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Recognition of the symptoms of a concussion by Canadian and Hungarian ice hockey players

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Abstract

The objective of the current study was to measure and compare the Canadian and Hungarian ice hockey players' concussion recognition skills. A total of 128 Canadian and Hungarian ice hockey players were evaluated for the purposes of this study using the Concussion Recognition Questionnaire. At the moment of the evaluation, all participants were 16 years old and members of their national team. Our findings showed that the Canadian players identified more real symptoms and signs of concussion compared to Hungarian players, while the Hungarian players were significantly more accurate in terms of recognizing which were the fake symptoms. Importantly, previous experience concerning concussion did not influence the players' ability to recognize correct concussion-related symptoms. This research has crucial practical implications, as they highlight the importance of developing players' knowledge and skills of concussion recognition for preventing negative physical health outcomes.

Keywords: *ice hockey, concussion, symptoms, recognition, player*

As ice hockey allows physical contact between players, this sport has a higher concussion frequency than others (Clay, Glover, & Lowe, 2013). Ice hockey is a sports game characterized by high speed movement and frequent body contact with possible hard hits and fights. But the players cannot prepare or train their brain against a special type of traumatic injury: brain injury. A study conducted by Emery and Meeuwisse (2006) analyzed the risk of injury in different age groups of hockey players and found that 45% of all injuries occurred due to a lack of body checking skills. Current sports literature focuses on sport concussion history emphasizing the practical relevance of this topic (Nagy & Géczi, 2014). This is of particular importance for ice hockey as the sport's rules allow physical contact, and hence,

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preventing reactions to such contact is extremely difficult. Nevertheless, recognizing early signs of concussion is of equal importance, as this ability can help avoiding some of its negative consequents on the players' health.

Concussion is defined as a brain injury and as a complex pathophysiological process affecting the brain, induced by biomechanical forces (McCrory, Meeuwisse, Dvorák, Aubry, & Bailes, 2017). Researchers in the field have proposed the term "sport-related concussion" (SRC). This terminology was adopted based on expert consensus, not based on clinical practice guidelines, which are intended to inform health care professionals for the non-professional sport participants. According to McCrory and colleagues (2017), SRC has several common features which may be utilized in clinical practice for defining the nature of concussive head injury, and these include the following: (1) it may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an "impulsive" force transmitted to the head; (2) it typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously, but in some cases, symptoms and signs may evolve over a number of minutes to hours; (3) it may be followed by neuropathological changes, yet the acute symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging investigations; and (4) SRC results in a graded set of clinical symptoms that may or may not involve loss of consciousness. In respect to the latter feature, it is specified that the resolution of the clinical and cognitive symptoms typically follows a sequential course, however, it is important to note that in some cases symptoms may be prolonged. Additionally, the clinical symptomatology cannot be explained by substance use, other injuries (e.g., cervical injuries), or comorbidities (e.g., coexisting medical conditions) (McCrory et al., 2017).

This medical definition may be specific enough for the qualified medical personnel, but unfortunately, it may be too complicated for sport participants, as it does not facilitate their understanding regarding what is really happening to the brain during/ as consequence of an SRC and why (Caron, Bloom, Johnston, & Sabiston, 2013). Additionally, although the concept is well defined and described in clinical settings, people may hold some misconceptions. For example, many people think that concussion necessarily involves loss of consciousness. However, it is important to underline that loss of consciousness is only one possible symptom among many other. There may be an immediate loss of consciousness, in which case the injured person usually does not remember pre- and post-accidental events. It is also a belief that only a blow to the head can cause concussion, whereas as earlier mentioned, any part of the body can cause shock when it is transmitted by impulsive force to the head (McCrory et al., 2005). According to Coghlin, Myles, and Howitt (2009) there are four types of symptoms of concussion: physical, cognitive, emotional and physical, which are presented in Table 1.

