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Effects of "Diagnosis Threat" on Cognitive and Affective Functioning Long After Mild Head Injury

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Abstract

Persistent cognitive complaints are common following a mild head injury (MHI), but deficits are rarely detected on neuropsychological tests. Our objective was to examine the effect of symptom expectation on self-report and cognitive performance measures in MHI individuals. Prior research suggests that when MHI participants are informed they may experience cognitive difficulties, they perform worse on neuropsychological tests compared to MHI participants who are uninformed. In this study, undergraduate students with and without a prior MHI were either informed that the study's purpose was to investigate the effects of MHI on cognitive functioning ("diagnosis threat" condition) or merely informed that their cognitive functioning was being examined, with no mention of status ("neutral" condition). "Diagnosis threat" MHIs self-reported more attention failures compared to "diagnosis threat" controls and "neutral" MHIs, and more memory failures compared to "diagnosis threat" controls. In the "neutral" condition, MHIs reported higher anxiety levels compared to controls and compared to "diagnosis threat" MHIs. Regardless of condition, MHIs performed worse on only one neuropsychological test of attention span. "Diagnosis threat" may contribute to the prevalence and persistence of cognitive complaints made by MHI individuals found in the literature, but may not have as strong of an effect on neuropsychological measures. (*JINS*, 2011, *17*, 219–229)

Keywords: Brain injuries, Mild concussion, Neuropsychological test, Attentions, Memory, Affects

Approximately 90% of all brain injuries are classified as mild, with an estimate of 1.5 million non-institutionalized new mild to moderate cases each year in the United States (Sosin, Sniezek, & Thurman, 1996). The high prevalence of mild head injuries (MHI) largely contributes to the economic burden of all head injuries, accounting for an estimated 44% of the 56 billion dollar cost annually in the United States (Thurman, 2001). Neuropsychological assessments are one contributor to the overall cost, and are often necessary to investigate residual and persistent symptoms (cognitive, physical, and/or affective) reported by 14.5% (Rutherford, Merrett, & McDonald, 1979) to 50% (Edna & Cappelen, 1987; Middleboe, Andersen, Birket-Smith, & Friis, 1992) of individuals who have sustained a MHI in their past. Prospective controlled studies show that MHI participants report a significantly higher frequency of concentration difficulties (Ponsford et al., 2000), periods of confusion (Vanderploeg, Curtiss, Luis, & Salazar, 2007), and memory problems (Vanderploeg et al., 2007; Vanderploeg, Belanger, & Curtiss, 2009) at least 3 months, up to several years, following their injury compared to non-head-injured controls.

Despite these persistent attention and memory complaints, standard neuropsychological tests do not consistently detect deficits in cognitive functioning. Prospective controlled studies have reported residual neuropsychological deficits (at least 3 months post-injury) in various aspects of attention (Chan, 2002; Potter, Jory, Bassett, Barrett, & Mychalkiw, 2002; Solbakk, Reinvang, Neilsen, & Sundet, 1999; Vanderploeg, Curtiss, & Belanger, 2005) and information processing speed (Bernstein, 2002; Potter et al., 2002); although the majority fail to detect significant long-term neuropsychological impairments (for meta-analyses, see Belanger, Curtiss, Demery, Lebowitz, & Vanderploeg, 2005; Binder, Rohling, & Larrabee, 1997; Vanderploeg et al., 2005). Moreover, when lingering problems are detected, they are frequently confounded by extraneous variables, such as pre-existing factors (Vanderploeg et al., 2007), co-morbid psychosocial factors (Chan, 2002; Dischinger, Ryb, Kuferea, & Auman, 2009; Fann, Uomoto, & Katon, 2001; Rapoport, McCullagh, Shammi, & Feinstein, 2005; Stulemeijer, Vos, Bleijenberg, & Van der Werf, 2007), and litigation (for review, see Belanger et al., 2005; Binder & Rohling, 1996; Tsanadis, Montoya, Hanks, Millis, & Fichtenberg, 2008).

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An additional variable shown to confound the extent of cognitive symptoms following a MHI is the mere *expectation* that an individual will experience symptoms. Mittenberg, DiGiulio, Perrin, and Bass (1992) initially reported this ''expectation bias'' and found that MHI patients consistently underestimated the prevalence of affective, somatic, and memory symptoms they experienced before being injured, as compared to a base rate of symptoms reported in control participants. This finding has more recently been replicated and termed the ''good-old-days'' bias. Specifically, individuals who have sustained a MHI in their past report experiencing significantly fewer symptoms pre-injury compared to the reported base rate of symptoms in controls, resulting in an overestimation of the actual degree of change that occurred (Davis, 2002; Gunstad & Suhr, 2001, 2004; Iverson, Lange, Brooks, & Rennison, 2010; Lange, Iverson, & Rose, 2010). The influence of expectation on self-reported symptoms has largely been ignored in the MHI literature, but is a critical variable that must be considered, as most, if not all, participants/patients are aware that they are being examined because of their MHI. As a result, the effects of the ''expectation/good-old-days'' bias on cognitive functioning cannot be teased apart from the long-term effects of the injury itself. Accordingly, in addition to extraneous factors such as psychosocial functioning and litigation status, ''expectation bias'' is another factor that may largely contribute to cognitive findings reported in the MHI literature.

In addition to elevating symptom ratings, negative expectations also affect cognitive performance in individuals with a sustained MHI. Suhr & Gunstad (2002) coined this phenomenon "diagnosis threat," which they relate to the term "stereotype threat": a member of a specific group may display poor task performance simply because he/she is aware that the task is thought to be performed poorly by members of that group. For example, Spencer, Steele, and Quinn (1999) found that women performed worse on the math Graduate Record Exam compared to men when they were told to expect gender differences, but had equal performance when gender differences were not mentioned. Similarly, "diagnosis threat" was evident in a study of undergraduate students who self-reported a past head injury (Suhr & Gunstad, 2002, 2005). The "diagnosis threat" MHI group, who were told that they may be experiencing cognitive problems post-injury, had lower performance on tests of general intellect, memory, and attention, as well as had slower average psychomotor speed compared to "neutral" MHI participants. Together, these studies demonstrate that negative expectations are substantial enough to result in overestimations of symptom change pre- to post-MHI and to result in cognitive impairment.

