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Phantom Brake Phenomenon in Survivors of Car Accidents

Zack Z. Cernovsky and Milad Fattahi

ABSTRACT

Background: **Survivors of high impact car accidents, when traveling in cars as passengers, may exhibit the phantom brake reaction. The reaction consists of involuntarily pressing the foot on the floor of the car in a reflexive attempt "to brake", even though there is no brake pedal in front of the passenger seat. This study examines the incidence and correlates of this special phenomenon.**

Method: **De-identified data of 114 survivors (37 men, 77 women; mean age 38.6, SD=12.4) of high impact motor vehicle accidents (MVAs) were available, with their responses to the Brief Pain Inventory, Insomnia Severity Index, Rivermead Post-Concussion Symptoms Questionnaire, Subjective Neuropsychological Symptoms Scale (SNPSS), PTSD Checklist for DSM-5 (PCL-5), ratings of depression and of generalized anxiety, and 3 questionnaire measures of driving anxiety, i.e., Whetstone's, Steiner's, and the Driving Anxiety Questionnaire (DAQ). One item of the DAQ assesses the phantom brake phenomenon on a 4-point scale (0=No, 1=Mild, 2=Moderate, 3=Severe): this is the key variable in the present study.**

Results: **Mild to severe forms of the phantom brake reaction were reported by 92.1% of the post-MVA patients. Significant correlations ($p<0.05$, 2-tailed) were found of the intensity of phantom brake reaction to the intensity of post-MVA pain (rs from 0.20 to 0.33), insomnia (r=0.40), the Rivermead post-concussion scale (r=.29), other post-concussive and whiplash symptoms as measured by the SNPSS (r=0.19), depression (r=0.30), generalized anxiety (r=0.32), and to DAQ (r=0.47) and Whetstone's (r=0.50) measures of driving anxiety. No significant relationships were found of the phantom brake reaction to age and gender.**

Discussion and Conclusion: **The phantom brake reaction was reported by almost all post-MVA patients and can be considered as a part of their post-MVA polytraumatic symptom pattern.**

Keywords: phantom brake reaction, pain, post-concussion syndrome, whiplash syndrome, driving anxiety.

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I. Introduction

Patients injured in high impact Motor Vehicle Accidents (MVAs) usually suffer from a polytraumatic symptom pattern that includes pain, pain related insomnia, PTSD, post-concussion and whiplash syndrome, depression, generalized anxiety, and also driving anxiety when again traveling in cars [1].

The present article focuses on a noteworthy part of the post-accident symptomatology, clinically known as the *phantom brake phenomenon*. It is the passenger's partly involuntary or unintended pressing of the foot on the floor of the car in a reflexive attempt "to brake," though there is no brake pedal in front of the passenger seat.

This unintended behavior often occurs in patients who resume travelling in cars after a serious MVA and are present as passengers. The passenger, responding as if by a reflex rather than a conscious decision, presses the foot on the floor when suddenly encountering a traffic situation that he or she subjectively perceives as potentially dangerous.

The present study examined statistical correlations of the phantom brake phenomenon to variables that constitute the polytraumatic post-MVA symptom pattern.

II. Method

We used de-identified archival data on 114 post-MVA patients (37 men, 77 women). Their age ranged from 18 to 69 years, with the mean at 38.6 (SD=12.4). The time elapsed since the patient's MVA ranged from 7 to 194 weeks, with the average at 53.8 weeks (SD=41.6), i.e., about a year. They all still experienced active post-accident symptoms that

required therapy. The majority of these patients still experienced some degree of the post-concussion syndrome (scores ranging from 7 to 63 on the Rivermead scale [2], [3], with mean=47.0, SD=9.9). Their scores on the Subjective Neuropsychological Symptoms Scale (SNPSS) [4] ranged from 0 to 52 with the mean at 20.8 points (SD=11.3). The SNPSS measures post-concussive symptoms that are not listed in the Rivermead scale (e.g., tinnitus, impaired balance, syndrome of word finding difficulty) and also symptoms of the cervical and lumbosacral whiplash [5] (e.g., tingling, numbness, reduced feeling in the limbs, reduced muscular control over the limbs).