Table 1.
Signs and symptoms of concussion

Physical symptoms	**Cognitive symptoms**	**Emotional symptoms**	**Physical signs**
Headache	Confusion	Depression	Loss of consciousness
Dizziness	Amnesia	Irritability	Poor coordination
Nausea	Disorientation	Moodiness	Easily distracted
Feeling "unsteady"	Poor concentration		Poor concentration
Feeling "dinged",	Memory disturbance		Slow responses
"stunned", "dazed"			Vomiting
Describing bell ring			"Glassy eyed"
"Seeing stars",			Photophobia
visual disturbance			Aphasia
Tinnitus			Personality change
Diplopia			Inappropriate behavior
			Decreased physical ability

According to the literature, it is of great significance to recognize even the mildest concussion, because the likelihood of negative consequences of newer concussions increases with failure of early detection (Slobounov, 2008). The symptoms and consequences of a second concussion may be more acute than those of the first one, and therefore, the recovery time may be significantly increased (Guskiewicz, McCrea, & Marshall, 2003). According to some researchers, special attention should be paid to young athletes' concussions, because their brain is still developing, and hence, injuries at this age may have serious consequences such as headache, cognitive impairments such as memory and executive-function disturbances, visual problems, motor and sensory changes, as well as seizures (Annegers, Hauser, Coan, & Rocca, 1998; Marchie & Cusimano, 2003). The seriousness of concussions has recently attracted a lot of media attention due to tragic events in many major sport leagues like the National Football League (NFL) or the National Hockey League (NHL; Armour, 2017; Associated Press, 2013, 2014; Boylen, 2017; Campbell, 2017; Cantu, 2007). Consequently, the flow of accurate information between coaches, players and parents should facilitate early recognition of concussions and prevention of negative consequences.

In the terms of athletes' early management of concussion signs and their "return to play" management following a concussion, the most important factor is early detection and proper documentation. One tool which aids early detection of concussions is represented by the Sport Concussion Assessment Tool (SCAT), developed by scientists and physicians to help recognize symptoms of concussion as quickly as possible. Currently, the SCAT is available in both classical paper-pencil format, as well as in the form of smart phone applications (i.e., FirstResponder, Concussion MD). The advanced SCAT (now SCAT 5) card was developed in several different sport concussion related congresses (McCrory, Meeuwisse, Aubry, Cantu, &

Dvorák, 2013; McCrory et al., 2017). SCAT card was developed based on previous tools for recognizing concussions employed in different sports such as: the Management of Concussion Sports Palm Card developed by the American Academy of Neurology and Brain Injury Association (Kelly et al., 1991), the Standardized Assessment of Concussion (McCrea, Randolph, & Kelly, 2000), the Sideline Concussion Check-UPMC/Thinksafe/Sports Medicine New Zeeland Inc. and Brain Injury Association (Khrapko, McLelland, Russell, & Henry, 2017), the McGill Abbreviated Concussion Evaluation (unpublished), the National Hockey League Physician Evaluation Form (unpublished), the United Kingdom Jockey Club Assessment of Concussion (Turner, 1998), and the Maddocks Questions Test for Concussion (Maddocks, Dicker, & Saling, 1995). Two other useful test protocols are frequently employed in practice, the King-Devick test (Smith et al., 2017) and the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT Test Battery; Schatz, Pardini, Lovell, Collins, & Podell, 2006), as they provide more information about the condition of the injured player. These tests are the most widely used scientifically proven computer-based batteries for concussion management. Players need to be assessed in an asymptomatic state, and after a possible concussion. Based on the differences between the results obtained in the two situations, feedback can be provided on the severity of the injury. However, in the lower level sport leagues and youth programs there are less well-trained people who are less familiar with the symptoms, and therefore, it is less likely that they use King-Devick or Impact tests. Additionally, in the Hungarian top-level ice hockey league none of the clubs have a full-time, highly qualified health professional as part of its staff.

Generally, in case of a concussion, the player is not able to detect the symptoms, and may not consider it as a serious problem or report it to the staff because he/she wants to continue playing (Osborne, 2001). Athletes' awareness and knowledge about concussions should be expanded, but many symptoms, such as glassy eyes, dazed look, irritability, or balance problems, are more easily detected by parents or coaches. The final decision to let an athlete play always belongs to the coach during a game. Even if an athlete is trying to hide the symptoms after a hit, the coach can request a medical evaluation and can prevent the injured athlete from playing. However, not all parents and coaches are aware of posttraumatic symptoms, and they do not have information about what happened to the player during the game. Parents and coaches may think that a minor headache or the need for more sleep is normal. Research is currently underway on methods that promote recognition, but a concussion cannot be detected by any medical device. Complex neuropsychological tests are appropriate for assessing the severity of concussion, but simpler tests that can be performed on smart phones or on paper are much more convenient for non-qualified people (McCrea, 2001). The role of a coach is extremely important in youth sports as they spend most of their time with the athletes they should see mostly what happened, so they have the greatest chance to recognize a concussion, so that the athlete can receive the best medical care.

