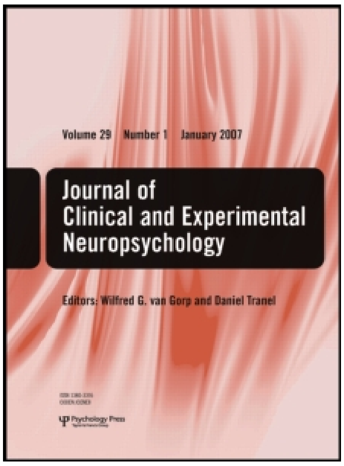

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The development of a survey to examine knowledge about and attitudes toward concussion in high-school students

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The development of a survey to examine knowledge about and attitudes toward concussion in high-school students

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The development of a new measure of concussion knowledge and attitudes that is more comprehensive and psychometrically sound than previous measures is described. A group of high-school students (N = 529) completed the measure. The measure demonstrated fair to satisfactory test–retest reliability (knowledge items, r = .67; attitude items, r = .79). Exploratory factor analysis of the attitude items revealed a four-factor solution (eigenvalues ranged from 1.07–3.35) that displayed adequate internal consistency (Cohen's alpha range = .59–.72). Cluster analysis of the knowledge items resulted in a three-cluster solution distributed according to their level of difficulty. The potential uses for the measure are described.

Keywords: Concussion survey; Survey validation; High-school athletes; Concussion attitudes; Concussion knowledge.

A concussion is defined as "a complex pathophysiological process affecting the brain induced by traumatic biomechanical forces" (McCrory et al., 2005, p. 48) resulting from a blow to the head, face, neck, or torso (it should be noted that this definition is consistent with World Health Organization definition of mild traumatic brain injury; von Holst & Cassidy, 2004). The blow may or may not be accompanied by short-term neurological dysfunction (American Congress of Rehabilitation Medicine, 1993; McCrory et al., 2005), which most often manifests in confusion and/or disorientation (present in up to 95% of cases; Guskiewicz, Weaver, Padua, & Garrett, 2000; Macciocchi, Barth, Alves, Rimel, & Jane, 1996) with amnesia and loss of consciousness (LOC) manifesting at far lower rates (less than 10% and less than 25%, respectively; Guskiewicz et al., 2003; Guskiewicz et al., 2000; Macciocchi et al., 1996).

Recovery from concussion takes about 5–10 days in adults (Echemendia, Putukian, Mackin, Julian, & Shoss, 2001; Macciocchi et al., 1996; McCrea et al., 2003) and typically follows a specific course whereby clinical signs (i.e., neurological dysfunction) often resolve before cognitive signs and symptoms. Cognitive signs of concussion include diminished attention and concentration, slowed information processing, and memory deficits (Echemendia et al., 2001; Erlanger et al., 2003; Macciocchi et al., 1996; McCrea et al., 2003). Postconcussive symptoms include headache, dizziness, difficulty remembering, and irritability (Echemendia et al., 2001; Lovell & Collins, 1998).

Although there has been some debate about the reliability and validity of the diagnostic criteria for postconcussion syndrome (PCS), empirical findings point to a subset of concussed individuals who experience prolonged (i.e., several weeks or months

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postinjury) postconcussive symptoms such as headache, fatigue, concentration difficulties, and so on (American Psychiatric Association, 2000; McCrea, 2008). Second impact syndrome (SIS) as defined by Cantu (1998) is a rare but catastrophic condition that occurs when an individual sustains an additional concussion before the physiological effects of an initial concussion have resolved. The second concussion involves a severe and irreversible rise in intracranial pressure due to unregulated brain edema and can result in death (Cantu, 1998; Cantu & Voy, 1995; McCrory & Berkovic, 1998; Saunders & Harbaugh, 1984).

As more information about the etiology, course, and sequelae of concussion has emerged, awareness about the importance of safe concussion management has improved. This is evidenced by the increasing number of neuropsychological testing programs in professional sports (Lovell & Barr, 2004; Lovell, Echemendia, & Burke, 2004), college sports (Echemendia et al., 2001; McCrea, et al., 2003), and, more recently, in high-school sports (Lovell et al., 2003; Moser, Schatz, & Jordan, 2005).

Given the substantial financial and personnel resources necessary to implement neuropsychological testing programs, it appears that a shift in thinking about concussion has occurred on the administrative level in the professional and college ranks and in a growing number of high schools. However, it is unclear whether efforts to improve the safety of concussion management have, in fact, increased awareness and altered potentially unsafe attitudes about concussion in the athletes that these programs are meant to protect.

To date, little has been done to examine the knowledge about and attitudes toward concussion in athletic populations. High-school athletes are an especially important group to examine due to their increased vulnerability to SIS (Cantu, 1998; Saunders & Harbaugh, 1984), the prolonged recovery periods exhibited by adolescent athletes relative to adults (Field, Collins, Lovell, & Maroon, 2003; Lovell et al., 2003; McClincy, Lovell, Pardini, Collins, & Spore, 2006), and the potential for PCS due to the fact that they are less likely to present to medical professionals after injuries (Aukerman, McNamara-Aukerman, & Browning, 2006; Olympia, Dixon, Brady, & Avner, 2007; Rosenbaum, 2007). In cases where medical professionals are not available to manage concussions, coaches, who tend to be less qualified to treat concussions, are often left in the position of managing both the concussed athlete and the athletic event (Guilmette, Malia, & McQuiggan, 2007; Rosenbaum, 2007).

