Original Article

Competition trick analysis in snowboard slopestyle and big air

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ABSTRACT

Snowboarding tricks are judged by execution, difficulty, amplitude, variety and progression in freestyle disciplines. In Slopestyle, an additional judging criterion termed Overall Impression (40% of final score) quantifies the flow of the run. To maximise final score, we aim to investigate the relationship between jump rotation and judging score by gender and take-off side in Slopestyle and Big Air events and the effect of individual Slopestyle features on overall impression score. Only jump features (n = 675) from 9 competitions were analysed (249 female, 426 male). Multiple linear regression was used to determine the relationship between score and trick rotations by sex and take-off side, and to determine the presence of individual feature effect on overall impression score. There was a strong linear relationship between jump rotation and score ($p < .001$), though at different rates of increase based on gender and take-off side. Switch frontside take-off is rewarded with the highest scores at high levels of rotation in both genders. In Slopestyle features, the last jump was found to have the highest relative importance on overall impression score (92.02%). These findings allow athletes and coaches to better design training interventions and competition strategy, while providing judges with useful information about judging patterns.
Keywords: Performance analysis of sport; Sports performance; Judging; Scoring; Skill; Snowboard.

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INTRODUCTION

Snowboarding is an increasingly popular sport that has fast become professional and a major Olympic sport. With these events being thrust into the mainstream since the proliferation of their Olympic inclusion as recent as 2018 for certain events, very little is known about the key performance variables of the sport, unlike other traditional sports (J. W. Harding et al. 2007). Across the different Freestyle snowboarding disciplines like slopestyle and big air, competition outcome is judged on a number of areas such as execution, difficulty, amplitude, variety and progression. Additionally, the slopestyle event has an extra measure on the overall flow of the run, termed "*overall impression*" which accounts for 40% of the final score (F.I.d.S. (FIS) 2008/2009). The overall impression criteria in slopestyle allows for individuality and creativity of the sport to be maintained, where progression can be kept in the hands of the competitors, allowing for the continuing growth of the sport (Federation et al. 2008/2009). These criteria are determined subjectively by the judges, where the subjective judging system in elite snowboarding competition is important to the athletes as it is a maintenance of the sport culture and athletic freedom of expression, as opposed to automated feedback and an objective judging system (J. W. Harding et al. 2007). Understanding the relationship of the performance metrics in tricks as they relate to judging scores is thus empirical to identify key performance variables so we can systematically target training interventions and competition strategy to maximise performance scores. The knowledge of various key performance variables may enhance the capacity of coaches to monitor athlete performance progression and to set specific competition goals based upon objective information instead of the current reliance on purely subjective performance indicators, specifically judged scores (J. W. Harding, Small, and James 2007). Snowboarders compete in much more complex and open environments without strictly regulated apparatuses that allow for higher levels of consistency. With unpredictable variables in an open environment, it allows for more degrees of freedom, and as such it might be more important and deserving to find out key performance variables that could aid in an athlete's training and patterns of skill evolution too. The same challenges with an open environment could also possibly account for the lack of study in this sport as compared to other sports. This paper hence aims to add on to the current literature on the key performance variables in the slopestyle and big air events, specifically on the relationship between the degree of rotation in jumps and the judged score.

Difficulty, amplitude, and execution are criteria that are present in both slopestyle and big air events. Amplitude is the height of a trick, and although airtime is sometimes used to reflect amplitude, the time in air and the actual height are not always reflective of each other due to differences in technique of entry-speed to the jump and active "*pop*" on the take-off to increase amplitude. Execution reflects how well the technical aspects were performed throughout (i.e., take-off, grab timing, rhythm, landing technique).

