

# Content Validity of the Rodeo-SCAT

## Authors

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## Key words

- content validation
- concussion evaluation
- SCAT
- rodeo

## Abstract

▼ The purpose of this study was to establish the content validity of the Rodeo SCAT for the sport of rodeo and bull riding. The study design was comprised of expert consensus and content validation. A modified Ebel procedure was employed to content validate the rodeo SCAT. Content validation using this method includes experts agreeing on the importance of each item that comprises the rodeo SCAT. This 3-stage process involved: 1) face validation by a local committee; 2) initial expert consensus measurement via distance; and

3) a face-to-face discussion for items that did not originally achieve 80% consensus of the group. Experts were chosen from the Canadian Professional Rodeo Sport Medicine Team (Canada) and the Justin Sports Medicine Team (USA). 27 out of a total possible 68 items achieved 80% consensus in the second stage. In the third stage, 4 of the 68 items were removed with consensus from the expert group. All remaining items achieved 80% consensus for inclusion. In summary, the rodeo SCAT is content valid and thus, appropriate for use in the sport of rodeo context or environment.

## Background

▼ Head injury and concussion are a significant concern in rodeo and bull riding and have been reported as much as double the rate in other sports [4, 30]. Butterwick et al. identified concussion as the third most prevalent injury (8.6% of all injuries) in rodeo next to knee and shoulder injury [5]. Further, they cited 39 concussions during a 5-year epidemiology study with bull riders comprising 15/39 of those injuries (38.5%), bareback riders comprising 10/39 (26%) and saddle bronc comprising 5/39 (12.8%) with the remaining 9 (23%) being scattered throughout other rodeo events [5]. Concussions accounted for 13.8% of all rodeo competitor inter-collegiate injuries, third only to contusions (42%) and strains (15.9%) [29]. Considering the unique nature of rodeo and transient nature of the participants [29], evaluating and managing concussion is important [29].

Understanding the natural sequelae of concussion in sport is constantly evolving [11]. In 2004 the Concussion in Sport (CIS) group met with international experts to report on the agreement or consensus for the safety and health of athletes suffering concussion in ice hockey, soccer and

other sports [27]. A significant outcome from this symposium was the introduction of the Sport Concussion Assessment Tool or SCAT (SCAT 1 herein). The purpose of the SCAT 1 was "to create a standardised tool that could be used for patient education as well as for physician assessment of sports concussion" [27, pg.198]. The SCAT 1 was an attempt to combine a multitude of classification systems in circulation into one standardized health measurement scale. Arnheim and Prentice's 10<sup>th</sup> edition of "Principles of Athletic Training" book [2] outlined 13 different classification systems, none of which were accepted fully by experts [7, 9, 12, 16–18, 20, 31–33, 36–38]. It was possible that no single classification system truly measured what experts thought it should measure. In other words, there appeared to be a gap in the literature where experts did not agree on one concussion evaluation tool (i.e., there was no content validity). The introduction of SCAT 1 appeared to be an attempt to standardize concussion evaluation and permit comparison of athletes across a multitude of sports [3]. The SCAT 1 was a good start to standardize concussion evaluation, but there are no published studies on the content validation of the SCAT 1.

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	Difficulty		
I m p o r t a n c e	Easy & Essential .9	Medium & Essential .7	Hard & Essential .5
	Easy & Important .7	Medium & Important .5	Hard & Important .3
	Easy & Unimportant .5	Medium & Unimportant .3	Hard & Unimportant .1

**Fig. 1** The modified Ebel Grid for Establishing a Minimal Passing Score.

The CIS group met again in Zurich, Switzerland in 2008 to discuss new developments of concussion evaluation and management. It resulted in the SCAT 2 which was intended “only as a guide and is of a general nature consistent with the reasonable practice of a healthcare professional. Individual treatment [would] depend on the facts and circumstances specific to each individual case” [28, pg. 191]. Eckner and Kutcher compared the SCAT 1 and SCAT 2 and found 2 primary changes: some symptoms in the symptom scale were altered and they exchanged the Balance Error Scoring System (BESS) for the Romberg test [11]. This study took place between the time the SCAT 1 and SCAT 2 were released. Attempts were made with the rodeo SCAT design to mirror the design of SCAT 2 with the content mirroring SCAT 1, primarily.