Langlois, Rutland-Brown, and Wald (2006) reported that approximately 1.6–3.8 million concussions occur in the United States annually. Empirical data suggest that 50–75% of concussions among high-school athletes go unreported (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004; Sye, Sullivan, & McCrory, 2006). When asked why they do not report concussions, high-school athletes report difficulty detecting the injury, not feeling that it was severe enough to report, and/or fearing that they would be removed from competition (McCrea et al., 2004).

These findings suggest the presence of concussion knowledge and attitude deficiencies among athletes. To date, a small number of studies have formally examined what high-school and college athletes know and feel about concussion. In college athlete samples, misconceptions about return to play (RTP) guidelines, postconcussive symptoms, vulnerability to concussion, and mechanisms of injury were found (Livingston & Ingersoll, 2004; Sefton, 2003). In the study of high-school athletes, about 25% of the 296-athlete sample reported that concussion was best characterized by LOC (Sye et al., 2006).

Regarding concussion attitudes of high-school athletes, Sye et al. (2006) found that about 50% of their sample indicated they had returned to play after concussion without medical clearance or against physician's orders (22%), and/or they indicated that the importance of the game should influence RTP decisions (27%). Although these results do not address knowledge about concussion management among treating physicians, the seeming reluctance by some injured athletes to make healthy decisions suggests the presence of unsafe attitudes about concussion management. In the college athlete samples, almost 20% believed that they should make RTP decisions unilaterally (Livingston & Ingersoll, 2004), and approximately one third stated that it would be acceptable to wait until the end of a game/practice to report a concussion (Sefton, 2003).

Taken together, the research about concussion knowledge and attitudes in high-school and college athletes suggests that, despite the efforts that have been made to improve the management of concussion, unsafe attitudes and somewhat deficient knowledge about concussion exist in athlete populations, which may indicate that the new emphasis on the part of school administrations has not had a marked impact on their athletes. The dearth of available empirical data highlights the need to further understand what high-school athletes know and feel about concussion. However, this task may be difficult because the existing measures that have been developed to examine concussion knowledge and attitudes have several limitations.

The surveys developed by Livingston and Ingersoll (2004) and Sye et al. (2006), respectively, each assessed concussion knowledge and attitudes, but neither provided psychometric data about the survey. Limited data were reported by the developers of the two other known measures of concussion knowledge and attitudes: the College Football Head Injury Survey (Sefton, 2003) and the Knowledge and Attitudes about Sports Concussion Questionnaire (KASCQ-24; Simonds, 2004). The items on the College Football Head Injury Survey were evaluated for clarity and appropriateness by an expert panel, and the survey was administered to a small group of athletes to establish test–retest reliability, which was found to be satisfactory (r = .87; Sefton, 2003). However, no additional psychometric analyses were conducted, and the survey was composed of items that almost exclusively pertained to concussion knowledge, with only a few items addressing attitudes.

The KASCQ-24 was initially evaluated by an expert panel and was consequently revised and administered to samples of athletes (N = 49) and nonathlete controls (N = 68). Internal consistency analyses revealed that 28 of the original 52 items displayed low item-to-total correlations, but the remaining 24 items formed a unitary scale (internal consistency = .82; Simonds, 2004). Many of the items that were removed focused on knowledge and attitudes about mechanism of injury, concussion signs and symptoms, and so on, whereas the remaining items that comprise the current version of the KASCQ-24 focused on knowledge and attitudes specific to RTP guidelines.

On the basis of this information, it is apparent that the existing measures of concussion knowledge and attitudes have not been subjected to extensive psychometric scrutiny. Moreover, these surveys are limited in their coverage of the full range of the domains associated with concussion knowledge, attitudes, and management, and no measure has been updated to reflect recent research. Given these factors, with the current study we sought to develop a comprehensive measure of concussion knowledge and attitudes that possesses good reliability and validity.

It is important to develop such a measure for at least two reasons: (a) A psychometrically sound measure of concussion knowledge and attitudes has not yet been established and is necessary to accurately evaluate the effectiveness of emerging concussion education programs (e.g., the Heads Up! program—Centers for Disease Control, 2005—and the National Academy of Neuropsychology/National Athletic Trainers' Association programs—R. Echemendia, personal communication, February 5, 2008) in improving knowledge and altering unsafe attitudes; and (b) to develop a measure that can be used to document the concussion knowledge and attitudes of high-school athletes so that targets for potential intervention can be accurately identified.

Our study had several goals: (a) to develop scales that measure knowledge of and attitudes toward concussion; (b) to develop knowledge and attitude indices that have adequate internal consistency and test–retest reliability; and (c) to develop a measure of attitudes that was not especially susceptible to social desirability.

METHOD

Participants

High-school students in Grades 9–12 (mean age = 16.1 years; SD = 1.4 years; range 13–20 years) were recruited from six rural high schools in Northern New York. A total of 569 students completed at least a portion of the survey. Table 1 shows that the sample consisted of about one half males and one half females. About two thirds of the participants in the study reported participating in interscholastic sports. Chi-square analysis revealed that males and females were proportionately represented in the athlete and nonathlete groups, $\chi^2(1, N = 492) = 0.08, p > .05$. On average, participants had completed about 2 years of high school (M = 1.8 years; SD = 1.4 years).

