogginess severity was rated on a 6-point scale, with 1 indicating very mild fogginess and 6 indicating severe fogginess. The breakdown of this group by fogginess severity was as follows: 1 = 31.6%, 2 = 21.1%, 3 = 10.5%, 4 = 31.6%, and 5 = 5.3%. The two groups did not differ in age but they did differ in gender composition. All of the athletes in the persistent fogginess group were male, whereas 19% of the athletes without persistent fogginess were female.

Results & Discussion

Athletes with persistent fogginess also experienced a large number of other post-concussion symptoms, compared to the athletes with no fogginess ($p < .0001$; $d = 3.44$, very large effect size). In addition, the athletes with persistent fogginess had significantly slower reaction times ($p < .0002$; $d = 1.0$, large effect), reduced memory performance ($p < .01$; $d = .97$, large effect), and slower processing speed ($p < .004$; $d = .79$, large effect). Descriptive statistics, mean comparisons, and effect sizes are presented in Table 1. These differences in

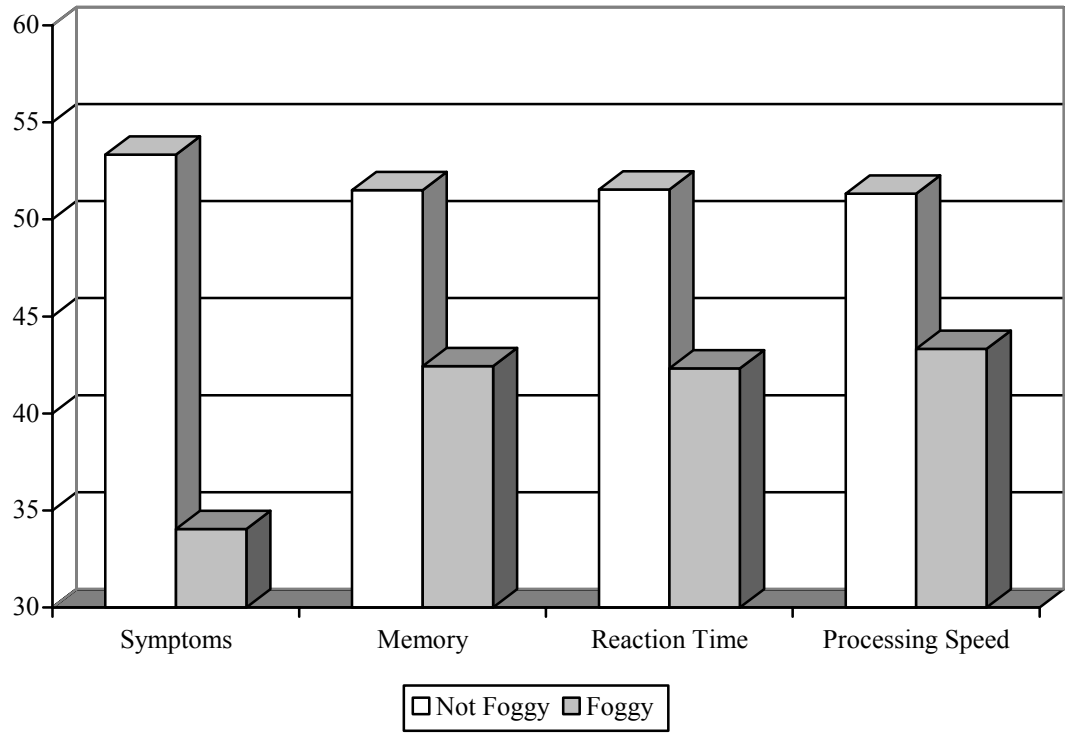
total symptoms, reaction time, memory, and processing speed are illustrated graphically in Figure 1. Thus, athletes with any degree of self-reported fogginess at one-week post injury are likely to have persistent adverse effects from their concussions in multiple domains.

Table 1. Descriptive statistics, mean comparisons, and effect sizes.

	No Fogginess		Persistent Fogginess			
Variable	Mean	SD	Mean	SD	p	Effect Size
Symptom Total Score	3.7	6.5	35.5	22.9	<.0001	3.44
Reaction Time Composite	.58	.09	.67	.10	<.0002	1.0
Processing Speed Composite	33.5	8.1	27.1	8.2	<.004	.79
Memory Composite	81.9	11.4	69.9	16.9	<.01	.97

P-values are based on independent t-tests. Nonparametric, Mann Whitney U tests revealed identical results. Cohen's effect sizes (d) are interpreted as follows: small effect = .2, medium effect = .5 and large effect = .8. The represent pooled and weighted standard deviation units.

Figure 1. Comparison of groups on the four composite scores transformed into uniform T-scores.



Note: These T-scores are not normative T-scores. They are standardized scores. The distributions of scores for each composite were standardized with a mean of 50 and a standard deviation of 10. The direction of the symptom score and the reaction time score was reversed, so that lower T-scores represented worse scores. Thus, all four composites can be compared graphically on a common metric.

The two groups comprising the total sample were used to investigate the relation between on-field injury severity markers and fogginess status at one-week post injury. Chi-square, between-group comparisons were conducted using the on-field markers as the dependent variables. As seen in Table 2, athletes with persistent fogginess were significantly more likely to experience retrograde amnesia ($p = .031$). However, they were not more likely to experience an initial on-field loss of consciousness, post-traumatic amnesia, or disorientation.

If the four primary on-field severity markers are considered simultaneously, 12.8% of athletes with no fogginess evidenced 3 or 4 of these markers, whereas 30.8% of the persistent fogginess group evidenced 3 or 4 abnormal markers. Although the chi square was not significant, there certainly was a trend in these data; an odds ratio revealed that players with persistent fogginess are 3 times more likely to demonstrate 3-4 abnormal on-field markers.

A variable representing mental status change for five or more minutes was also created. Approximately 22% of players with no fogginess had prolonged immediate post-injury mental status changes compared to 42% of players with persistent fogginess. Although the chi square was not significant, there appears to be a trend toward a relationship between on field mental status change and persistent fogginess.

Table 2. On-field Concussion Severity Markers by Group.

Variable	N	No Fogginess	Persistent Fogginess	X^2	p	Odds Ratio	95% Confidence Interval
Positive LOC	101	10.7%	5.9%	.37	.543	---	---
Retrograde Amnesia	92	19.0%	46.2%	4.7	.031	3.7	1.1 – 12.5
Post-Traumatic Amnesia	92	26.6%	46.2%	2.1	.15	---	---
Disorientation	70	62.7%	72.7%	.41	.524	---	---
3-4 Abnormal Markers	91	12.8%	30.8%	2.8	.097	3.0	.8 – 11.7
5+ Min. Mental Status Δ^*	88	22.4%	41.7%	2.1	.151	---	---

Due to the natural difficulties with collecting onfield markers, varying degrees of missing data were present. The number of subjects who had each marker coded ranged from 70 to 101.
*Five or more minutes of retrograde amnesia, post-traumatic amnesia, or disorientation.

The practical implication of this study is that it might be possible to have a simplified return-to-play heuristic for coaches and athletic trainers. That is, any degree of fogginess is associated with increased risk for incomplete recovery. Therefore, high school athletes with post-injury fogginess, regardless of severity, will likely benefit from an extended break from participation.

References

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