Difficulty considers several factors such as the spin direction, axis, grab type, and the trick difficulty relevant to the particular feature. However, the amount of rotation is a major part of the judging considerations under the "*difficulty*" criteria, and one that receives a lot of attention within and outside of snowboarding (Federation et al. 2008/2009). It is commonly accepted that degree, or amount of rotation, is one of the strongest performance indicators associated with competition success (Jason William Harding and James 2010). This aligns with previous research done by the Australian Institute of Sport, where total air time and average degree of rotation accounted for 50% of the variance associated with the overall score ($r^2 = 0.49$) (J. W. Harding et al. 2007). In slopestyle, the first study that assessed the effect of jump difficulty through the degree of rotation on final performance showed a positive correlation between the number of rotations in jumps and the final judged score ($p < .05$) (Muñoz et al. 2018), however, the overall judged score is a global measure of the run, one cannot distinguish or evaluate individual trick difficulty. With the introduction of the new Snowboarding Live Scoring (SLS) System launched in 2010, it has a focus on individual tricks combined with

overall impression where there are dedicated trick judges, allowing for an investigation of the relationship between difficulty (i.e., rotation) and score using the trick score judged on each individual jump feature. Therefore, we hypothesized there is a different relationship between jump rotation and judging score by sex and take-off side in both Slopestyle and Big Air events. As an additional aim, as there are dedicated judges for overall impression in the SLS judging system, we hypothesized the effect of individual Slopestyle feature on the overall impression score is different.

MATERIAL AND METHODS

We obtained World Cup and US Open competition video recordings from CBC (https://www.cbc.ca), Red Bull (https://www.redbull.com), and YouTube (https://www.youtube.com) from 2019-2021. Explicit permission to use the dataset was not required due to data being publicly accessible. There were a total of 676 sequences from various Slopestyle (n = 521) and Big Air (n = 155) competitions with 431 male and 245 female participants.

Procedures
For slopestyle , we recorded trick performed and its given score for each feature (rail, transition, and jump) alongside the overall impression score for the run. For big air, we recorded the trick performed and its final score. Next, we filtered the data to only consider the jump feature reducing the number of data from 2695 to 593. Then we only selected the score greater than 50 as a cut-off, to refine our analysis to landed tricks (i.e. trick considered "*completed*"), which further reduced the data to a total of 380 jumps, of which 140 were female participants and 240 were male participants. Trick performed was further categorized into 2 variables, take-off side and total number of rotations. For trick difficulty comparison analysis, we further filtered the data to only runs where athletes attempted all three jumps (n = 45).

Analysis
We used multiple linear regression to determine the relationship between score and trick rotations by sex, and to determine the presence of individual feature effect on the overall impression score. Trick rotations between the last 3 jump features in a Slopestyle course were compared using one-way Analysis of Variance. Tukey HSD post-hoc procedure was used to control for type I error in making multiple comparisons to determine the significant difference between the rotations between the jump features. All statistical analyses were performed in R (Version 4.0.2, Vienna, Austria).