Most of the participants (78.1%; N = 413) identified themselves as Caucasian, 11% (N = 58) did not report their race/ethnicity, and the remainder were from other racial/ethnic groups (i.e., Biracial, 5.9%; African-American, 1.5%; Hispanic/Latino/Latina, 1.5%; Asian, 1.3%; and Native American, 0.8%).

TABLE 1
Comparison of participants according to athletic status and sex

	Participants with partially or fully completed surveys[a,b]		*Participants with fully completed surveys*[c,d]	
Athletic status	*Male*	*Female*	*Male*	*Female*
Athlete	186	158	133	128
Nonathlete	78	70	53	48

[a] N = 529; 8 participants (1.5%) did not report their sex, and 29 participants (5.5%) did not report their athletic status and were excluded from the statistical analyses. [b] Chi square of sex by athletic status: $\chi^2(1, N = 492) = 0.08, p > .05$. [c] N = 366; 4 participants (1.1%) did not report their athletic status and were excluded from the statistical analyses. [d] Chi square of sex by athletic status: $\chi^2(1, N = 362) = 0.07, p > .05$.

Recruitment

Approval was obtained from the Institutional Review Board before the study commenced. Six high-school administrators and/or school boards provided approval for the study and mandated that parental permission be obtained. Parental consent was obtained via electronic or conventional mail. Of the 1,866 parents who received consent materials, 76% ($N = 1{,}422$) consented to allow their child to be recruited. Thus, 1,422 students were available for recruitment, although only 762 of the students were eligible to be recruited because the remaining students were recruited for participation in a separate study.

Students were recruited during visits to each of the six high schools. Of the 762 possible students, 198 were absent or unable to complete the survey on the day(s) it was administered. A total of 529 of 556 (95.1%) of the remaining students completed at least a part of the survey.

The survey was administered in either individual or group formats and was administered via computer or paper and pencil. As an incentive to participate, students were provided an opportunity to place their name into a drawing for a cash reward.

Measures

Rosenbaum Concussion Knowledge and Attitudes Survey—Student Version (RoCKAS-ST)

The RoCKAS-ST consisted of 55 items and was divided into five sections. Several of these items were selected from previous traumatic brain injury (TBI)/mild traumatic brain injury (mTBI) surveys designed by Gouvier, Prestholdt, and Warner (1988); Sefton (2003); and Simonds (2004), although most of the selected items were altered to better facilitate participant comprehension.

Sections 1 and 2 of the RoCKAS-ST examined knowledge of the causes and sequelae of concussion through the use of 18 true/false items. Each of the items contained a correct response choice (see Appendix A). The correct response choices are supported by the existing clinical data and empirical literature. In Section 1, knowledge was examined through the use of 15 basic items (e.g., "After 10 days, symptoms of a concussion are usually gone") and, in Section 2, knowledge was assessed by using three applied items (i.e., two sports scenarios; e.g., "Player Q and Player X collide. Player Q has never had a concussion in the past. It is likely that Player Q's concussion will affect his long term health and well-being"). Section 5 contained a checklist of eight commonly reported postconcussive symptoms (e.g., headache) and eight distractor symptoms (e.g., hives). The legitimate postconcussive symptoms are among the most commonly reported symptoms by concussed athletes (Guskiewicz et al., 2003; Guskiewicz et al., 2000; the legitimate and distractor symptoms are listed in Appendix A). Correctly answered items received 1 point, and incorrectly answered items received no points. The Concussion Knowledge Index (CKI) was derived by summing the scores across Sections 1, 2, and 5. Possible scores on the CKI ranged from 0–25, with higher scores indicating higher levels of knowledge.

Attitudes were measured in Sections 3 and 4, which contained a total of 15 items, each with 5-point Likert scales ranging from "strongly disagree" to "strongly agree." Of the 15 items, 5 were basic opinion items (e.g., "I feel that coaches need to be extremely cautious when determining whether an athlete should return to play"), and 10 were applied opinion items (i.e., scenarios similar to the applied knowledge questions, but participants chose from five Likert scale response choices rather than true/false choices). Participants received 1 to 5 points on each item depending on the safety of their response (i.e., 1 point for a very unsafe response and 5 points for a very safe response; see Appendix A for the responses that were classified as "safe"). The scores from Sections 3 and 4 were tabulated and comprised the Concussion Attitudes Index (CAI). Possible scores on the CAI ranged from 15–75, and higher scores represented safer attitudes about concussion.

Because of the high face validity of the RoCKAS-ST, seven items were included to assess poor/inconsistent effort and/or lack of thoughtfulness while completing the survey and comprised the Validity Scale (VS). Of these, only three were retained because these items were responded to incorrectly by less than 5% of the participants who satisfactorily completed at least part of the survey. The VS items were in true/false format. Correct responses warranted 1 point, and incorrect responses resulted in 0 points. Possible scores on the VS ranged from 0–3; scores of 0 or 1 were interpreted as invalid, and invalid surveys were discarded.

Marlowe–Crowne Social Desirability Scale (Marlowe–Crowne)

This scale included 33 items that were used to examine individuals' tendencies to present themselves in a favorable and socially desirable manner (Crowne & Marlowe, 1964). The items pertained to common experiences and reactions that may lead an individual to experience some discomfort or upset. Individuals who deny having many of these experiences are believed to be attempting to present themselves in an overly favorable manner (Crowne & Marlowe, 1964). This measure was used to identify the participants in the current study who appeared to be answering questions in a manner that suggested an overly socially desirable presentation, which may obscure any important trends in unsafe attitudes. Items were in true/false format, and socially desirable responses received a score of 1 whereas normative responses received 0 points.