Their mean rating was 6.5 (SD=1.5), on the "average pain" item of the Brief Pain Inventory [6]) and 23.9 (SD=4.4) on Morin's Insomnia Severity Index [7].

The patients' ratings were also available on Items 10 to 12 of the Whiplash Disability Questionnaire [8], i.e., ratings of depression, anger, and of anxiety via scales from 0 ("not at all") to 10 ("always"). These ratings of depression ranged from 2 to 10 points, with the mean at 8.3 (SD=1.7). Those of anger ranged from 0 to 10, with the mean at 8.5 points (SD=1.7). Those of anxiety ranged from 2 to 10, with the mean at 8.8 points (SD=1.6).

Most patients developed driving anxiety after their MVA. Their scores ranged from 23 to 93 (mean=66.3, SD=17.2) on the Whetstone Vehicle Anxiety Questionnaire [9], from 30 to 123 (mean=91.4, SD=23.2) on the Driving Anxiety Questionnaire (DAQ) [9], and from 9 to 18 (mean=15.1, SD=2.3) on Steiner's Automobile Anxiety Inventory [10].

Forty patients also completed the PTSD Checklist for DSM-5 (PCL-5).[11] Their PCL-5 scores ranged from 16 to 80 points with the mean of 57.0 (SD=16.0).

In their vehicular accident, 92 were the drivers, 18 were passengers, one drove a motorcycle, and 3 were pedestrians. The majority (N=76, i.e., 66.7%) had no previous MVA, 33 (28.9%) had one, 4 patients (3.5%) had 2, and one patient had 5 previous MVAs.

The key variable in the present study was the urge to press the foot on the floor to "brake." It was measured via Item 41 of the Driving Anxiety Questionnaire. On this item, the patients had to indicate whether the urge to press floor to "brake" was not experienced = 0, or was mild = 1, or moderate = 2, or severe = 3. We assessed the correlations of this variable to scores on the various questionnaires and rating scales, and also to age and gender.

III. Results

A. Incidence of the Phantom Brake Reaction

The majority of the post-MVA patients reported phantom brake reaction: 92.1% of the 114 patients reported experiencing the urge to press the foot on the floor to "brake." With respect the intensity of the urge or of the unintentional reaction, it was rated as "severe" by 64.9% of the patients, as "moderate to severe" by one patient (0.9%), as "moderate" by 19.3% of the patients, as "mild" by 7.0%, and as absent by 7.9% of the patients.

B. Correlations of Phantom Brake Reaction to Clinical Variables

The correlations of phantom brake reaction to scores on various clinical questionnaires are listed in Table I. Those to measures of pain intensity (average, least, and worst pain ratings on the Brief Pain Inventory), and to ratings of depression, anger, and anxiety (Items 10 to 12 of the Whiplash Disability Questionnaire), and to the post-concussion and whiplash syndrome can be considered as weak: the magnitude of the underlying coefficients does not provide an adequate basis for clinical predictions in individual cases.

The correlations of phantom brake reaction to the PTSD Checklist for DSM-5 (PCL-5), insomnia scores, and Whetstone Vehicle Anxiety Questionnaire and to the Driving Anxiety Questionnaire (DAQ) are of moderate magnitude.