The goal of the current study was to examine the effect of diagnosis threat on self-reported everyday cognitive errors and affective functioning, as well as behavioral measures of cognitive functioning, in individuals who sustained an MHI in their distant past (at least 6 months before testing). Unlike previous diagnosis threat studies, which investigated the effect by comparing two MHI groups (i.e., ''diagnosis threat'' *versus* ''neutral'' MHI groups), we recruited additional non-head-injured, gender-, age-, and education-matched controls, yielding two conditions each with two groups (controls and MHI). In ''diagnosis threat'' condition, we examined cognitive and affective functioning in undergraduate students with and without a self-reported MHI. All participants were informed, before data collection, of their specific group membership and were told that the purpose of the study was to investigate the potential long-lasting negative effects of a MHI on memory and attention. In the ''neutral'' condition, we similarly examined individuals with and without a MHI on cognitive and affective measures. Here, however, participants were told the purpose of the study was to merely examine memory and attention in young adults. No mention was made of group membership, or of the possibility of long-term negative effects of a past MHI.

In each condition, a battery of questionnaires and neuropsychological tests were administered to acquire self-report and behavioral measures of memory and attention. Unique to this study, we administered self-report scales that provide separate measures of attention and memory failures in everyday life: the Attention-related Cognitive Error Scale (ARCES; Carriere, Cheyne, & Smilek, 2008) and the Memory Failures Scale (MFS; Carriere et al., 2008), respectively. The more commonly used self-report measure of everyday cognitive failures is the Cognitive Failures Scale (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982). The CFQ, however, is not limited to attention-related errors, but rather errors due to action, attention and/or memory failures, thus memory and attention-related errors cannot be distinguished from one another. Our use of the ARCES and MFS allowed us to obtain separate measures of everyday errors due to two different types of cognitive failures: attentional lapses and memory lapses, respectively. Given previous research (Suhr & Gunstad, 2002), we hypothesized the ''diagnosis threat'' MHI group would report more everyday failures of memory and/or attention on average, and would also show performance impairments on measures of neuropsychological functioning, compared to the ''neutral'' MHI group and/or compared to the non-head-injured control groups.

METHODS

Participants

Undergraduate participants were recruited from the University of Waterloo's Research Experience Group, and received course credit for participating. The study was approved by the University of Waterloo's Office of Research Ethics. Students were prescreened for MHI, demographic and health status via a generic online questionnaire completed by all students taking Psychology courses at the beginning of the semester (see Appendix 1). A MHI was defined as any strike to the head or any acceleration/deceleration force (i.e., whiplash; Kay et al., 1993) that resulted in a loss of consciousness. Head injury severity was determined by duration of loss of consciousness (LOC), post-traumatic amnesia (PTA), and disorientation and/or confusion. Participants who had reported experiencing a

MHI, classified by a LOC not exceeding 30 min, were invited to participate in our study. Participants could have also experienced PTA, disorientation, and/or confusion, all not exceeding 24 hr (Kay et al., 1993; see Table 1). Table 1 also indicates if individuals sought medical attention ("Doc Visit"). The majority of MHI participants did not undergo brain imaging following their injury, and of those who did, all reported that no brain abnormalities were detected.

Participants were recruited from a group of 5325 undergraduate students who completed an online prescreen questionnaire at the beginning of either the winter, spring or fall 2009 semester. Of those students, 567 (10.6%) reported experiencing a head injury in the past and 475 (8.9%) fit our criteria for MHI (period of unconsciousness less than 30 min, at least 6 months before testing). A total of 43 undergraduates with a self-reported MHI (21 females) and 44 with no history of a previous MHI (25 females) signed up to participate in this experiment. All participants completed another demographic/head injury questionnaire at the time of testing to confirm details reported in the online prescreen. All participants were fluent English speakers, and had normal or corrected-to-normal hearing and vision. Participants also reported that they had never been clinically diagnosed with a psychological disorder, neurological disorder, depression or anxiety.

The experiment title and instructions were manipulated across conditions. Twenty-one participants with no history of head injury (11 females) and 22 participants (9 females), who had reported a past MHI, signed up to take part in a study that we entitled, "Working memory in young adults who have experienced a head injury compared to young adults who have not experienced a head injury." This condition was labeled the "diagnosis threat" condition, as all participants were explicitly informed in the Information letter that the experiment was being conducted to examine the potential negative effects of head injury on cognitive functioning. For our "neutral" condition, 23 participants (14 female) with no history of head injury and 21 participants (12 females), who had reported a past history of MHI, signed up to participate in a study we entitled "Working memory and Attention in Young Adults"; thus participants in this condition were unaware we were investigating the effects of past a MHI on cognitive functioning.

Procedure

In the "diagnosis threat" condition, all participants received an Information/Consent letter informing them that they were participating in a study entitled "Working memory in young adults who have experienced a head injury compared to young adults who have not experienced a head injury" (see Appendix 2). After signing the Consent form, participants were asked for demographic and health information. On this form, MHI participants were asked for additional details regarding their prior head injury (to supplement the information reported on the online prescreen questionnaire). Next, participants completed the neuropsychological tests and questionnaires in the following order: Digit-Span forward and backward, Trail-making A & B, CVLT, Computerized Stroop task, BDI, STAI, ARCES, and the MFS.

In the "neutral" condition, all participants received an Information/Consent letter at the beginning of the experiment informing them that they were participating in a study entitled "Working Memory and Attention in Young Adults" (see Appendix 2). Unlike those in the "diagnosis threat" condition, in which participants filled out the demographic and health questionnaire immediately after signing the Consent form, participants in the "neutral" condition first completed the neuropsychological tests and questionnaires. The demographic and health questionnaire was administered only at the very end of the test session as we did not want participants to be aware during testing that we were investigating effects of head injury. All participants were tested during the second and third months of term, and not during the final exam period, to ensure that any group differences were not related to final exam period stressors.

Self-report Questionnaires

Participants in both conditions filled out the Beck Depression Inventory (BDI; Beck, Steer, & Brown, 1996), State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970), the Attention-related Cognitive Error Scale and the Memory Failures Scale (ARCES and MFS; Carriere et al., 2008). The latter two scales are composed of 12 questions that ask participants to respond by choosing one of five responses on a Likert scale ranging from "Never" to "Very Often" (see Appendix 3). Items on this scale were selected from the cognitive failures scale (Broadbent et al., 1982), Reason's diary studies (Reason & Mycielska, 1982) in which participants recorded descriptions of slips of action in their daily lives, and from the authors' own experiences, based on personal diaries of attention and memory lapses. Both the ARCES and MFS have been shown to have good distributional and psychometric properties: good range of scores, no significant deviations from normality in skewness or kurtosis, good internal consistency, and good item-total correlations (Carriere et al., 2008).