Validity and reliability testing are fundamental to the development of any health measurement scale [10]. Validity and reliability work together to create psychometrically sound measurement tools [34]. Lynn argued that content validation is overlooked by researchers because it is a simplistic statistical analysis often confused with face validity [24]. Content validity is a simple method that asks a group of experts if they agree or disagree with the inclusion of items to measure an underlying, predetermined outcome or construct (concussion in this case). Expert consensus of 80% or greater establishes the final inclusion of those items [24]. The hazard of completing a more complex validation study prior to content validation (i.e., construct validity or criterion validity) is that the context and content of the intended measure may not be explicit unless you have completed content validation first. It is possible for a health measurement scale to possess strong reliability without knowing its content validity. In other words, a health measurement scale could be reliable without being valid, thus potentially measuring a construct that is not the intended target.

The CIS Group created the SCAT 1 but did not report a formal content validation process [27]. Subsequently, the SCAT 2 followed the procedures for “a formal consensus meeting following the organizational guidelines set forth by the US National Institute of Health” [28, pg. 191–192].

Hodges identified a need for contextualized content validity and, Gioia et al. advocated for ‘ecological validity’ for a subset specialty population of concussion: children [13, 15]. The validity of the SCAT 2 should be considered context-specific and the healthcare pro-

vider should be prepared to adjust the tool for each circumstance [1, 11]. Ecological validity would take into account variables surrounding the application of a measurement scale (i.e., content validity). For example, in what environment would the scale be employed? What was the intended audience of the measurement scale? Formalized content validation processes with experts familiar with the environment in which the measurement scale would be employed would help to accomplish that goal of contextualized or ecological validity. The SCAT 1 was originally developed by sports medicine officials who were primarily from 2 sports: ice hockey and football (North American soccer). It was not necessarily intended to be exclusive for those sports but medical professionals working in rodeo and bull riding were not convinced the SCAT 1 was applicable in their environment. In fact, there were enough members of the Canadian Pro Rodeo Sport Medicine Team and the Justin Sports Medicine Team (USA) that had reservations about using the SCAT 1 in rodeo or bull riding environments that it prompted the purpose of this study. The purpose of this study was to determine expert consensus (i.e., from a rodeo environment) on the appropriateness and applicability of the SCAT 1 for the rodeo environment which will be referred to as “rodeo SCAT” in the remainder of this manuscript.

## Methods



### Modified Ebel procedure – content validation

The modified Ebel procedure has been traditionally employed as a method to establish a minimal passing score in practical, performance-based examinations such as objective structured clinical examinations (OSCEs) [6]. The primary purpose of the modified Ebel procedure was for content validation through expert consensus or agreement [24]. The modified Ebel procedure has been adapted and employed in establishing content validity of a variety of health measurement scales [21, 22].

The modified Ebel procedure employs 3 stages of iterative development and expert consensus. The first stage consisted of local experts who develop the first iteration of the tool (face validity). The second stage consisted of the first iteration of the rodeo SCAT being sent to a group of experts through survey format to grade the importance of each item in the rodeo SCAT (◉ Fig. 1). The adaptation of the modified Ebel procedure was to not use the ‘difficulty’ metric as it would only be necessary for establishing a minimal passing score for practical examinations. In this study, only the 3-point importance scale (i.e., essential to keep, important to keep, unimportant to keep) was employed (◉ Fig. 2). Experts were asked to grade each item in the newly proposed rodeo SCAT on a 3-point scale of importance for inclusion in the final rodeo SCAT. The target was to achieve 80% consensus for the inclusion of items in the final rodeo SCAT. Those items that did not achieve 80% consensus were moved to the third and final stage of the modified Ebel procedure. The third and final stage consisted of an in-person, face-to-face discussion amongst experts with the items that did not achieve 80% consensus for inclusion in the rodeo SCAT from the second stage. Current literature outlining valid and reliable items in the SCAT 1 were shared with the group and face-to-face discussion ensued. Experts were permitted to give their opinions, ask questions about the literature, and ultimately vote on the final inclusion or exclusion of the item after discussion was saturated. Experts voted with a show of hands. The final rodeo SCAT included in this paper is the result of this process and expert consensus.

Rodeo SCAT							Recommend Delete	Recommend Change To:
Importance			Difficulty					
	E S S E N T I A L	I M P O R T A N T	U N I M P O R T A N T	H A R D	M E D I U M	E A S Y		
Patient Information								
Date of Injury	x					x		
Date of Exam	x					x		
Rodeo Event (eg. BB/SB/BR/SW/CR/TR/WBR/SR/Other)		x				x		
MOI (eg. Head hit ground/Head hit animal/Head hit chute or fence/Kicked /Noncontact/ Other)	x					x		

Fig. 2 Stage 2 of the Modified Ebel Procedure through the On-line Survey for Grading Importance and Difficulty.

Table 1 Items that achieved 80% Consensus during Stage 2 of the Modified Ebel Procedure.