Because higher scores on the CAI and CKI indicated higher knowledge and safer attitudes, respectively, and lower scores on the Marlowe–Crowne initially indicated lower levels of socially desirable responding, Marlowe–Crowne scores were reverse coded (e.g., an initial score of 33, which suggested high levels of socially desirable responding, was reverse coded and was assigned a score of 1). After reverse coding, high levels of socially desirable responding were indicated by lower scores, and low levels of socially desirable were indicated by higher scores.

Procedure

Of the 529 students who completed a part of the survey, 366 (69.2%) satisfactorily completed the survey. A participant's survey data were deemed satisfactory if they completed at least 90% of the items pertaining to knowledge (i.e., 23 of 25 items), attitudes (i.e., 14 of 15 items), and social desirability (i.e., 30 of 33 items), and/or answered at least two of the three VS items correctly (it should also be noted that 8 students were removed from the analysis because they did not report their gender). Participants who completed less than 90% of the items on any of the knowledge, attitude, or social desirability indices (N = 140) and participants who incorrectly answered at least two VS items (N = 23) were removed from the analysis due to the increased likelihood that their responses would be invalid. Table 1 shows that the sample of participants who satisfactorily completed the survey consisted of about one half males and one half females. About 70% of these participants reported participating in interscholastic sports. Chi-square analysis revealed that males and females were proportionately represented in the athlete and nonathlete groups, $\chi^2(1, N = 362) = 0.08$, $p > .05$. Most of the statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) Version 15 (SPSS, Inc., 2005), and GPower (Erdfelder, Faul, & Buchner, 1996) was used to conduct some of the power analyses.

Qualitative validation of RoCKAS-ST from experts and students

Three neuropsychologists, one psychophysiologist, and one industrial/organizational psychologist reviewed the RoCKAS-ST to provide information about the content validity of the survey. This panel was asked to identify any potentially confusing, unnecessary, or problematic content within the measures. Much of the feedback obtained resulted in minor wording changes, and some suggestions were made about the removal of superfluous items. Based on these suggestions, seven items were removed.

Further information about the content validity of the measure was obtained from a group of 7 high-school students. A total of 3 students received the computerized survey, and the remaining 4 students received the written version. In order to assess the clarity of the items, the principal investigator (PI) sat with each participant individually as they completed the measure and asked students to point out any confusing items. Additionally, the PI preselected several items on the RoCKAS-ST and queried participants about their interpretation of the meaning of the items and their rationale for the answers that they provided. Ultimately, one item was removed.

Quantitative validation of RoCKAS-ST

In order to examine the susceptibility of the attitude items to socially desirable responding, the Marlowe–Crowne—in addition to the RoCKAS-ST—was administered to 366 high-school students.

Development of construct validity and internal consistency

To identify the factor structure of the RoCKAS-ST CAI, an exploratory factor analysis (EFA) was conducted. A cluster analysis, which can be used to categorize variables into discrete groups (i.e., CKI items; Revelle, 1979; Silverstein & Fisher, 1974), was conducted to examine the construct validity of the index. Although cluster analysis is often used to examine distance or similarities across cases rather than variables (Revelle, 1979), in the current study cluster analysis was used to identify homogeneous subgroups of CKI items because the binary nature of the data violated normality and variability of assumptions of factor analysis (Tabachnick & Fiddell, 2001). Internal consistency (Cronbach's alpha) analyses were conducted on the CAI to establish the reliability of the scales derived from the EFA.

Test–retest reliability

The test–retest reliability analyses were conducted after 54 students completed the measure on two occasions with 2 days separating the administrations. Ideally, the test–retest interval would have been 1–2 weeks (Pedhazur & Schmelkin, 1991). However, the 2-day test–retest interval was chosen to accommodate the needs of the high-school students, teachers, and administration. Two-way random-effects intraclass correlation coefficient (ICC) analyses were conducted using participants' scores at Testing Time 1 and Time 2 on the CAI and CKI, respectively.

RESULTS

Analysis of socially desirable responding on Concussion Attitude Index

In order to establish the content validity of the attitude portion of the RoCKAS-ST, the CAI scores were correlated with the total scores on the Marlowe–Crowne using pearson product moment correlational analyses. The results revealed a statistically nonsignificant ($r = -.09$, $N = 367$, $p > .05$, $d = 0.008$) relationship which suggested that the RoCKAS-ST was likely to be an adequate indicator of attitudes about concussion relatively uncontaminated by social desirability.

Test–retest reliability

A significant positive correlation between CAI scores at Time 1 and Time 2 (ICC = .79, $p < .001$) was identified suggesting that the test–retest reliability of the CAI was adequate (Constantine & Ponterotto, 2006). Although a statistically significant positive correlation between CKI scores was identified (ICC = .67, $p < .001$), the failure of the coefficient to reach at least .70 places the stability of the CKI into question. This result may be explained by several factors, which are discussed in the next section.

