PERFORMANCE EVALUATION OF DIVING USING THE BORG CR100 SCALE®

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Abstract

In some sports, as for example in diving, performance is measured as a subjectively evaluated artistic gestalt. The purpose of this study was to compare the traditional scale used in competitive diving with the Borg CR100 scale®, a scale where categorical expressions are placed where they perceptually belong on a ratio scale (e.g., G. Borg and E. Borg, 2001). Two internationally recognized Swedish judges volunteered as subjects and judged a sample of 45 videotaped dives, both with the traditional scale and with the CR scale. The results show that the Borg CR100 scale® worked at least equally well as the traditional scale, even though there might have been some tendency for translation between scales.

Within most sports and athletics, performance is measured by reliable physical measures for time, length, weight or amount. For a number of sports, for example diving, figure skating, ski jumping, etc., the best performance is, however, the ideal combination of several separate parts in an artistic gestalt, and is subjectively evaluated. The scales used differ somewhat, but are usually of ordinal or "semi-interval" character.

In diving, for example, five (or sometimes seven) judges evaluate their overall impression of the technique and grace of the dive based on the starting position and the approach, the take-off, the flight, and the entry into the water. The scale used internationally up until recently had the following categories (FINA, 2002):

Completely failed	0
Unsatisfactory	0.5 – 2.0
Deficient	2.5 – 4.5
Satisfactory	5.0 – 6.0
Good	6.5 – 8.0
Very good (perfect)	8.5 – 10

The purpose of this pilot study was to compare the scale above with the psychophysical category-ratio scale developed by Gunnar and Elisabet Borg (G. Borg and E. Borg, 1994, 2001; E. Borg and G. Borg, 2002; and E. Borg, 2007), the Borg CR100 scale® (Fig. 1) in performance evaluation of diving. The CR100 scale is a general intensity scale that combines the value of Stevens' ratio scaling (Stevens, 1975) with the value of obtaining direct level estimation made possible by the categories of the scale. One of the main principles behind the construction of the CR scales, is Gunnar Borg's range model that emphasizes the need of an interindividually valid reference point, usually defined as a previously perceived maximal intensity, of, for example, perceived exertion (G. Borg, 1962, 1998).

Method

Two professional Swedish judges partook in the experiment. Both had many years of experience in judging diving internationally. The material used was 45 videotaped dives of

varying difficulty from international diving contests (10 m springboard: men and women; 1 m springboard: men, from 1996 - 2003). The selection of dives was made by one of the professional judges.

The dive was presented to the judges on a TV-monitor and the video was paused directly at the finish of the dive before the result was shown. The judges then made their evaluation according to the traditional scale (TS) presented above in the introduction, where "Good" is the main reference level, and then according to the Borg CR100 scale® (Fig. 1). Maximal (100) on the CR100 scale was defined as a perfect dive. To obtain a criterion for each dive the competition result for the dive was divided by the product of the difficulty of the dive and 0.6 times the number of judges (FINA, 2002).

Results

The average results for the two judges (A and B) and the two scales, as well as for the criterion (competition results for the dives) are presented in Fig. 2. Only the upper half of each scale was used (from 4.5 on the traditional scale and from 45 on CR scale). Data distributions were somewhat more even with the CR scale, as well as average agreement between the two judges.

Individual data for both scales are shown in Fig. 3 with the criterion on the x-axis. On the traditional scale the finest increment was 0.5, whereas the Borg CR100 scale® is more finely graded. To study to what extent this was used, data from the traditional scale was multiplied by 10 and the differences between the two scales were computed. For Judge A there was a 5 point difference in 10 dives, but in 15 dives (33%) the difference was between 1 to 4 points. The corresponding values for Judge B was 3 and 4 dives respectively.

Correlations are presented in Table 1. High correlations, above 0.7, were obtained with the criterion for both judges and both scales. Inter-rater correlations were also above 0.7. The correlations between the two scales were very high, above 0.9, for both judges.

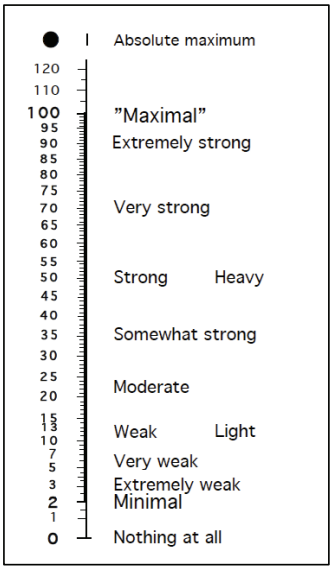

Fig. 1. The Borg CR100 scale® (© G. Borg and E. Borg, 1987, 1994, 2001, 2007).