SCAT Constructs	Essential	Important
<b>Patient Information</b>		
date of injury	87.50	
date of exam	87.50	
<b>Overt Signs and Symptoms</b>		
amnesia/difficulty remembering	81.30	
loss of consciousness/unresponsiveness	81.30	
<b>Cognitive Assessment</b>		
immediate 5 word recall: house, book, tree, bird, shovel, truck, plane, river, apple, dime, grape, train, street, phone		85.70
hat		87.50
serial 7 subtraction, begin at 100		86.70
<b>Neurological Screening</b>		
speech	81.30	
eye motion and pupils	87.50	
nystagmus	87.50	
finger to nose		
eyes open	80.00	
pronator drift	81.80	
<b>Return to Rodeo</b>		
1) rest until Asymptomatic (physical and mental rest)	93.80	
5) return to rodeo participation	80.00	

Subjects

The first stage consisted of a local group of experts (i.e., authors of this paper) who took the SCAT 1 and modified it for rodeo and bull riding purposes. In the second stage, experts were chosen from members of the Canadian Professional Rodeo Sport Medicine Society (primarily certified athletic therapists) and the Justin Sports Medicine Team housed in the United States of America (athletic trainers, sport medicine physicians, orthopedic surgeons, physical therapists and neurosurgeons). A convenience sample of experts was chosen through self-selection and volunteerism from these 2 specialty groups. Confirmation of their participation and expertise was confirmed with membership in their respective organizations since members can only join if they have an interest and experience working in rodeo and/or bull riding. The entire sample population

of experts was 129 (both Canadian and American). There were 16 experts who completed the second stage of the modified Ebel procedure. The third stage had 40 experts who were present at the annual Wrangler National Finals Rodeo Sport Medicine Conference (the original 16 plus 24 additional experts). In other words, 24 additional experts who were attending the Wrangler National Finals Rodeo Sport Medicine Conference were asked if they would consider participating in the final stage of content validation for the Rodeo SCAT and agreed to participate. No attempt was made to inquire as to why these additional 24 did not submit their initial thoughts during the second stage. However, all 24 additional experts were confirmed members of either the Canadian or American professional group.

Results

In the second stage of the modified Ebel procedure, experts returned the rodeo SCAT with their evaluation of importance on the 3-point scale (i.e., essential, important, unimportant). 27 out of a total possible 68 items (that comprised the first iteration of the rodeo SCAT) achieved at least 80% consensus to keep in the rodeo SCAT (see Table 1). The remaining items (41) that did not receive 80% consensus were pushed to the face-to-face discussion at the Wrangler National Finals Rodeo Sport Medicine Conference (i.e., stage 3).

The results from the discussion during the third stage are listed in Table 2. Most items (32) achieved at least 80% consensus and were kept in the rodeo SCAT. 4 items were removed after there was consensus they were unimportant for the rodeo SCAT: 1) "what round is it?" (a 'round' is a rodeo term analogous to an 'inning' or sometimes to a 'game' within a series); 2) "how did you do?"; 3) "finger-to-nose testing;" 4) and "serial 7's". This item was brought on to the third stage even though it had accomplished at least 80% consensus during the second stage of the modified Ebel procedure. After discussion and exposure to the literature on "serial 7's", the expert group agreed that removal of this item was appropriate [8, 14, 39]. There were no other items that presented a conflict between expert opinion and evidence from the literature to remove that item.

**Table 2** Descriptive data from the third stage of the modified Ebel procedure for the rodeo SCAT items.

	Importance			Recommend Delete
	Essential	Important	Unimportant	
<b>Patient Information</b>	% Agreement			
rodeo event	80.60	19.40	0.00	
MOI	89.47	10.53	0.00	
helmet used (Y/N)	84.21	12.24	3.55	
<b>Memory</b>				
what city/town are we in?	87.50	12.50	0.00	
what month is it?	80.00	20.00	0.00	
what round is it?	0.00	20.00	80.00	yes
what happened (during ride/event)?	100.00	0.00	0.00	
what was your score?	87.50	12.50	0.00	
who is travelling/staying with you?	84.21	12.24	3.55	
where did you compete last?	87.50	12.50	0.00	
how did you do?	0.00	15.79	84.21	yes
where are you up next and when?	24.32	40.54	35.14	yes
<b>Cognitive Assessment</b>				
serial sevens	0.00	10.53	89.47	yes
months in reverse order	89.47	10.53	0.00	
delayed 5 word recall	16.21	27.03	56.76	no
<b>Neurological Screening</b>				
one Foot Standing/tilt head back				
eyes open	80.00	20.00	0.00	
eyes closed	80.00	20.00	0.00	
finger to finger	3.55	12.24	84.21	Yes
gait assessment: heel to toe and walk in a straight line	62.50	37.50	0.00	no
Return to Rodeo				
2) aerobic exercise	94.60	0.00	5.40	
3) resistance training	24.32	59.46	16.22	no
4) sport specific training	24.32	59.46	16.22	no