TABLE I: Correlations of Phantom Brake Reaction to Clinical Variables

	Pearson Correlations	Significance values (2-tailed)
Ratings on Items 3 to 5 of the Brief Pain Inventory [6], N=114:		
Worst pain	0.29	p=0.002
Least pain	0.20	p=0.038
Average pain	0.33	p<0.001
Insomnia Severity Index [7], N=113	0.40	p<0.001
Rivermead Post-Concussion Symptoms Questionnaire [2], [3], N=87	0.29	p=0.007
Subjective Neuropsychological Symptoms scale (SNPSS) [4], N=113	0.19	p=0.041
Ratings on Items 10 to 12 on the Whiplash Disability Questionnaire [8], N=114		
Depression	0.30	p=0.001
Anger	0.39	p<0.001
Generalized Anxiety	0.32	p=0.001
PTSD Checklist for DSM-5 (PCL-5) [11], N=40	0.41	p=0.008
Whetstone Vehicle Anxiety Questionnaire [9], N=100	0.50	p<0.001
Driving Anxiety Questionnaire [9], N=114	0.47	p<0.001
Steiner's Automobile Anxiety Inventory [10], N=68	0.20	p=0.098

Legend: Since the Item 41 of DAQ measures the phantom reaction, we have calculated the correlation of the Item 41 only to a revised total DAQ score from which the Item 41 was deducted, to avoid an undue inflation of the correlation coefficient.
All correlations in Table I are significant at p<0.05, 2-tailed, except the one involving Steiner's Automobile Anxiety Inventory, however, even that correlation would be significant if 1-tailed test were used (some readers would prefer 1-tailed test).

It is also of interest to examine correlations of the phantom brake reaction to the individual items of the Rivermead Post-Concussion Symptoms Questionnaire, and to those of the Subjective Neuropsychological Symptoms Scale (SNPSS), the Whetstone Vehicle Anxiety Questionnaire and to those of the Driving Anxiety Questionnaire (DAQ), and to those of the PTSD Checklist for DSM-5 (PCL-5). The correlation matrix involving all these 121 coefficients is very large. To avoid interpreting less salient findings, we focus only on correlations significant at p<0.001, 2-tailed. Such significant correlations involving the individual questionnaire items were found only to DAQ and Whetstone's measures of driving anxiety. Those involving DAQ items are listed in Table II and those involving Whetstone's items in Table III.

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C. Correlations of Phantom Brake Reaction to the Individual Items of the Rivermead Post-Concussion Symptoms Questionnaire and to those of the Subjective Neuropsychological Symptoms Scale (SNPSS)

None of these coefficients involving individual items of the Rivermead and of the SNPSS reached the significance level of p<0.001, 2-tailed. Those closest to this criterion were, in the Rivermead questionnaire, coefficients involving correlations of phantom brake reaction to headaches (r=0.42, p=0.002, 2-tailed), fatigue (r=0.42 p=0.002, 2-tailed), and slow speed of thinking (r=40, p=0.003, 2-tailed). Unfortunately, our data set with computerized responses to all individual Rivermead items was small (N=51), even though, as noted in Table I, the Rivermead total scores were available from archival files for 87 patients.

The closest to the significance criterion in the SNPSS data (N=113) was the coefficient involving correlation of phantom brake reaction to tinnitus (r=0.28, p=0.003, 2-tailed).

No other coefficients involving SNPSS items were significant even at p<0.01, 2-tailed).

D. Correlations of Phantom Brake Reaction to the Individual Items of the PTSD Checklist for DSM-5 (PCL-5)

No correlations of individual PCL-5 items to the phantom brake reaction were significant at p<0.001, 2-tailed. None of the coefficients reached even the criterion of p<0.01, 2-tailed.

E. Correlations of Phantom Brake Reaction to the Individual Items of the Driving Anxiety Questionnaire (DAQ)

All correlations involving individual DAQ items significant at p<0.001, 2-tailed are listed in Table II.