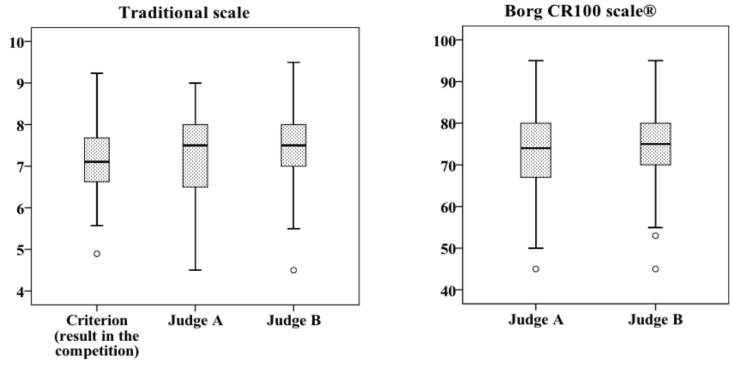

Fig. 2. Boxplot graphs (medians in the center and 25th and 75th percentiles as the edges of the box). Obtained performance evaluation of 45 dives with the traditional scale (left) and the Borg CR100 scale® (right).

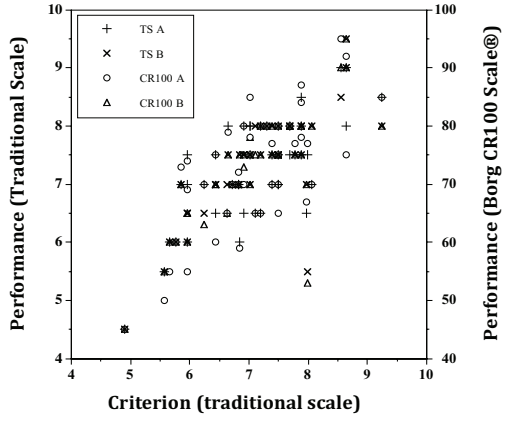

Fig. 3. Individual data for both judges and both scales.

Table 1. Correlations with the criterion and between evaluations for 45 dives ($p < .001$).

	Criterion	Judge A (TS)	Judge A (CR100)	Judge B (TS)
Judge A (TS)	.72			
Judge A (CR100)	.72	.97		
Judge B (TS)	.78	.72	.69	
Judge B (CR100)	.78	.74	.71	.99

Discussion

The purpose of this study was to investigate the possibility to apply the Borg CR100 scale® (Fig. 1) for performance evaluation in diving. As can be seen from Fig. 3 and Table 1 the Borg CR100 scale® worked equally well compared to the criterion as did the traditional scale.

The Borg CR100 scale® is more finely graded than the traditional scale. This advantage was used by Judge A in 33% of the dives, but only in a few dives by Judge B. Another advantage with the CR100 is the inclusion of a stable "ideal" dive at the maximum of the scale. The lack of this in the traditional scale may explain the small displacement between the two judges found with the traditional scale, but not with the CR100 (Fig. 2). Since this study was performed the scale used for diving, has been somewhat altered in that an additional anchor, "excellent", has been added to the top of the scale (10) (FINA, 2012).

The CR scale is a general intensity scale and the verbal anchors on the scale were not specifically chosen to suit diving. A suspicion that arises (visible also in Fig. 2) is that scale values were only translated between scales. Despite the instruction to use the verbal anchors on the Borg CR100 scale® this seems to some extent to have been the case, since the values used covered a very similar number range (separated only by a factor 10). Thus, instead of using "Strong" (50) on the CR100 scale as a correspondence to "Good" (which is probably more similar as to perceived intensity), "50" on the CR scale was used as a correspondence to 5,0 on the traditional scale ("Satisfactory"). This points to the need to further emphasize the importance of the verbal anchors on the CR100. An alternative design where only one scale was used at the time might also have reduced this tendency. The judges are, however, so used to the traditional scale, that it is very possible that this would make no difference.

There are several sports, for example diving, figure skating, ski jumping, etc., where the Borg CR100 scale® could be of value for performance evaluation. Emphasis should then be put on the importance to not just translate from one scale to the other, but of using the verbal anchors. It would also be interesting to try the Borg CR100 scale® on a larger group of judges both on recorded dives and in a live situation.

Acknowledgments

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