Consensus was not reached for 5 items: 1) “where are you up next?” (this was intended to know where a cowboy competitor would compete next in their rodeo schedule); 2) the “delayed 5 word recall”; 3) “gait assessment”; the use of 4) “resistance training in the return to play guidelines”; and 5) “sport-specific training prior to returning to play”. The item “where are you up next?” was removed from the final version because there would be no way to confirm or refute the answer to the question. The remaining 4 items were included in the final rodeo SCAT since combining the votes from the “essential” and “important” categories resulted in 100% consensus. Finally, the expert group was asked their preference in separating the signs from the symptoms sections. There was 85% agreement to separate the 2 constructs in the final rodeo SCAT. The final consensus vote did not result in an addition or reduction of any items, but rather merely a re-organization of items. The final rodeo SCAT consists of a total of 63 items that achieved consensus through 3 stages of the modified Ebel procedure.

## Discussion

The SCAT 1 underwent strong face validation with its original purpose, but rodeo and bull riding were not part of the sports originally intended for its adoption. The SCAT 2 followed the procedures for “a formal consensus meeting following the organizational guidelines set forth by the US National Institute of Health” [28, pg. 191–192]. It should be noted that this expert

consensus process is different than the expert consensus, content validation process outlined in this paper. The modified Ebel procedure is specifically designed for the development of scale, in this case the rodeo SCAT. The expert group who worked in a rodeo sport medicine environment questioned the validity and application of the SCAT 1. Therefore, the primary reason for formal tool development was to establish its content validity in a rodeo-specific environment.

A significant area where the rodeo sport culture was evidently different in the SCAT 1 was in the “history” category and “modified Maddocks questions” category. Many of the questions in the original “modified Maddocks questions” were related to traditional sports. As a result, the rodeo SCAT proposes that rodeo-specific “history” questions and “modified Maddocks questions” be used in a combined format. This change from the SCAT 1 was supported by the expert group in the rodeo sport medicine discipline and reached consensus. Furthermore, the rodeo SCAT removed the “orientation” section from the SCAT 1 due to the overlap with the new “modified Maddocks questions” that had been added specifically for the purpose of rodeo and bull riding. Part of the research team’s role was to evaluate the evidence for each item included in the SCAT 1 scale. There was clear evidence that employing “serial 7’s” were neither a valid nor reliable measure of cognitive ability even though the expert committee achieved consensus in keeping “serial 7’s” in the rodeo SCAT [8, 14, 39]. In the third stage of the consensus process, data from these articles were shared with the expert group [8, 14, 39]. 89 % agreed that removal of this item was important after being

exposed to the literature that supported the argument for removal. Other items that achieved consensus for removal (i.e., greater than 80% deemed unimportant) were: "what month is it?"; "how did you do?"; and finger-to-finger neurological screening. None of these items are included in the final version of the rodeo SCAT.

5 items did not achieve consensus from the expert group after stage 3 of the modified Ebel procedure. One of the items is not included in the final rodeo SCAT because there was no way to confirm or refute the veracity of the patient's answer to "where are you up next and when?". The investigators agreed to keep the remaining 4 items when researchers combined the "essential" and "important" categories. Arguably, the agreement to keep items based on delineation between positive variations to keep the item was the rationale for combining the 2 categories and keeping these items. Gait assessment was kept in the final rodeo SCAT because, when the 2 category of votes of "essential" and "important" were combined, they totaled 100% consensus. Further, gait assessment has been proposed as a valid measure of balance and proprioception [19]. The "delayed 5 word recall" also did not achieve 80% consensus. The investigators decided to include it in the final rodeo SCAT because there was such overwhelming evidence for this item as a valid measure of a patient's cognition [25,26]. The final 2 items that did not achieve 80% consensus were the "return to sport" and "graded testing to ensure readiness for return to sport". Investigators left both of these in the final rodeo SCAT since there were no suitable alternatives in the return to sport protocol/section of the tool. It is obvious that a significant amount of work needs to be done in this area in the future in order to accomplish greater adoption of the rodeo SCAT as well as more scientific outcomes.

The SCAT 2 was published between the stages of the modified Ebel procedure. Thus, there was an attempt to mimic the design and functionality of the SCAT 2 with the content of the rodeo SCAT being driven primarily by the content in the SCAT 1.