Exploratory factor analysis of CAI items

Before conducting the exploratory factor analysis (EFA) on the 15 items comprising the CAI, a listwise missing values analysis was performed to identify the rates of missing responses for each item. On most of the 15 CAI items, data were missing in only 2% of the cases, and none of the items was missing more than 3.7% of the data. Thus, because the rates of missing data were within acceptable limits (i.e., 5% or less; Tabachnick & Fiddell, 2001), the missing data were replaced using a group mean replacement procedure whereby the mean score of the student sample was calculated and used to fill in the empty data cells. As was indicated earlier, a casewise analysis was conducted in order to identify and remove participants' data from the analyses that were missing responses on more than 2 of the CAI items.

EFA of the 15 items on the CAI produced a four-factor solution containing 13 items that explained 58.9% of the total variance. A principal components analysis with direct oblimin rotation produced the final solution, but two EFAs were conducted before reaching this solution.

EFA 1 was an unconstrained principal components analysis with direct oblimin rotation because it was hypothesized that the factors would exhibit significant intercorrelations. This hypothesis was supported, and the second and third EFAs were conducted using direct oblimin rotation with delta set at zero. As was the case with EFA 1 and each of the additional EFAs, factors were selected based on a scree test and eigenvalues greater than or equal to 1 (Stevens, 2002). A five-factor solution was obtained and contained several items that displayed multicollinearity among factors, and one of the factors (Factor 5) included a single item.

Based on these findings, data were placed into a constrained four-factor EFA (i.e., EFA 2) including all 15 CAI items in the model. Relative to EFA 1, loadings improved for most of the items with the exception of two items that were multicollinear. These items were removed, and the final EFA (i.e., EFA 3) was conducted using the 13 remaining items, which were placed into a constrained four-factor solution.

The final solution approached simple structure. Factor 1 (eigenvalue = 3.35) consisted of four items pertaining to personal attitudes about concussion (e.g., "I feel that an athlete has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion") and was labeled Personal RTP Attitudes. The second factor (eigenvalue = 1.74) contained four items that were related to others' attitudes towards concussion (e.g., "Most athletes would feel that an athlete should tell their coach about symptoms of concussion") and was labeled Views about Others' RTP Attitudes. Participants' views about athletic trainers' concussion management were addressed in Factor 3 (eigenvalue = 1.50). This factor contained two items (e.g., "I feel that an athletic trainer, rather than the athlete, should make the decision about returning the athlete to play") and was labeled Views about Athletic Trainers' Concussion Management. Factor 4 (eigenvalue = 1.07) contained three items that were focused on views about the role of the coach (e.g., "I feel that coaches need to be extremely cautious when determining whether an athlete should return to play"). This factor was labeled Views about Coaches' Concussion Management and Precautions.

Internal consistency of extracted CAI factors

Internal consistency analyses using Cronbach's alpha scores were conducted on the entire 13-item index as well as on each of the subscales. The internal consistency of the 13-item index was adequate (coefficient alpha = .76; Constantine & Ponterotto, 2006). According to the coefficient alpha, and the change in Cronbach's alpha if an item was deleted, there did not appear to be any items that should have been removed from the index. Subscales 1 and 2 (Personal RTP Attitudes and Views about Others' RTP Attitudes, respectively) displayed adequate coefficient alpha values of .72 and .69, respectively (Constantine & Ponterotto, 2006). However, the coefficient alpha estimates for Subscales 3 and 4 (Views about Athletic Trainers' Concussion Management and Views about Coaches' Concussion Management & Precautions, respectively) fell below the adequacy threshold as they each displayed alphas of .59. These low estimates were likely due to the relative lack of items within each subscale (two items and three items, respectively). A more detailed discussion of this issue is included in the next section.

Cluster analysis of CKI items

A hierarchical cluster analysis using binary measurement (i.e., correct responses set to 1 and incorrect responses set to 0) of squared Euclidean distances was conducted, and the agglomeration schedule was used to visually estimate the number of clusters. An unconstrained cluster analysis was conducted using all 25 CKI items, and examination of the agglomeration schedule suggested a 2–5-cluster solution. Next, a second cluster analysis was conducted that constrained the data to 2–5 clusters. The item composition of each of the cluster solutions was examined and was evaluated on the basis of theoretical and practical relevance and applicability. A three-cluster solution was selected because it portrayed the relationships among the data in the most comprehensible and parsimonious manner. Table 2 displays this solution and the percentage of participants who correctly answered each item.

The table shows the diversity of items within each cluster. There do not appear to be any consistent theoretical constructs underlying the clusters but, rather, items seem to be distributed on the basis of percentage of participants who answered the items correctly. Thus, it appears that these items assessing concussion knowledge comprise discrete groups based on their level of difficulty. Cluster 1 contained items of low difficulty. This is evidenced by the fact that only 2 of the 20 items were answered incorrectly by more than 25% of the sample. Cluster 2 was composed of two items of moderate difficulty as evidenced by the fact that the items were answered correctly by at least half of the participants. Cluster 3 contained three items that resulted in incorrect responses in at least 65% of the participants, which suggests that these items have a high level of difficulty. Due to the categorical nature of the variables and the relative lack of variability among the items included in the CKI, internal consistency analyses could not be conducted.

RoCKAS-ST Validity Scale

As indicated, the VS contained three items. The scale initially included seven items, but an analysis of the frequency of incorrectly answered items revealed that four items were answered incorrectly by between 17.4 and 36.3% of the participants. These items were deemed inadequate and were removed from the VS due to the high rates of incorrect responses. The incorrect response rates on these items indicated that the items likely lack the specificity required to identify participants who were providing adequate effort.

The response rates on the remaining three items ranged from 2.2–4.8%, and these items were retained in the VS.