Cognitive Measures

Attention span and working memory were assessed using the Digit-span forward and backward tasks, respectively (Wechsler, 1997). The Trail-making A and B tests (Reitan & Wolfson, 1985) were used to examine processing speed and cognitive flexibility, respectively. Performance on Trial 1 of List 1 of the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987) was examined to obtain a measure of immediate verbal memory. Participants also completed a 5-min computerized version of the Stroop task administered with E-prime v.1.2 software; Psychology Software Tools Inc., Pittsburg, PA. They were informed that a string of letters ("xxxx", "red", or "green") would appear one at a time on the computer screen and to press the "z" key if the font color was red and "m" if the font color was green

Table 1. Head injury characteristics

	'Diagnosis threat' MHI group					
Cause of injury	TSI	LOC	PTA	Conf.	Disor.	Doc Visit
Head hit into hockey boards	1.3	2.0	*	*	*	*
Fell off bike & hit head on rock	13	6.0			*	
Tire swing fastener fell on head	9.0	15	*		*	*
Hit water head first after jump	0.7	1.0		*	*	
Head hit ground during rugby	1.0	1.0	*	*	*	
Biking accident	3.0	1.0				*
Head hit into hockey boards	8.0	0.08				*
Pushed & head hit bookshelf	10	0.1			*	
Dove & hit head into wall	9.0	1.0			*	
Kicked in head during Rugby	0.8	1.0			*	
Hit in head during hockey	0.6	1.0			*	
Hit head against pole skiing	2.0	2.0	*		*	
Head punched in martial arts	1.6	0.03	*		*	
Fell off bike & hit head	0.5	0.02				
Pushed & head hit on ground	8.5	5.0			*	
Head hit bolt on trampoline	5.0	1.0				
Fell out of tree	1.3	5.0	*	*		*
Pushed & hit head on ice	5.0	1.0	*		*	*
Fell down stairs	2.0	2.0		*	*	
Dropped on head wrestling	8.0	1.0			*	
Tire swing rail fell on head	18	2.0	*	*	*	*
Pushed & hit head on ground	3.0	1.0	*	*	*	
MEAN	**5.1**	**2.2**				
SD	**4.8**	**3.3**				

	'Neutral' MHI group					
Cause of injury	TSI	LOC	PTA	Conf.	Disor.	Doc Visit
Fell & hit head on door hinge	13	0.5				*
Hit head running into someone	12	0.3		*	*	*
Hit in head with ice block	16	0.5		*		
Hit head on football goal post	5.0	0.8		*	*	
Hit in head with a discus	9.2	3.0			*	
Fell & hit head snowboarding	0.5	0.2	*	*	*	*
Fell & hit head on table	1.0	2.0	*		*	*
Hit in head with tire swing	10	3.0			*	
Hit heads playing baseball	4.0	2.0		*		*
Rode bike into wall	10	5.0	*			*
Fell & hit head snowboarding	9.0	3.0	*	*		*
Fell and hit head on ground	10	0.5			*	
Pushed into hockey boards	2.0	1.0		*	*	
Hit head on ice in hockey	4.0	0.3			*	*
Fell & hit head snowboarding	7.0	1.0				
Car accident-head hit door	5.0	0.3	*			*
Fell climbing-head hit ground	9.0	0.2				
Hit in head by baseball	4.0	1.0		*	*	*
Fell climbing-head hit ground	12	0.3	*		*	*
Pushed & hit head on bench	13	15	*	*		*
Hit in head by lacrosse stick	2.0	0.5		*	*	
	7.5	**1.9**				
	4.5	**3.3**				

Note. MHI = mild head injury; TSI = time since injury in years; LOC = duration of loss of consciousness in minutes; PTA = post-traumatic amnesia; Conf. = confusion; Disor. = disorientation. Means and SDs bolded for TSI & LOC. Asterisks indicates that participant experienced the specific side effect (< 24hr) listed in column header.

Table 2. Demographic characteristics

	Diagnosis threat condition		Neutral condition	
	Control $N = 21$	MHI $N = 22$	Control $N = 23$	MHI $N = 21$
Age	19.5 (3.5)	19.3 (1.1)	20.0 (1.2)	20.3 (2.1)
Education	13.9 (1.2)	13.5 (0.8)	13.8 (0.9)	13.7 (1.3)
% Female	52	41	61	57
TSI (years)	N/A	5.1 (4.8)	N/A	7.5 (4.5)
LOC (minutes)	N/A	2.2 (3.3)	N/A	1.9 (3.3)

Note. MHI = mild head injury; TSI = time since injury; LOC = duration of loss of consciousness.

(counterbalanced). The task was made up of 138 trials: 46 of which were neutral ("xxxx" shown in red or green), 46 congruent (the word, "red" in red font and the word, "green" in green font), and 46 incongruent (the word, "red" in green font and the word, "green" in red font). Participants' accuracy and response time (RT) were recorded in each condition.

RESULTS

All data were analyzed using a 2 × 2 analysis of variance (ANOVA) with Group (control and MHI) and Instruction condition ("diagnosis threat" and "neutral") as the independent variables. Planned independent samples *t* tests were administered to determine group differences when a significant interaction was detected.

Demographics

There were no significant main effects of Group, Instruction condition, or a Group × Instruction condition interaction on mean age or mean years of participants' education (see Table 2 for means and SDs). Independent *t* tests showed that there were also no differences between "diagnosis threat" MHI and "neutral" MHI participants on time since injury, $t(41) = -1.74$, $p > .05$, or duration of unconsciousness, $t(41) = 0.32$, $p > .05$ (see Table 2).

Self-report Measures

Table 3 shows the means for each measure across participant grouping.

Although the main effects of Group and Instruction condition were not significant for responses to statements on the ARCES, a significant Group × Instruction condition interaction emerged, $F(1,83) = 5.12$, $p = .03$. In the "diagnosis threat" condition, MHI participants complained of more everyday attention failures compared with controls, $t\ (15) = -2.37$, $p = .02$ (see Figure 1). MHI participants in the "diagnosis threat" condition also reported more attention failures compared to MHI participants in the "neutral" condition, $t(41) = 2.01$, $p = .05$. No other group differences emerged. Similarly, scores on the MFS revealed a significant Group X Instruction condition interaction, $F(1,57) = 3.94$, $p = .05$. MHI participants reported higher numbers of everyday errors due to memory lapses compared to controls, and this difference was limited to those in the "diagnosis threat" condition, $t(15) = -2.37$, $p = .03$ (see Figure 2). No other group differences emerged, and the main effects were non-significant.

A significant Group × Instruction condition interaction was also detected on self-reported state anxiety levels, $F(1,83) = 5.34$, $p = .02$. Specifically, the "neutral" MHI group reported higher mean state anxiety scores compared to the "neutral" control group, $t(42) = -2.11$, $p = .04$ and compared to the "diagnosis threat" MHI group, $t(41) = -2.52$, $p = .02$ (see Figure 3). No other group differences emerged, and the main effects were non-significant. For the measure of trait anxiety, the interaction trended in the same direction, $F(1,83) = 3.57$, $p = .06$. Specifically, "neutral" MHI participants tended to report higher levels of trait anxiety compared to "neutral" controls, $t(42) = -2.00$, $p = .05$. There were no significant main effects or an interaction on BDI questionnaire responses.