Current study

This study's aim was to investigate ice hockey players' recognition skills based on the Concussion Recognition Questionnaire (CRQ; Coghlin et al., 2009). More specifically, our objective was to analyze and compare players from one of the most "developed" countries (Canada) in terms of exposing players and coaches to concussion recognition skills with players from a "developing" ice hockey country (Hungary) on their knowledge about the signs and symptoms of concussions. Therefore, we intended to: (1) assess Canadian and Hungarian players' abilities to recognize both real and fake concussion symptoms; and (2) compare the number of correctly recognized concussion symptoms as a function of both country (Canada vs. Hungary), and previous experience with concussion (concussed vs. non-concussed).

METHOD

Participants

A total of 108 questionnaires were distributed to Canadian players and 50 to Hungarian players. The total returned questionnaires were 101 for Canadian players and 46 for Hungarian players, but only the fully completed questionnaires were analyzed. Thus, the final study sample (N = 128) consisted of 84 Canadian and 44 Hungarian players (all players were born in 1998 and 16 years-old at the moment of the evaluation).

Measures

Recognition skills of concussion signs and symptoms were evaluated with the CRQ. The original CRQ was developed in order to gather information from parents of 13–14 years-old athletes participating in hockey tournaments (Coghlin et al., 2009). The reason that they asked 13–14 years-old ice hockey players' parents was that these players had been in a body contact age group for at least two seasons, and thus would have exhibited increased risk of having sustained a concussion compared to younger players (Willer, Kroetsch, Darling, Hutson, & Leddy, 2005). The authors of the above-mentioned questionnaire were contacted, and their permission was obtained for using the survey for our research. The only change to the initial version was the fact that two new questions related to demographic characteristics were added. The translation, adaptation and validation of the Canadian questionnaire were made according to the method outlined by Geisinger (1994). With the help of the Canadian questionnaire's authors, the original questionnaire was translated into Hungarian, and then, back translated into English. Minor modifications to the

Hungarian wording were performed, where deemed necessary. The survey was distributed to the ice hockey players by hand on paper during their national team training camp in 2014.

The demographic questions were designed to indicate the position of the ice hockey player and the home club (Hungarian players) or provincial association (Canadian players). The next six questions are meant to determine the player's ability to recognize the signs or symptoms by guideline information that is currently being used to determine whether a player has received a blow to the head or body that may be diagnosed as a concussion. Questions 1–4 and 6 were of the Yes/No type while question 5 was unique. Question 5 consisted of twenty-five true or false questions asking the players to identify signs and symptoms of concussion. The questionnaire instructed the players to check true or false depending on whether they believed the items were correct signs or symptoms of a concussion. Out of the 25 questions, there were 17 true answers and 8 false answers. Specifically, the 8-false included: difficulty with urination, lowered pulse rate, difficulty with defecation, hearing voices, sinus congestion, feelings of euphoria, inability to swallow, and chest pain. These incorrect signs or symptoms were included to avoid the possibility of guessing all the correct answers, and to establish the extent to which players were able to discriminate between correct and incorrect answers.

Procedure

All participants individually completed the CRQ scale. Consequently, we calculated a score for the number of correctly indicated symptoms, as well as for the correctly recognized fake symptoms.

RESULTS

As presented in Table 2, players from both countries responded correctly to a high percentage of questions, but the accuracy percentages were somewhat lower for Hungarian players for each question. The fifth question required players to mark from the 25 listed symptoms those which represent true symptoms of a concussion. In the first step of the analysis, we compared the average of the correct answers. A two-sample independent *t* test was performed to compare the mean scores of the Canadian and Hungarian players' correct answers for the 25 questions. Hence, the Canadian players (M = 20.80, SD = 2.13) were able to recognize significantly more correct answers compared to the Hungarian players (M = 18.16, SD = 2.47), $t(127) = 6.33$, $p < .001$.

Table 2.
Percentage of correct answers regarding concussion symptoms by Canadian and Hungarian players

Questions	**Canadian Players** *N* = 84	**Hungarian Players** *N* = 44
1. Does a loss of consciousness determine whether a concussion has occurred?	85.7%	70.5%
2. Can a player who has suffered a concussion return to play in the same day?	100%	97.7%
3. A concussion may be caused by a blow to the neck, jaw, or elsewhere in the body?	90.5%	79.5%
4. Is it necessary for a player to be medically evaluated after having heard bell ringing?	98.8%	81.8%

Table 3 includes percentages corresponding to the number of times real symptoms were incorrectly identified by the players when completing the questionnaire. The results suggest that the real symptoms were incorrectly identified by a large portion of the Canadian and Hungarian players. Several real symptoms were however more difficult to recognize. The increased emotion/irritability was marked as not a real symptom by 39% of the Canadian, and 82% of the Hungarian players. Increased sleeping was not considered a real symptom by 50% of the Canadian and 71% of the Hungarian players. The third problematic symptom was seizures, as 51% of the Canadian and 93% of the Hungarian players believed that it is not a real symptom of concussion. Neck pain was interesting, as only a minority (18%) of Canadian marked it as fake symptom, but the majority (68%) of the Hungarian players thought it was not a real symptom.