TABLE II: CORRELATIONS OF PHANTOM BRAKE REACTION TO INDIVIDUAL ITEMS OF THE DAQ (N=114)

Situations associated with Driving Anxiety, as a driver:	Pearson Correlations
Item 2: As a driver, sitting in vehicle	0.32
Situations associated with Driving Anxiety, as a passenger:	
Item 16: As a passenger, sitting in vehicle	0.33
Item 18: Long distance trips	0.40
Item 19: In traffic	0.44
Item 20: On highways	0.35
Item 21: After nightfall	0.38
Item 22: Inclement weather	0.35
Item 25: When cars are following too close	0.43
Item 26: Making turns	0.35
Item 27: Changing lanes	0.33
Item 28: Near buses/trucks	0.47
Feeling/Behaviors as a driver:	
Item 30: Clutching the steering wheel or other objects	0.35
Item 31: Checking mirrors too often	0.35
Feeling/Behaviors as a passenger:	
Item 36: Feeling tense and uneasy	0.53
Item 37: Clutching objects	0.65
Item 38: Checking areas for danger	0.52
Item 39: Feeling compelled to give instructions to driver	0.49
Item 40: Feeling like driver is not driving safely	0.59

Legend: All correlations listed in Table 2 are significant at p<.001, 2-tailed.

The most salient coefficients in Table II suggest that the phantom brake reaction is more common among those patients who, as passengers, are clutching on objects in the car, feel that their driver is not proceeding safely, they report feeling tense and uneasy as passengers in cars, and keep checking the area for dangers. They feel compelled to give instructions to the driver, and report feeling uneasy when near busses or trucks, when in traffic, and also when other cars are following their vehicle too closely.

F. Correlations of Phantom Brake Reaction to the Individual Items of the Whetstone Vehicle Anxiety Questionnaire (N=100)

All correlations significant at p<0.001 (2-tailed) involving individual Whetstone items are listed in Table III. Most salient are the coefficients indicating that patients with the phantom brake reaction experience more anxiety as passengers and often point out hazards to the driver, feel stiff or tight when in cars, perspire more than normal when in cars, and feel a "need to be in control" when in cars.

TABLE III: CORRELATIONS OF PHANTOM BRAKE REACTION TO INDIVIDUAL ITEMS OF THE WHETSTONE (N=100)

Situations associated with Driving Anxiety:	Pearson Correlations
Item 5: When driving, I am very concerned when vehicles following behind are close	0.40
Item 7: I am anxious when others drive, and I am often pointing out hazards to them	0.52
Item 8: As a passenger, I am anxious when vehicles approach from the side	0.36
Item 9: As a passenger, I worry about vehicles behind us	0.37
Item 10: I feel a "need to be in control" when I am a passenger	0.46
Item 11: I feel light-headed or dizzy being in a vehicle	0.36
Item 12: I get headaches or pains when I am in a vehicle	0.36
Item 13: I feel stomach sickness or nausea when I am in a vehicle	0.43
Item 14: I perspire more than normal when I am in a vehicle	0.49
Item 15: I notice that my body is stiff or tight when I am in a vehicle	0.50
Item 21: When I think about getting in a vehicle, I get upset	0.44
Item 27: Aggressive drivers frighten me much more than before	0.40
Item 28: I get into more family arguments about driving than I did previously	0.37

Legend: All correlations listed in Table 3 are significant at p<.001, 2-tailed.

G. Correlations of Phantom Brake Reaction to Age, Gender, and Number of prior MVAs

With the significance criterion of p<0.05, 2-tailed, the intensity of phantom brake reaction was not significantly correlated with age (r=0.05, p=0.617), gender (r=0.12, p=0.218), and number of prior MVAs (r=0.05, p=0.622). Patients who were drivers during their recent MVA were not significantly more likely to engage in the use of phantom brake than those who were passengers at the time (r=0.10, p=0.300).

IV. DISCUSSION

The results suggest that severe forms of the phantom brake reaction might perhaps be as frequent as in 64.9 %, i.e., about two-thirds of post-MVA patients, when they resume participating in vehicular traffic as passengers in cars after their MVA. Less severe forms are observed in an additional 27.2% of the patients. The reaction seems reflexive and unintended and occurs when the passenger suddenly

encounters a situation he or she views as potentially dangerous.