Table 3. Neuropsychological test and questionnaire results

Neuropsychological test/ questionnaire	Diagnosis threat controls	Diagnosis threat MHI	Neutral controls	Neutral MHI	Interaction *F* value	Interaction *p* value
Digit span forward	9.90 (2.17)	8.41 (2.22)	8.78 (2.37)	8.48 (1.54)	1.73	.19
Digit span backward	7.24 (1.30)	7.10 (2.11)	7.30 (2.14)	7.33 (2.18)	0.04	.84
Trail Making A	20.28 (7.39)	18.12 (4.20)	17.36 (5.00)	18.84 (4.60)	2.46	.12
Trail Making B	44.19 (18.74)	41.94 (16.57)	39.93 (12.69)	35.96 (9.39)	0.07	.79
CVLT Trial 1	7.38 (2.01)	8.09 (2.35)	8.00 (1.80)	7.29 (1.42)	2.96	.09
ARCES	32.95 (5.15)	38.00 (7.74)	35.30 (7.90)	33.57 (7.73)	5.12	**.03**
MFS[1]	25.30 (5.25)	32.67 (6.28)	28.78 (7.00)	27.95 (6.37)	3.94	**.05**
STAI (state)	32.67 (6.84)	30.55 (6.50)	30.82 (9.06)	36.67 (9.26)	5.34	**.02**
STAI (trait)	37.71 (8.00)	35.64 (10.80)	35.35 (8.29)	40.81 (9.86)	3.57	.06
BDI	7.43 (4.86)	10.95 (7.33)	8.83 (8.11)	10.62 (7.88)	0.32	.58

Notes. Values represented are mean group scores (standard deviations in parentheses). Bold items indicate significant interactions. CVLT = California Verbal Learning Test; ARCES = Attention-related Cognitive Error Scale; MFS = Memory Failures Scale; STAI = State Trait Anxiety Inventory; BDI = Beck Depression Inventory.
[1]Once all participants completed the 'diagnosis threat' condition, they were emailed and asked to fill out an additional online questionnaire (the MFS). Only a subset of participants responded (MHI = 6; controls = 10). All participants in the 'neutral' condition completed the MFS.

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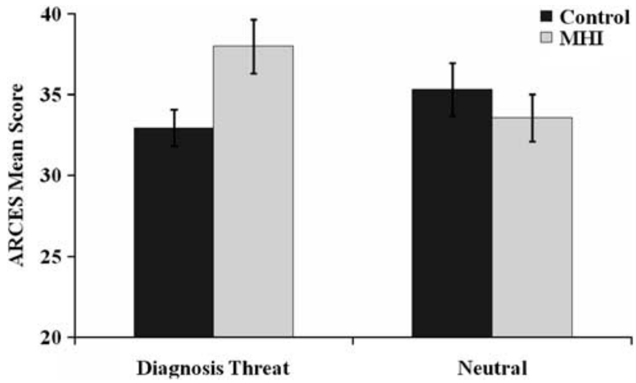

Fig. 1. "Diagnosis threat" mild head injury (MHI) participants reported significantly more everyday attention-related cognitive errors compared to "diagnosis threat" control participants and "neutral" MHI participants on the Attention-related Cognitive Error Scale (ARCES). No other group differences were found.

Neuropsychological Task Measures

Table 3 shows the group means for each neuropsychological measure. There was a main effect of Group on Digit span forward performance, $F(1,83) = 3.97$, $p = .05$, such that, regardless of instruction type, control participants outperformed MHI participants (see Figure 4). Although the Group × Instruction condition interaction was not significant, $F(1,83) = 1.73$, $p = .19$, planned comparisons showed that controls outperformed MHI participants, $t(41) = 2.24$, $p = .03$, but only in the "diagnosis threat" condition.

ANOVAs using data from the digit span backward, Trail making tests, and CVLT did not reveal any significant main effects or interactions.

Two separate 2 × 2 × 3 repeated measures ANOVAs were conducted to examine Stroop accuracy and median RT, with *Group* (control and MHI) and *Instruction condition* ("diagnosis threat" and "neutral") as the between variables, and *Trial Type* (congruent, incongruent, and neutral) as the within variable.

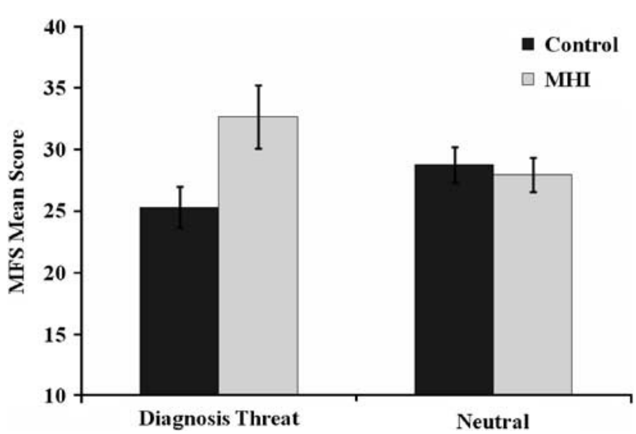

Fig. 2. "Diagnosis threat" mild head injury (MHI) participants reported significantly more everyday memory-related cognitive errors on Memory Failures Scale (MFS) compared to "diagnosis threat" control participants. No other group differences were found.

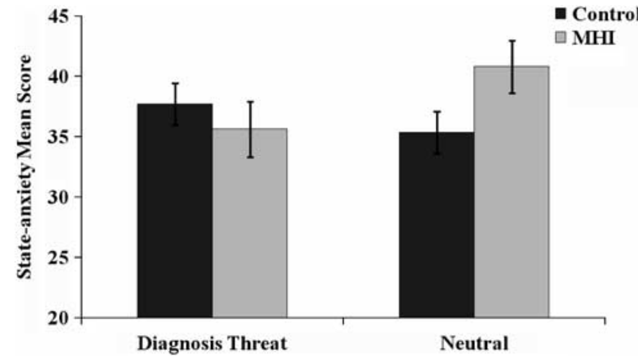

Fig. 3. "Neutral" mild head injury (MHI) participants reported significantly higher state anxiety levels compared to "neutral" control participants and compared to "diagnosis threat" MHI participants on the State Trait Anxiety Inventory (STAI). No other group differences were found.