DISCUSSION

The purpose of this study was to establish the psychometric characteristics of the RoCKAS-ST—a survey pertaining to knowledge about and attitudes toward concussion—in a sample of high-school athletes. A qualitative analysis of the RoCKAS-ST was conducted by presenting it to a panel of psychologists, neuropsychologists, and a group of high-school students. Recommendations made by these individuals were integrated into revisions of the measure. The qualitative analysis of the measure resulted in the establishment of content validity and in the development of an instrument with items that possess good face and content validity.

The RoCKAS-ST, which contains items that comprise the 25-item Concussion Knowledge Index (CKI) and the 15-item Concussion Attitudes Index (CAI), underwent extensive psychometric scrutiny. A cluster analysis was conducted to identify the construct(s) underlying the knowledge items in the CKI. Three subscales were identified, but they did not point to the presence of any underlying constructs. Rather, subscales of low, moderate, and high difficulty were identified.

TABLE 2
Cluster structure of Concussion Knowledge Index

	Cluster		
Item	*1: Low difficulty*	*2: Moderate difficulty*	*3: High difficulty*
Cluster Item 1	There is a possible risk of death if a second concussion occurs before the first one has healed. (89.9)	People who have had one concussion are more likely to have another concussion. (46.2)	After a concussion occurs, brain imaging (e.g., CAT scan, MRI, X-ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot, etc.) to the brain. (16.1)
Cluster Item 2	In order to be diagnosed with a concussion, you have to be knocked out. (93.2)	A concussion can only occur if there is a direct hit to the head. (50.5)	After a concussion, people can forget who they are and not recognize others but be perfect in every other way. (26.2)
Cluster Item 3	Being knocked unconscious always causes permanent damage to the brain. (75.4)		An athlete who gets knocked out after getting a concussion is experiencing a coma. (34.2)
Cluster Item 4	Symptoms of a concussion can last for several weeks. (91.5)		
Cluster Item 5	Sometimes a second concussion can help a person remember things that were forgotten after the first concussion (76.0)		
Cluster Item 6	If you receive one concussion and you have never had a concussion before, you will become less intelligent. (95.6)		
Cluster Item 7	After 10 days, symptoms of a concussion are usually completely gone. (53.3)		
Cluster Item 8	Concussions can sometimes lead to emotional disruptions. (83.3)		
Cluster Item 9	There is rarely a risk to long-term health and well-being from multiple concussions. (76.0)		
Cluster Item 10	It is likely that Player Q's concussion will affect his long-term health and well-being. (78.4)		
Cluster Item 11	It is likely that Player X's concussion will affect his long-term health and well-being. (85.0)		
Cluster Item 12	Even though Player F is still experiencing the effects of concussion, her performance will be the same as it would be had she not suffered a concussion. (88.5)		
Cluster Item 13	Headache (96.2)		
Cluster Item 14	Sensitivity to light (81.4)		
Cluster Item 15	Difficulty remembering (83.1)		
Cluster Item 16	Feeling in a fog (79.8)		
Cluster Item 17	Feeling slowed down (79.8)		
Cluster Item 18	Difficulty concentrating (84.4)		
Cluster Item 19	Dizziness (95.1)		
Cluster Item 20	Drowsiness (73.2)		

Note. The values in parentheses indicate the percentage of participants correctly answering the item.

Exploratory factor analysis was used to evaluate the factor structure of the CAI. Four factors were derived from the EFA, and they are as follows: personal concussion attitudes, views about others' concussion attitudes, views about coaches' concussion management and precautions, and views about athletic trainers' concussion management.

The test–retest reliability of the RoCKAS-ST CAI and CKI indices was examined, and the results showed that the CAI displayed adequate reliability. The items on the CKI closely approached an appropriate level of reliability. These findings suggest that the CAI is a stable measure of concussion attitudes, and the CKI is an acceptable measure of concussion knowledge. The final measure can be found in Appendix B.

An issue not addressed during the development of previous measures of concussion attitudes (Sefton, 2003; Simonds, 2004; Sye et al., 2006) was the extent to which the measures were affected by socially desirable responding. Because attitudes assessed with face valid measures may be obscured by socially desirable response biases, the influence of these biases on the CAI of the RoCKAS-ST was examined in the current study. The findings show that the CAI does not appear to be strongly influenced by underreporting or diminishment of attitudes.

The development of the RoCKAS-ST also involved the direct examination of the constructs of concussion knowledge and attitudes, which distinguishes this measure from the College Football Head Injury Survey (Sefton, 2003) and the KASCQ-24 (Simonds, 2004), both of which were developed using only analyses of reliability. The attitude constructs that were identified in the current study have practical utility because they do not merely speak to a general attitude toward concussions, but rather they represent discrete views about coaches, athletic trainers, teammates, and the athlete's own views. Thus, through the use of the CAI, it may be possible to examine separate views about different individuals who are important in the education, recognition, and management of concussion (i.e., coaches and athletic trainers). These individuals may significantly influence the athlete by facilitating knowledge development and shifts in attitudes.

Although specific knowledge constructs were not found, the identification of discrete subscales categorized on the basis of difficulty suggests that the CKI can be used to discriminate between students who possess different levels of knowledge. Hence, when interpreting total CKI scores, it is also possible to examine the difficulty level of the items answered incorrectly and derive qualitative information about athletes' knowledge of concussion.