Table 3.
Percantage of players who incorrectly indentified each real symptom of concussion

	Canadian players	Hungarian players	Rank of symptom – Canadian	Rank of symptom – Hungarian
Dizziness	1.2%	0%	14	16
Neck pain	17.9%	68.2%	4	4
Difficulty concentrating	0%	15.9%	16	11
Difficulty with memory	1.2%	15.9%	15	12
Problems with vision	8.3%	25.0%	9	9
Inability to describe time and place	4.8%	38.6%	10	8
Feeling dazed or in a "fog"	9.5%	13.6%	8	13
Seizures	51.2%	93.2%	1	1
Ringing the ears	4.8%	22.7%	11	10
Increased emotion/irritability	39.3%	81.8%	3	2
Increased sleeping	50.0%	70.5%	2	3

	Canadian players	Hungarian players	Rank of symptom – Canadian	Rank of symptom – Hungarian
Headache	3.6%	0.0%	13	17
Feeling nauseous	4.8%	9.1%	12	14
Difficulty falling asleep	14.3%	59.1%	6	5
Slurred speech	15.5%	47.7%	5	6
Drowsiness / fatigue	13.1%	43.2%	7	7
Feeling of "pressure" in the head	0%	2.3%	17	15

Each real symptom of a concussion which was not identified as a true symptom was assigned a rank, meaning that a real symptom which was most often not identified as a true symptom received the highest rank and the other answers were assigned a rank in descending order considering the frequency of them being misidentified. This is an indirect measure of the respondents' ability to associate knowledge about a symptom with the notion of concussion. The results showed that regarding the incorrectly recognized real symptoms, the rank correlation of answers provided by Canadian and Hungarian players was high (Spearman rank correlation $\rho = 0.88$). This result suggested that players from both countries encountered difficulties in correctly recognizing the similar symptoms.

A multivariate ANOVA was conducted to test for the effect of nationality on two dependent variables: the number of correctly recognized true symptoms, and the number of correctly recognized false symptoms. The results indicated that there was a significant effect of nationality for the number of correctly recognized true symptoms, $F(1,127) = 11.35$, $p = .001$, as well as for the correctly recognized false symptoms, $F(1,127) = 93.93$, $p < .001$. Post-hoc Scheffe tests indicated that the Canadian players marked more real symptoms as true ($M = 14.61$, $SD = 2.36$) than Hungarian players ($M = 10.93$, $SD = 1.85$), and this difference was statistically significant, $t(127) = 3.38$, $p = .001$). However, the Hungarian players were better at recognizing the false symptoms ($M = 7.22$, $SD = 1.25$) compared to Canadian players ($M = 6.19$, $SD = 1.82$). This difference was statistically significant as well, $t(127) = 9.70$, $p < .001$.

Answers to question 6 from the CRQ indicated that a total of 99 players (CAN: 66 and HUN: 33) answered that they have not had a concussion, whereas 29 had a concussion before (CAN: 18 and HUN: 11). Therefore, we conducted ANOVA to test for the effect of two variables, namely previous exposure to concussion (concussed / non-concussed) and player nationality (Canadian / Hungarian) on the average of correctly recognized concussion symptoms. Means and standard deviations for each group are reported in Table 4. The results indicated that there was no significant effect of previous exposure to concussion on correct recognition of concussion symptoms, $F(1, 127) = 0.54$, $p = .47$, but there was a significant effect of nationality, $F(1, 127) = 27.93$, $p < .001$. Post-hoc Scheffe test revealed that Canadian players were more likely to correctly recognize concussion

symptoms, $t(127) = 5.28$, $p < .001$. Consequently, it can be concluded that concussion history does not seem to influence players' ability to correctly recognize symptoms.