Using accuracy as the dependent variable, there were no significant main effects, and no 2-way or 3-way interactions. Using median RT as the dependent variable, the main effects and 3-way interaction did not even approach significance, although the 2-way Group × Instruction interaction was suggestive, $F(1,83) = 1.07$, $p = .21$. Specifically, MHI participants in the "diagnosis threat" condition had slower median RTs ($M = 496.84$ s; $SD = 97.73$) compared with MHI participants in the "neutral" condition ($M = 448.49$ s; $SD = 84.10$), $t\ (41) = 1.74$, $p < .01$.

DISCUSSION

The key finding in this study is that the initial information provided to participants regarding the study's purpose influenced cognitive and affective self-report measures in individuals who sustained a MHI in their distant past. In line with our hypotheses, when informed that a MHI may result in persistent, but subtle, cognitive weaknesses ("diagnosis threat" instruction condition), individuals who sustained a past MHI reported significantly more attention-related errors

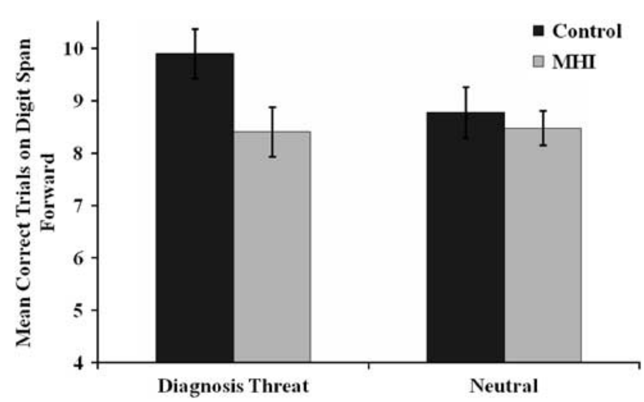

Fig. 4. Controls outperformed mild head injury (MHI) participants on the Digit span forward task, regardless of instruction type.

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in everyday life compared to non-head injured controls, and compared to MHI participants who were not exposed to the "diagnosis threat" instructions ("neutral" MHI group). Similarly, "diagnosis threat" MHI participants reported experiencing significantly more everyday memory failures compared to "diagnosis threat" controls. In contrast, no differences between MHI participants and controls emerged on these self-report measures, or on behavioral measures, when the study's purpose made no mention of MHI ("neutral" instruction condition). Importantly, there were no significant differences between the two control groups on any of the self-report or behavioral measures, confirming that both MHI groups were being compared to a similar control base rate. Notably, we found differences between control and MHI participants in the "neutral" condition in terms of anxiety levels: MHI participants reported experiencing higher levels of anxiety at the time of testing. "Neutral" MHI participants also reported higher state anxiety levels compared to "diagnosis threat" MHI participants.

With regard to cognitive performance, controls outperformed MHI participants on Digit span forward performance, regardless of instruction type. No other measure of neuropsychological functioning distinguished group performance, although Digit span forward and Stroop test performance showed trends suggesting that diagnosis threat may also impair attention span and slow information processing speed in MHI participants, respectively. Taken together, these results suggest that self-reports of everyday attention and memory functioning may be more susceptible to "diagnosis threat" than standard neuropsychological tests of memory and attention functioning. A novel aspect of the current study is that we not only examined the effect of diagnosis threat by manipulating instructions provided to MHI participants, but also compared these groups to their own age-, education-, and gender-matched controls. The addition of non-head-injured controls was essential as prior studies have found that even control performance may be negatively impacted by stereotype threat effects even though they are part of the "non-stereotyped" group (for a review, see Wheeler & Petty, 2001). To our knowledge, this is the first study to show that non-head injured control performance was not negatively impacted by exposure to a MHI "diagnosis threat".

The effect of "diagnosis threat" on self-reported attention- and memory-related cognitive errors in the present study is in line with past research demonstrating an underestimation of pre-injury symptoms by MHI participants compared to control base rates (Davis, 2002; Gunstad & Suhr, 2001, 2004; Iverson et al., 2010; Lange et al., 2010; Mittenberg et al., 1992). We suggest that individuals who have sustained a MHI may attribute their present day cognitive errors to their past head injury, unlike non-head injured individuals, who perceive the same errors as normal everyday cognitive foibles. This "expectation" phenomenon is not unique to MHI, but rather is akin to the more general and widely-researched term, "suggestibility". Suggestibility is an individual's proneness to accept new information while inhibiting critical judgment and has long been shown to have the power to both accelerate recovery, and worsen serious medical conditions (see Spiegel, 1997 for review). We have shown that "suggestibility", long after MHI, contributes to an increase in the frequency of self-report cognitive complaints. To our knowledge, ours is the first study to show that MHI individuals have higher levels of self-reported everyday attention and memory difficulties at least 6 months after the injury compared with non-head-injured controls, but only when they were informed of the possible negative effects head injury may have on cognitive performance.

The lack of significant differences between control and MHI participants on the majority of neuropsychological tests in this study is consistent with past reports. Standard neuropsychological tests often fail to detect deficits which distinguish individuals with a past MHI from non-head-injured controls (for meta-analyses, see Belanger et al., 2005; Binder et al., 1997; Vanderploeg et al., 2005). We did, however, find that MHI participants had lower Digit span forward scores, a measure of attention span, compared to controls, which is in line with some other studies reporting neuropsychological deficits on attention tasks at least three months after MHI (Bernstein, 2002; Chan, 2002; Potter et al., 2002; Solbakk et al., 1999; Vanderploeg et al., 2005). It is unclear, however, whether these are affected by diagnosis threat. Suhr and Gunstad (2002, 2005) found that MHI participants exposed to the "diagnosis threat" had larger decrements in attention and psychomotor speed compared to MHI participants in their "neutral" condition. Psychomotor speed in our study was slower in "diagnosis threat" MHI participants than in "neutral" MHI participants on the Stroop Task, and they also showed lower Digit span scores than their controls, although our conclusions are limited by our relatively small sample size. Inconsistencies in detection of neuropsychological deficits following MHI, in the extant literature, may be a result of the heterogeneity of the MHI population being examined across studies, including, but not limited to, individual differences in time since injury, cause of injury, and MHI criteria used by researchers. It is important to keep in mind that we relied on self-report measures of MHIs in university students. Thus, we tested high-functioning young adults with head injuries that are arguably on the very mild end of the severity scale (i.e., average duration of LOC was approximately 2 min; see Table 1), which may have contributed to the lack of significant neuropsychological test findings.