Additionally, as indicated, the RoCKAS-ST contains 25 knowledge items and 15 attitude items. These items address a greater range of topics pertaining to concussion and RTP than the KASCQ-24 (Simonds, 2004), which has 24 items mostly focusing on knowledge and attitudes about RTP, and the College Football Head Injury Survey (Sefton, 2003), which has 22 items and almost exclusively focuses on knowledge about concussion causes, symptoms, and potential consequences. Although several items from each of these measures were adapted and included in the RoCKAS-ST, the survey represents an upgrade from these existing measures due to the inclusion of several other important items from previous studies and the addition of new items that are empirically and clinically based.

Despite the fact that the EFA identified four discrete factors, the relatively small number of items that comprise the CAI is an area of concern. Due to the small number of items, the internal consistency estimates were difficult to conduct and interpret. Additional attitude-related items should be developed in the future to add to the robustness of the constructs, identify additional constructs, and/or better establish the reliability of the factors.

A potential problem with the CKI was that the test–retest reliability fell slightly below acceptable levels. This finding reflects the fact that some individuals were providing different responses at Survey Time 1 and Time 2 despite the fact that Survey Time 2 was only two days after Time 1. An examination of the mean group CKI scores showed that these scores were not significantly different across testing times, suggesting the absence of widespread exposure to information about concussion that would have been obtained between Times 1 and 2. The finding may be more due to the possibility that participants did not know the answers to the questions and guessed on both occasions. The use of a binary (i.e., true/false) response method reduces the possibility that uncertainty about the correct response items is detected. To account for uncertainty among participants, a four-item Likert scale could be used in place of the binary response method. The use of a four-item Likert scale might facilitate the development of a more dynamic view of concussion knowledge by providing more response variability, potentially resulting in a more stable measure of concussion knowledge.

The RoCKAS-ST, which was subject to rigorous psychometric examination, was found to be a fairly valid and reliable measure of concussion knowledge and attitudes in high-school students. The psychometric soundness and comprehensiveness of the RoCKAS-ST items suggests that it possesses several advantages over previously developed measures. Most importantly, the results of the study point to the usefulness of the RoCKAS-ST in the evaluation of knowledge about the etiology, course, and sequelae of concussion as well as in the assessment of attitudes about concussion reporting and management. Thus, a measure is now available for use by future researchers in the examination of the effectiveness of educational programs intended to improve knowledge, attitudes, and reporting of concussion.

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APPENDIX A

Scoring key for RoCKAS-ST

Section														
1			*2*			*3*			*4*			*5*		
Item	*Correct Response*	*Index*[a]	*Item*	*Correct Response*	*Index*	*Item*	*"Safer" Response*[b]	*Index*	*Item*	*"Safer" Response*	*Index*	*Symptom*	*Distractor/ Legitimate*[c]	*Index*
1	TRUE	CKI	1	FALSE	CKI	1	SD/D	CAI	1	SA/A	CAI	Hives	D	NI
2	FALSE	NI	2	TRUE	CKI	2	SA/A	CAI	2	SA/A	CAI	Headache	L	CKI
3	TRUE	CKI	3	FALSE	CKI	3	SA/A	NI	3	SD/D	CAI	Difficulty Speaking	D	CKI
4	TRUE	VS				4	SA/A	NI	4	SD/D	CAI	Arthritis	D	NI
5	FALSE	CKI				5	SD/D	CAI	5	SD/D	CAI	Sensitivity to Light	L	CKI
6	FALSE	CKI				6	SD/D	CAI	6	SD/D	CAI	Difficulty Remembering	L	CKI
7	FALSE	CKI				7	SA/A	CAI	7	SA/A	CAI	Panic Attacks	D	NI
8	TRUE	CKI				8	SD/D	NI	8	SA/A	CAI	Drowsiness	L	CKI
9	FALSE	CKI							9	SA/A	CAI	Feeling in a "Fog"	L	CKI
10	TRUE	VS							10	SA/A	CAI	Weight Gain	D	NI
11	FALSE	CKI										Feeling Slowed Down	L	CKI
12	FALSE	CKI										Reduced Breathing Rate	D	NI
13	TRUE	CKI										Excessive Studying	D	NI
14	FALSE	CKI										Difficulty Concentrating	L	CKI
15	FALSE	VS										Dizziness	L	CKI
16	TRUE	CKI										Hair Loss	D	NI
17	TRUE	CKI												
18	FALSE	CKI												

[a]CKI = Concussion Knowledge Index; CAI = Concussion Attitude Index; VS = Validity Scale; NI = no index—item not part of any index. [b]SD/D = strongly disagree/disagree; SA/A = strongly agree/agree. [c]L = legitimate symptom; D = distractor symptom.

APPENDIX B

RoCKAS-ST

NOTE: The phrase "Return to play/competition" refers to being cleared to play in both practice and games.

Section 1

DIRECTIONS: Please read the following statements and circle TRUE or FALSE for each question.