Table 4
The average of number of correct answers among concussed / not concussed and Hungarian / Canadian players

	Mean	***N***	***SD***
No concussion / CAN	20.89	66	2.08
No concussion / HUN	18.24	33	2.54
Concussion / CAN	20.50	18	2.33
Concussion / HUN	17.90	11	2.34

Note. CAN = Canadian, HUN = Hungarian

DISCUSSIONS

The first objective of this study was to evaluate concussion recognition in Canadian and Hungarian ice hockey players. The results concerning the first four questions from the CRQ regarding concussion symptoms (see Table 2) were answered correctly by the vast majority of the players, while the recognition of the symptoms was approximately 80%. The results of the statistical analysis of the players' data suggest that there is a significant difference between the answers of the players in the two countries. The Canadian players have increased knowledge about the symptoms and signs of concussion, as they identified more real symptoms and signs of concussion compared to Hungarian players. One possible interpretation of these outcomes is that ice hockey is considered as Canada's number one sport and their National governing organization, Hockey Canada, is actively focusing on implementing a special program for increasing awareness about safety regulations. Also, Hockey Canada developed a concussion awareness application for mobile devices which can be downloaded free of charge. Such strategies are not implemented by the Hungarian Ice Hockey Federation. Additionally, when a top athlete suffers a concussion in Canada and misses a couple of games or weeks (sometimes months), the media awareness and coverage are superior compared to similar situations depicted in the Hungarian media. The most prominent Canadian case occurred when one of the best players of the national team, Sidney Crosby, had suffered a concussion and, consequently, he had to miss nearly 11 months from the National Hockey League (Boylen, 2017). This case yielded great media attention. These reasons might explain the significant differences between the mean scores of the correct results in the Canadian and Hungarian samples.

Interestingly, fake symptoms yielded a significant difference between the two groups, as they were more accurately detected by the Hungarian players. This result might be attributed to a certain amount of confirmation bias in the Canadian

sample. Because in Canada more people associate ice hockey and risk for concussion more frequently, this might lead to misinterpreting several symptoms as a consequence of concussion, when in fact these are not signs of such problems. This interpretation might provide an explanation to the surprising result that although Canadian ice hockey players are more likely to recognize the real symptoms, they also rate fake symptoms as real more frequently. The most common falsely marked real symptoms or signs were the same in both the Hungarian and Canadian sample. If we compare these results with our previous research results, in which data were collected from the Hungarian ice hockey coaches and parents (Nagy, Kiss, Sós, & Géczi, 2016), we can conclude that three out of the four most frequently falsely marked real symptoms were similar in both studies. These data suggested that ice hockey players, as well as their coaches and parents have a good general knowledge about the most common symptoms and signs, but still need education about concussion recognition criteria. Given the current results, the symptoms with a low rank deserve special attention when educating the players (i.e., seizures, increased need of sleep, increased irritability). Considering that the rank correlation of the symptoms was high between the two samples, it means that the knowledge about the concussion was somewhat independent from the ice hockey culture – which underlines the importance of general education about the topic (in schools, in media etc.).

Additionally, contrasting our expectations, there was no significant difference between the results of players who already suffered concussion and those who never had have a concussion regarding the recognition of the real signs and symptoms. This would suggest that simply having been exposed to traumatic events does not increase awareness regarding concussion knowledge, which again highlights the importance of educating athletes about concussion symptoms.

Findings from the current study have important practical implications, because increasing awareness about concussion symptoms has an impact on the players' immediate and long term health status. Athletes' health should be the number one priority at all levels, because the professional athlete's career spans only a few years, and therefore it should be vital for them to have knowledge that can prevent injury related negative outcomes. We consider it important that the ice hockey players be informed in the future about concussion thereby protecting their health. Continuous education of players can help them to create better atmosphere within the team and players can correctly identify their symptoms and understand the reason why they cannot or should not continue playing.

Limitations and future directions. There were several limitations to our study. One limitation refers to the fact that only one age group of players was included in the sample. As players gain more experience, their knowledge about various injuries might increase, therefore it would be recommended that future studies use a more diverse sample. Another limitation of our research is related to the fact that other variables, which can affect the outcomes, such as previous

trainings regarding concussion recognition, were not taken into consideration. Therefore, future studies might investigate the effects of such variables on the ability to correctly recognize concussion symptoms. Also regarding the possible future research directions, it is might be considered advisable to conduct research using a similar methodology among the on ice officials and compare their results with the other participants involved in the sport. This would be important, because on ice officials are responsible for maintaining fair-play during the game, and their actions, as well as knowledge about such traumatic injuries, could help either preventing concussion from occurring during ice hockey matches, or to quickly intervene in circumstances when concussions occur by recommending a medical check for the player.

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