Although persistent neuropsychological deficits may be present long after sustaining a single MHI (Bernstein, 2002; Chan, 2002; Potter et al., 2002; Solbakk et al., 1999; Vanderploeg et al., 2005), they may be less frequent and more subtle than subjective reports. Consequently, these subtle cognitive weaknesses may only be detected by experimental paradigms that heavily tax cognitive processing resources, such as divided attention tasks (Bernstein, 2002; Cicerone, 1996; Pare, Rabin, Fogel, & Pepin, 2008), or through the use of neuroimaging techniques. For example, functional magnetic resonance imaging (fMRI) has shown increased neural activation in MHI participants during working memory tasks compared to non head-injured controls (McAllister et al., 1999, 2001; Zhang, Johnson, Pennell, & Ray, 2010), and this increase in activation has been shown to positively correlate with severity of post-concussion symptom reports (Smits et al., 2009). Diffusion tensor imaging (DTI) is a more recent advancement that is being used to examine the effect of a MHI on the white matter integrity. Messe and colleagues (2010) have shown that individuals with post concussive syndrome (PCS; increased complaints beyond 3 months in cognitive, emotional, and somatic domains) had disruptions of long white matter tracts involved in various aspects of cognitive functioning compared to MHI individuals without PCS and non head-injured controls. The extent of damage has been reported to correlate with slower information processing speeds on a simple attention task (Niogi & Mukherjee, 2008). Together these imaging studies show that MHI may result in alterations in neural functioning *without* affecting behavioral performance. Moreover, cognitive weaknesses may be difficult to detect in these populations because of cognitive reserve—unaffected brain areas become active to compensate for the damaged areas. Such compensation likely prevents significant cognitive decrements in individuals with a past MHI, but may result in increased complaints (i.e., everyday slips of action due to memory and attention lapses) due to less efficient neural processing on a daily basis.

A finding unique to this study was that state anxiety measures were heightened in "neutral" MHI participants compared to their matched "neutral" controls, but no such differences were found between MHI and control groups in the "diagnosis threat" condition. As well, "neutral" MHI participants reported higher levels of state anxiety compared to "diagnosis threat" MHI participants. Prior studies have also found increased levels of self-reported anxiety (Dischinger et al., 2009; Westcott & Alfano, 2005) and increased prevalence of anxiety-related disorders (Mooney & Speed, 2001) long after MHI. This study adds to that literature in that higher anxiety levels were reported by high-functioning undergraduate students with a MHI following the completion of a neuropsychological test battery, but only when they were *unaware* the effects of their head injury were being investigated. Other research shows that MHI may interrupt neural pathways important for regulating emotional states. For example, brain areas implicated in post traumatic stress disorder (PTSD) have shown to overlap with those affected by MHI; the orbitofrontal and dorsolateral cortex and hippocampus (Stein & McAllister, 2009).

Our study suggests that "diagnosis threat" may differentially affect emotional and cognitive processing. Group differences in self-report anxiety levels may have been undetected in the "diagnosis threat" condition because the "diagnosis threat" Information letter acted as justification for participants' perceived poor performance. Feelings of anxiety may have been obscured by the expectation, for MHI participants, to show cognitive weaknesses. In other words, if individuals are explicitly reassured that they may show subtle cognitive deficits on these specific tasks due to their previous head injury, anxiety may be temporarily decreased. On the other hand, if MHI individuals are not provided with reassurance before cognitive task completion ("neutral" MHI group), reported anxiety levels may be elevated, and more representative of everyday levels, compared to the "diagnosis threat" MHI group and non-head-injured "neutral" controls.

The current study emphasizes that in addition to litigation, effort, malingering, psychosocial and pre-existing factors, "diagnosis threat" is another variable that should be considered when assessing cognitive status in MHI participants. In a recent report, Iverson, Zasler, and Lange (2007) compared effect sizes of common variables from meta-analytic studies that influence neuropsychological functioning and found that MHI had the smallest effect size ($d = -0.12$) on neuropsychological performance, followed by diagnosis threat ($d = -0.45$), litigation ($d = 0.48$), depression ($d = -0.49$), and malingering ($d = -1.1$). It is important to emphasize that "diagnosis threat" studies (Suhr & Gunstad, 2002, 2005), including the current one, demonstrate the negative impact of "diagnosis threat" on cognitive performance in high-functioning undergraduate students who self-reported a prior MHI, for which the main motivation to participate was extra class credit. Thus, "diagnosis threat" may be even more apparent in participants examined in the majority of the MHI literature, as most are recruited from hospital emergency departments or neuropsychologists' databases. Future research should continue to investigate the negative effects of suggestion/expectation on cognitive and affective functioning long-after MHI using self-report measures, sensitive behavioral tasks, and neuroimaging techniques.

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REFERENCES

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Manual for the Beck Depression Inventory-II*. San Antonio, TX: Psychological Corporation.

Belanger, H.G., Curtiss, G., Demery, J.A., Lebowitz, B.K., & Vanderploeg, R.D. (2005). Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. *Journal of the International Neuropsychological Society*, *11*, 215–227.

Bernstein, D.M. (2002). Information processing difficulty long after self-reported concussion. *Journal of the International Neuropsychological Society*, *8*, 673–682.

Binder, L.M., & Rohling, M. (1996). Money matters: A meta-analytic review of the effects of financial incentives on recovery after closed-head injury. *American Journal of Psychiatry*, *153*, 7–10.

Binder, L.M., Rohling, M.L., & Larrabee, G.J. (1997). A review of mild head trauma. Part I. Meta-analytic review of neuropsychological studies. *Journal of Clinical and Experimental Neuropsychology*, *19*, 421–431.

Broadbent, D.E., Cooper, P.F., FitzGerald, P., & Parkes, K.R. (1982). The cognitive failures questionnaire (CFQ) and its correlates. *British Journal of Clinical Psychology*, *21*, 1–16.

Carriere, J.S.A., Cheyne, J., & Smilek, D. (2008). Everyday attention lapses and memory failures: The affective consequences of mindlessness. *Consciousness and Cognition*, *17*, 835–847.

Chan, R.C.K. (2002). Attention deficits in patients with persisting postconcussive complaints: A general deficit or specific component deficit? *Journal of Clinical and Experimental Neuropsychology*, *24*, 1081–1093.

Cicerone, K.D. (1996). Attention deficits and dual task demands after mild traumatic brain injury. *Brain Injury*, *10*, 79–89.

Davis, C.H. (2002). Self-perception in mild traumatic brain injury. *American Journal of Physiological Medicine Rehabilitation*, *81*, 609–621.

Delis, D.C., Kramer, J.H., Kaplan, E., & Ober, B.A. (1987). *The California Verbal Learning Test*. San Antonio, TX: The Psychological Corporation.

Dischinger, P.C., Ryb, G.E., Kufera, J.A., & Auman, K.M. (2009). Early predictors of postconcussive syndrome in a population of trauma patients with mild traumatic brain injury. *The Journal of Trauma*, *66*, 289–297.

Edna, T.H., & Cappelen, J. (1987). Return to work and social adjustment after traumatic head injury. *Acta Neurochirurgica*, *85*, 40–43.