The incidence of the phantom brake reaction is correlated to measures of intensity of post-accident pain, post-MVA sleep difficulties, post-concussion syndrome, whiplash syndrome, depression, anger, generalized anxiety, and driving anxiety. The largest correlation coefficients were statistically of moderate magnitude and involved primarily DAQ and Whetstone's measure of post-MVA driving anxiety. This suggests that the phantom brake reaction could be viewed as a part of the overall verbal and nonverbal phenomenon of driving anxiety.

Psychological profile of post-MVA patients with phantom brake reactions involves those persons who, when as passengers in cars, clutch onto parts of the car or onto other objects, feel that the driver is not proceeding safely, report feeling tense and uneasy as passengers, often point out road hazards to the driver, keep checking the area for danger, feel that their body becomes stiff and tight when in cars, they tend to perspire more when in cars, feel uneasy when near buses or trucks, and experience the "need to be in control" when in cars.

With respect to neuropsychological correlations of the phantom brake reaction, patients with more intense forms of phantom brake reaction are somewhat more likely to also report headaches, tinnitus, fatigue, and problems with slow speed of thinking.

How would behavioral theory of conditioning explain the phantom brake reaction? Theories of operant conditioning might point out that phantom brake reaction has its roots in so called avoidance conditioning when anxiety of the driver is reduced by activating the brake pedal as it usually resolves potentially dangerous road situations such as when a car ahead too abruptly slows down to turn into a parking lot. As a result of the avoidance conditioning, pressing the foot on the brake becomes an unplanned, unpremeditated, reflexive reaction to certain environmental stimuli, associated with little or no voluntary control. The reaction happens more frequently in highly anxious post-MVA patients, those present only as a passenger with no brake in front of the passenger seat. The typical triggers for this reflexive reaction are road situations subjectively perceived by the post-MVA patient as potentially dangerous.

Psychological theory of nonverbal learning via operant conditioning might explain the persistence of phantom brake reaction by pointing out that it is a behavior acquired through the process of so-called avoidance conditioning (see, e.g., explanations in Wortman et al.'s textbook of psychology [12], pages 194-195): behavior acquired via avoidance conditioning, i.e., avoidance learning, is usually highly resistant to extinction.

Some readers might wonder to what extent the phantom brake reaction correlates with *avoidance of driving* (as an important indicator of fear of driving). In Steiner's Automobile Anxiety Inventory, [9] the Item "*Do you avoid driving whenever possible?*" was not significantly correlated to the phantom brake reaction (r=0.01, p=0.912, 2-tailed). The correlation between the phantom brake reaction and another Steiner's Item "*Do you avoid being a passenger in a car whenever possible?*" reached the significance level of p=0.05, but the magnitude of the related correlation coefficient is low (r=0.24) and thus, indicates only a weak relationship, not suited for sufficiently precise clinical predictions in individual cases.

Most post-MVA patients drive less frequently after their accident: many of them avoid car trips when possible. However, there are too many confounding factors in studies on avoidance of driving after car accidents. For many post-accident patients, especially for those in Canadian remote rural locations, driving or travelling in cars is an almost unavoidable necessity. Furthermore, even for some patients in urban settings, using public transportation is inconvenient for those who experience an excessive pain when walking to the nearest bus, streetcar, or subway (underground train) stop.

V. Conclusions

The results of this study suggest that severe forms of the phantom brake reaction occur in perhaps about two-thirds of survivors of high impact car accidents. The phantom brake reaction is likely to be observed jointly with other symptoms of driving anxiety such as clutching onto parts of the car or onto other objects, feeling that the driver is not proceeding safely, and reports of feeling tense and uneasy as a passenger. From a statistical correlational perspective, the phantom brake phenomenon is correlated with measures of intensity of post-accident pain, post-accident insomnia, post-concussion and whiplash syndrome, depression, anger, generalized anxiety, and driving anxiety.

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