The SCAT 2 was an excellent progression in terms of approaching a true health measurement scale [11,23]. A health measurement scale may be useful to determine diagnosis, but perhaps more importantly, it may be useful in measuring severity to assist in management and treatment of concussion. There was an attempt in the final version of the rodeo SCAT to mimic the SCAT 2 in concept and design. Conceptually, the categories (constructs) have been separated into sections and all contribute to a final composite score entitled "Overall score" (pg. 3 of the rodeo SCAT). The way in which those sections contribute to the "Overall score" is different in the rodeo SCAT compared to the SCAT 2. The first way the rodeo SCAT differs from the SCAT 2 is the way, which the rodeo SCAT counts the "symptom score", and how that score contributes to the "Overall score". The symptom score measures 2 aspects of the patient's symptoms: 1) do they have the symptom or not?; 2) if they do have the symptom, how severe is it? If a patient does not have a symptom, then the raw score for one patient may be different than another patient, so the symptom score for the rodeo SCAT has been converted to a percentage score rather than a raw score (which is what the SCAT 2 did). The "Overall score" is a composite of 4 sign and symptom measures (i.e., weighted symptom score, coordination score, balance and gait score and physical signs score) and 3 cognitive assessment measures (i.e., immediate memory score, concentration score and the delayed recall score). The weighted symptom score had to be converted to a percentage score since the denominator may change from patient to patient. As a result,

the remaining components in the "Overall score" (i.e., coordination score; balance and gait score; physical signs score; immediate memory score; concentration score; and, delayed recall score) were converted to a percentage score. By converting every measure to a percentage score, each of them was weighted equally against each other in the overall final "Rodeo SCAT Score". This equal weighting may be one way the rodeo SCAT may evolve over time where some measures may prove to be more predictive of diagnosis, management, or return to play and thus need to be weighted more heavily in the "Overall score".

When comparing the rodeo SCAT to the SCAT 2, another difference was the score for the Glasgow Coma Scale (GCS) was not included in the rodeo SCAT. The GCS was included in the design, but did not contribute to the "Overall score" since the intent of the GCS is different than the intent of measuring concussion [11,19]. The GCS construct measurement is intended to distinguish between mild traumatic brain injury (MTBI) and more severe brain injury. The GCS is not intended to measure severity of concussion, which is the intention of the "Overall score" in the rodeo SCAT.

The final "Overall score" should be interpreted in such a way that a higher percentage score signifies, potentially, a more severe concussion. Thus, a lower "Overall score" should signify a healthier individual with zero being someone who is concussion free. There is some evidence to demonstrate the constructs that contribute to the "Overall score" may be indicative of the presence or absence of concussion, but not a great deal of evidence to demonstrate severity of the concussion [35]. Therefore, further research must be conducted to correlate the "Overall score" to concussion severity over time to understand the importance of scaling responses with concussion. In other words, is a dichotomous scale (i.e., presence or absence of concussion) more appropriate than a scale that grades the severity as was more popular in the past? Between the 2<sup>nd</sup> international symposium and the 3<sup>rd</sup> international symposium for concussion in sport, the concept of grading severity has disappeared since this factor can only be diagnosed retroactively [27,28]. However, the content validity of those past scales to measure severity may not have undergone stringent development such as content validation. Therefore, it is possible that tool development and refinement may create a more reliable mechanism to measure the severity construct over time. For this reason, the rodeo SCAT has undergone content validation with the severity construct in mind in case severity can ultimately be measured similar to other health measurement scales.

## Conclusions



The final rodeo SCAT is the result of expert group consensus on measuring concussion in the sport of rodeo and bull riding (can be found on the following websites: [www.justinsportsmedicine.com/](http://www.justinsportsmedicine.com/) and [www.canadianprorodeosportmedicine.com/](http://www.canadianprorodeosportmedicine.com/)). The rodeo SCAT is comprised of content from primarily the SCAT 1 but also same from the SCAT 2 and rodeo/bull riding specific environments, thus making it more ecologically valid for a rodeo and bull riding specific environment. Medical professionals working in the rodeo sport medicine industry are more likely to adopt this new tool because it has undergone this process to make it sport specific. Tool development and refinement are part of the natural evolution of health measurement scales and the rodeo SCAT should be considered yet another iteration for a spe-

cialized population (i.e., ecologically valid). This kind of research supports the future directions outlined by the Concussion in Sport Group [28]. In conclusion, like the SCAT 2, the rodeo SCAT should undergo further validity and reliability testing to confirm its psychometric soundness.

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