Fann, J.R., Uomoto, J.M., & Katon, W.J. (2001). Cognitive improvement with treatment of depression following mild traumatic brain injury. *Psychosomatics*, *42*, 48–54.

Gunstad, J., & Suhr, J.A. (2001). "Expectation as etiology" versus "the good old days": Post-concussion syndrome symptom reporting in athletes, headache sufferers, and depressed individuals. *Journal of International Neuropsychological Society*, *7*, 323–333.

Gunstad, J., & Suhr, J.A. (2004). Cognitive factors in post-concussion syndrome symptom report. *Archives of Clinical Neuropsychology*, *19*, 391–405.

Iverson, G.L., Lange, R.T., Brooks, B.L., & Rennison, A. (2010). 'Good old day' bias following mild traumatic brain injury. *The Clinical Neuropsychologist*, *24*, 17–37.

Iverson, G.L., Zasler, N.D., & Lange, R.T. (2007). Post-concussive disorder. In N.D. Zasler, D.I. Katz, & R.D. Zafonte (Eds.), *Brain injury medicine: Principles and practice* (pp. 373–403). New York: Demos Medical Publishing.

Kay, T., Harrington, D.E., Adams, R., Anderson, T., Berrol, S., & Cicerone, K. (1993). Report of the mild traumatic brain injury committee of the head injury interdisciplinary special interest group of the american congress of rehabilitation medicine: Definition of mild traumatic injury. *Journal of Head Trauma Rehabilitation*, *8*, 86–87.

Lange, R.T., Iverson, G.L., & Rose, A. (2010). Post-concussion symptom reporting and the "good-old-days" bias following mild traumatic brain injury. *Archives of Clinical Neuropsychology*, *25*, 442–450.

McAllister, T.W., Saykin, A.J., Flashman, L.A., Sparling, M.B., Johnson, S.C., Guerin, S.J., … Yanofsky, N. (1999). Brain activation during working memory 1 month after mild traumatic brain injury: A functional MRI study. *Neurology*, *53*, 1300–1311.

McAllister, T.W., Sparling, M.B., Flashman, L.A., Guerin, S.J., Mamourian, A.C., & Saykin, A.J. (2001). Differential working memory load effects after mild traumatic brain injury. *Neuroimaging*, *14*, 1004–1012.

Messe, A., Caplain, S., Paradot, G., Garrigue, D., Mineo, J., Ares, G.S., … Lehericy, S. (2010). Diffusion tensor imaging and white matter lesions at the subacute stage in mild traumatic brain injury with persistent neurobehavioral impairment. *Human Brain Mapping*, [Epub ahead of print].

Middleboe, T., Andersen, H.S., Birket-Smith, M., & Friis, M.L. (1992). Minor head injury: Impact on general health after 1 year. A prospective follow-up study. *Acta Neurologica Scandinavica*, *85*, 5–9.

Mittenberg, W., DiGiulio, D.V., Perrin, S., & Bass, A.E. (1992). Symptoms following mild head injury: Expectation as aetiology. *Journal of Neurology, Neurosurgery, and Psychiatry*, *55*, 200–204.

Mooney, G., & Speed, J. (2001). The association between mild traumatic brain injury and psychiatric conditions. *Brain Injury*, *15*, 865–877.

Niogi, S.N., & Mukherjee, P. (2008). Diffusion tensor imaging of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *25*, 241–255.

Pare, N., Rabin, L.A., Fogel, J., & Pepin, M. (2008). Mild traumatic brain injury and its sequelae: Characterisation of divided attention deficits. *Neuropsychological Rehabilitation*, *19*, 110–137.

Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Kelly, A., Nelms, R., … Ng, K. (2000). Factors influencing outcome following mild traumatic brain injury in adults. *Journal of International Neuropsychological Society*, *6*, 568–579.

Potter, D.D., Jory, S.H., Bassett, M.R., Barrett, K., & Mychalkiw, W. (2002). Effect of mild head injury on event-related potential correlates of stroop task performance. *Journal of the International Neuropsychological Society*, *8*, 828–837.

Rapoport, M.J., McCullagh, S., Shammi, P., & Feinstein, A. (2005). Cognitive impairment associated with major depression following mild and moderate traumatic brain injury. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *17*, 61–65.

Reason, J.T., & Mycielska, K. (1982). *Absent-minded? The psychology of mental lapses and everyday errors*. Englewood Cliffs, NJ: Prentice-Hall.

Reitan, R.M., & Wolfson, D. (1985). *The Halstead-Reitan neuro psychological test battery*. Tucson, AZ: Neuropsychological Press.

Rutherford, W.H., Merrett, J.D., & McDonald, J.R. (1979). Symptoms at one year following concussion from minor head injuries. *Injury*, *10*, 25–230.

Smits, M., Dippel, D.W.J., Houston, G.C., Wielopolski, P.A., Koudstaal, P.J., Hunink, M.G.M., & Lugt, A. (2009). Postconcussion syndrome after minor head injury: Brain activation of working memory and attention. *Human Brain Mapping*, *30*, 2789–2803.

Solbakk, A., Reinvang, I., Neilsen, C., & Sundet, K. (1999). ERP indicators of disturbed attention in mild closed head injury: A frontal lobe syndrome? *Psychophysiology*, *36*, 802–817.

Sosin, D.M., Sniezek, J.E., & Thurman, D.J. (1996). Incidence of mild and moderate brain injury in the United States, 1991. *Brain Injury*, *10*, 47–54.

Spencer, S.J., Steele, C.M., & Quinn, D.M. (1999). Stereotype threat and women's math performance. *Journal of Experimental and Social Psychology*, *35*, 4–28.

Spiegel, H. (1997). Nocebo: The power of suggestibility. *Preventive Medicine*, *26*, 616–621.

Spielberger, C.D., Gorsuch, R.L., & Lushene, R.E. (1970). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Stein, M.B., & McAllister, T.W. (2009). Exploring the convergence of posttraumatic stress disorder and mild traumatic brain injury. *The American Journal of Psychiatry*, *166*, 768–776.

Stulemeijer, M., Vos, P.E., Bleijenberg, G., & van der Werf, S.P. (2007). Cognitive complaints after mild traumatic brain injury: Things are not always what they seem. *Journal of Psychosomatic Research*, *63*, 637–645.

Suhr, J.A., & Gunstad, J. (2002). "Diagnosis threat": The effect of negative expectations on cognitive performance in head injury. *Journal of Clinical and Experimental Neuropsychology*, *24*, 448–457.

Suhr, J.A., & Gunstad, J. (2005). Further exploration of the effect of "diagnosis threat" on cognitive performance in individuals with mild head injury. *Journal of the International Neuropsychological Society*, *11*, 23–29.