1	There is a possible risk of death if a second concussion occurs before the first one has healed.	TRUE	FALSE
2	Running everyday does little to improve cardiovascular health.	TRUE	FALSE
3	People who have had one concussion are more likely to have another concussion.	TRUE	FALSE
4	Cleats help athletes' feet grip the playing surface.	TRUE	FALSE
5	In order to be diagnosed with a concussion, you have to be knocked out.	TRUE	FALSE
6	A concussion can only occur if there is a direct hit to the head.	TRUE	FALSE
7	Being knocked unconscious always causes permanent damage to the brain.	TRUE	FALSE
8	Symptoms of a concussion can last for several weeks.	TRUE	FALSE
9	Sometimes a second concussion can help a person remember things that were forgotten after the first concussion.	TRUE	FALSE
10	Weightlifting helps to tone and/or build muscle.	TRUE	FALSE
11	After a concussion occurs, brain imaging (e.g., CAT Scan, MRI, X-Ray, etc.) typically shows visible physical damage (e.g., bruise, blood clot) to the brain.	TRUE	FALSE
12	If you receive one concussion and you have never had a concussion before, you will become less intelligent.	TRUE	FALSE
13	After 10 days, symptoms of a concussion are usually completely gone.	TRUE	FALSE
14	After a concussion, people can forget who they are and not recognize others but be perfect in every other way.	TRUE	FALSE
15	High-school freshmen and college freshmen tend to be the same age.	TRUE	FALSE
16	Concussions can sometimes lead to emotional disruptions.	TRUE	FALSE
17	An athlete who gets knocked out after getting a concussion is experiencing a coma.	TRUE	FALSE
18	There is rarely a risk to long-term health and well-being from multiple concussions.	TRUE	FALSE

Section 2

DIRECTIONS: Please read each of the following scenarios and circle TRUE or FALSE for each question that follows the scenarios.

Scenario 1:			
	While playing in a game, Player Q and Player X collide with each other and each suffers a concussion. Player Q has never had a concussion in the past. Player X has had 4 concussions in the past.		
1	It is likely that Player Q's concussion will affect his long-term health and well-being.	TRUE	FALSE
2	It is likely that Player X's concussion will affect his long-term health and well-being.	TRUE	FALSE
Scenario 2:			
	Player F suffered a concussion in a game. She continued to play in the same game despite the fact that she continued to feel the effects of the concussion.		
3	Even though Player F is still experiencing the effects of the concussion, her performance will be the same as it would be had she not suffered a concussion.	TRUE	FALSE

Section 3

DIRECTIONS: For each question circle the number that best describes how you feel about each statement.

		Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
1	I would continue playing a sport while also having a headache that resulted from a minor concussion.	1	2	3	4	5
2	I feel that coaches need to be extremely cautious when determining whether an athlete should return to play.	1	2	3	4	5
3	I feel that mouthguards protect teeth from being damaged or knocked out.	1	2	3	4	5
4	I feel that professional athletes are more skilled at their sport than high-school athletes.	1	2	3	4	5
5	I feel that concussions are less important than other injuries.	1	2	3	4	5

(*Continued*)

Section 3
(*Continued*)

6 I feel that an athlete has a responsibility to return to a game even if it means playing while still experiencing symptoms of a concussion.	1	2	3	4	5
7 I feel that an athlete who is knocked unconscious should be taken to the emergency room.	1	2	3	4	5
8 I feel that most high-school athletes will play professional sports in the future.	1	2	3	4	5

Section 4

DIRECTIONS: For each question read the scenarios and circle the number that best describes your view. (For the questions that ask you what *most athletes* feel, base your answers on how you think MOST athletes would feel.)

	Strongly Disagree	*Disagree*	*Neutral*	*Agree*	*Strongly Agree*
Scenario 1:					
Player R suffers a concussion during a game. Coach A decides to keep Player R out of the game. Player R's team loses the game.					
1 I feel that Coach A made the right decision to keep Player R out of the game.	1	2	3	4	5
2 Most athletes would feel that Coach A made the right decision to keep Player R out of the game.	1	2	3	4	5
Scenario 2:					
Athlete M suffered a concussion during the first game of the season. Athlete O suffered a concussion of the same severity during the semifinal playoff game. Both athletes had persisting symptoms.					
3 I feel that Athlete M should have returned to play during the first game of the season.	1	2	3	4	5
4 Most athletes would feel that Athlete M should have returned to play during the first game of the season.	1	2	3	4	5
5 I feel that Athlete O should have returned to play during the semifinal playoff game.	1	2	3	4	5
6 Most athletes feel that Athlete O should have returned to play during the semifinal playoff game.	1	2	3	4	5
Scenario 3:					
Athlete R suffered a concussion. Athlete R's team has an athletic trainer on the staff.					
7 I feel that the athletic trainer, rather than Athlete R, should make the decision about returning Athlete R to play.	1	2	3	4	5
8 Most athletes would feel that the athletic trainer, rather than Athlete R, should make the decision about returning Athlete R to play.	1	2	3	4	5
Scenario 4:					
Athlete H suffered a concussion and he has a game in two hours. He is still experiencing symptoms of concussion. However, Athlete H knows that if he tells his coach about the symptoms, his coach will keep him out of the game.					
9 I feel that Athlete H should tell his coach about the symptoms.	1	2	3	4	5
10 Most athletes would feel that Athlete H should tell his coach about the symptoms.	1	2	3	4	5

Section 5

DIRECTIONS: Think about someone who has had a concussion. Check off the following signs and symptoms that you believe someone may be likely to experience AFTER a concussion.

✓	✓
Hives	Feeling in a "Fog"
Headache	Weight Gain
Difficulty Speaking	Feeling Slowed Down
Arthritis	Reduced Breathing Rate
Sensitivity to Light	Excessive Studying
Difficulty Remembering	Difficulty Concentrating
Panic Attacks	Dizziness
Drowsiness	Hair Loss