Thurman, D.J. (2001). The epidemiology and economics of head trauma. In L. Miller, & R. Hayes (Eds.), *Head trauma: Basic, preclinical, and clinical directions* (pp. 327–348). New York: John Wiley & Sons.

Tsanadis, J., Montoya, E., Hanks, R.A., Millis, S.R., & Fichtenberg, N.L. (2008). Brain injury severity, litigation status, and self-report of postconcussive symptoms. *The Clinical Neuropsychologist*, *22*, 1080–1092.

Vanderploeg, R.D., Belanger, H.G., & Curtiss, G. (2009). Mild traumatic brain injury and posttraumatic stress disorder and their associations with healthy symptoms. *Archives of Physical Medicine and Rehabilitation*, *90*, 1084–1092.

Vanderploeg, R.D., Curtiss, G., & Belanger, H.G. (2005). Long-term neuropsychological outcomes following mild traumatic brain injury. *The International Neuropsychological Society*, *11*, 228–236.

Vanderploeg, R.D., Curtiss, G., Luis, C.A., & Salazar, A.M. (2007). Long-term morbidities following self-reported mild traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *29*, 585–598.

Wechsler, D. (1997). *Wechsler adult intelligence scale* (3rd ed.). New York: The Psychological Corporation.

Westcott, M.C., & Alfano, D.P. (2005). The symptom checklist-90-revised and mild traumatic brain injury. *Brain Injury*, *20*, 1261–1267.

Wheeler, S.C., & Petty, R.E. (2001). The effects of stereotype activation on behavior: A review of possible mechanisms. *Psychological Bulletin*, *127*, 797–826.

Zhang, K., Johnson, B., Pennell, D., & Ray, W. (2010). Are functional deficits in concussed individuals consistent with white matter structural alterations: Combined fMRI and DTI study. *Experimental Brain Research*, *204*, 57–70.

Appendix 1

Please choose one option for each question below.

Have you ever had a concussion (a blow to the head)? If so, did you lose **consciousness** for:

- 0 seconds (did not experience loss of consciousness)
- 1–59 seconds
- 1–5 minutes
- 5–15 minutes
- 15–30 minutes
- greater than 30 minutes

When did the concussion occur?

- less than 1 month ago
- 1–3 months ago
- 3–6 months ago
- 6 months to 1 year ago
- over 1 year ago

If you have had a concussion, did you experience loss of **memory** (brief amnesia) for:

- 0 seconds (did not experience)
- 1–59 seconds
- 1–60 minutes
- 1–24 hours
- greater than 24 hours

If you have had a concussion, did you experience **confusion** (inability to focus attention) for:

- 0 seconds (did not experience)
- 1–59 seconds
- 1–60 minutes
- 1–24 hours
- greater than 24 hours

If you have had a concussion, did you experience **disorientation** (difficulty with regard to direction or position/ loss of physical bearings) for:

- 0 seconds (did not experience)
- 1–59 seconds
- 1–60 minutes
- 1–24 hours
- greater than 24 hours

Appendix 2

Diagnosis Threat Condition: Information Letter

"Working memory in young adults who have experienced a head injury compared to young adults who have not experienced a head injury"

You are invited to participate in a research study to help us learn more about memory performance in individuals who have experienced a head injury in their past (at least 6 months ago) that was a result of any contact forces (i.e., hit or fall) or acceleration/deceleration trauma (i.e., vehicle accident). Past research indicates that some people who have experienced a head injury show mild memory difficulties on some types of tasks, but not others. This can occur for a variable amount of time after the head injury, ranging from days to years. This study will examine whether having experienced a head injury affects aspects of working memory (the ability to store and manipulate information) long after the injury. You will be included as part of the healthy group of young adults who have not experienced a head injury [this would read 'young adults who have experienced a head injury' for the MHI group] and your data will be compared to that of young adults who have experienced a head injury.

This study involves completing one memory task, five questionnaires, two short verbal tasks, and one short visual task. In the memory task, you will be asked to recall a short list of words that you will have listened to. For the verbal tasks, you will be asked to repeat numbers and read some simple words aloud. For the visual task, you will be asked to connect numbers and letters together. For the four questionnaires, you will be asked some questions regarding your demographic and health information, and personality traits. Most tasks are short, and you will be given break time between tasks.

Neutral Condition: Information Letter

"Working Memory and Attention in Young Adults"

You are invited to participate in a research study to help us learn more about working memory and attention performance young adults. This study involves completing one memory task, four questionnaires, two short verbal tasks, and one short visual task. In the memory task, you will be asked to recall a short list of words that you will have listened to. For the verbal tasks, you will be asked to repeat numbers and read some simple words aloud. For the visual task, you will be asked to connect numbers and letters together. For the four questionnaires, you will be asked some questions regarding your demographic and health information, and personality traits. Most tasks are short, and you will be given break time between tasks.

Appendix 3

Attention-Related Cognitive Error Scale[1] (ARCES; Carriere et al., 2008)

1. I have gone to the fridge to get one thing (e.g., milk) and taken something else (e.g., juice).
2. I go into a room to do one thing (e.g., brush my teeth) and end up doing something else (e.g., brush my hair).
3. I have lost track of a conversation because I zoned out when someone else was talking.
4. I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge).
5. I have gone into a room to get something, got distracted, and left without what I went there for.
6. I begin one task and get distracted into doing something else.
7. When reading I find that I have read several paragraphs without being able to recall what I read.
8. I make mistakes because I am doing one thing and thinking about another.
9. I have absent-mindedly mixed up targets of my action (e.g., pouring or putting something into the wrong container).
10. I have to go back to check whether I have done something or not (e.g., turning out lights, locking doors).
11. I have absent-mindedly misplaced frequently used objects, such as keys, pens, glasses, etc.
12. I fail to see what I am looking for even though I am looking right at it.

Everyday Memory Failures Scale[1] (MFS; Carriere et al., 2008)

1. I forget people's names, even though I rehearsed them.
2. I forget people's names immediately after they have introduced themselves.
3. I forget to set my alarm.
4. I double-book myself when scheduling appointments.
5. Even though I put things in a special place I still forget where they are.
6. I remember facts but not where I learned them.
7. I forget what I went to the supermarket to buy.
8. I find I cannot quite remember something though it is on the tip of my tongue.
9. I forget to pass on messages (e.g., phone messages).
10. I forget appointments.
11. I forget important dates like birthdays and anniversaries.
12. I forget passwords.

[1] From Consciousness and Cognition, 17, Carriere, J. S. A., Cheyne, J., & Smilek., D., Everyday attention lapses and memory failures: The affective consequences of mindlessness, 835-847, 2008, with permission from Elsevier.

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