RESULTS

The results show jump score increase linearly with degree of rotation ($p < .001$), however this rate differs between sex. Figure 1 shows switch frontside take-off has the biggest rate of increase in score with rotation and that it also has the highest points at the highest degrees of rotation. Switch backside and backside take-off have approximately similar scores at low rotation but switch backside take-off shows a steeper increase as compared to backside take-off. Lastly, although frontside take-off has the lowest scores at low rotation, it has a steep increase and has scores approximately the same as backside take-off at higher rotation. In women, jumps with low rotations converge to approximately mid-50s irrespective of take-off side. However, as rotation increases, the score increases at a different rate based on take-off side except for frontside and backside take-off, which are comparable. Similar to the men's results, switch frontside take-off also showed the highest scores at higher rotation in women's jumps.
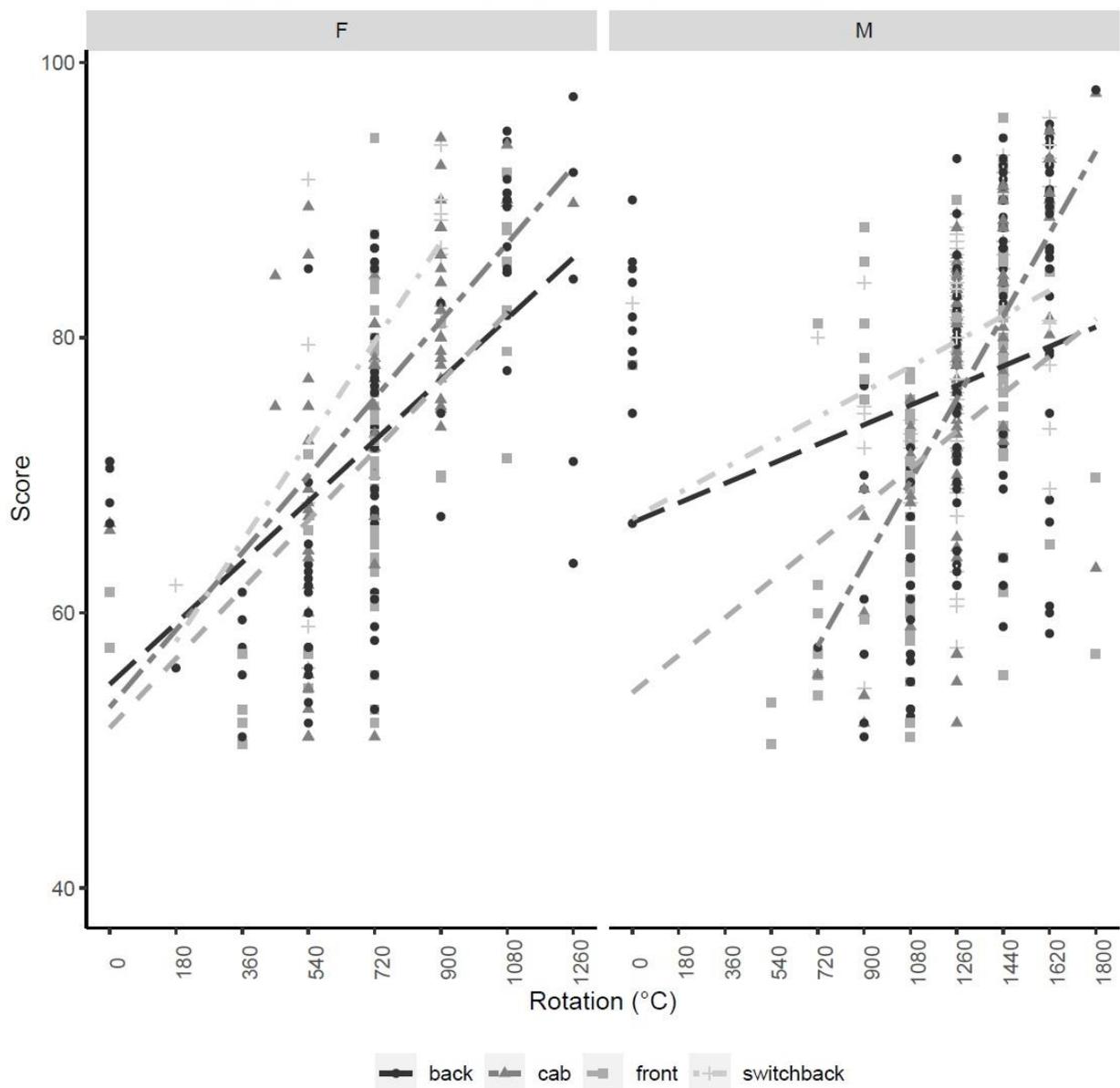
Figure 1. Judging score on trick rotations by take-off side.

Figure 2 shows each feature's relative importance to overall impression score. Our result showed that features have differing effects on the overall impression score (r^2 = 0.69, p < .001), where the last jump feature has the highest relative importance of 92.02% as compared to all other features which showed relative importance between 0.14% to 3.51%.

A more in-depth analysis into the difficulty of the tricks performed on the last 3 features showed 1073° - 1340° - 1460° rotations for men and 680° - 700° - 860° for women. Filtering for runs that only has progressive increase in difficulties showed similar average rotations for men but showed more difference in rotations for women (1026° - 1314° - 1512° and 540° - 720° - 1080° respectively).
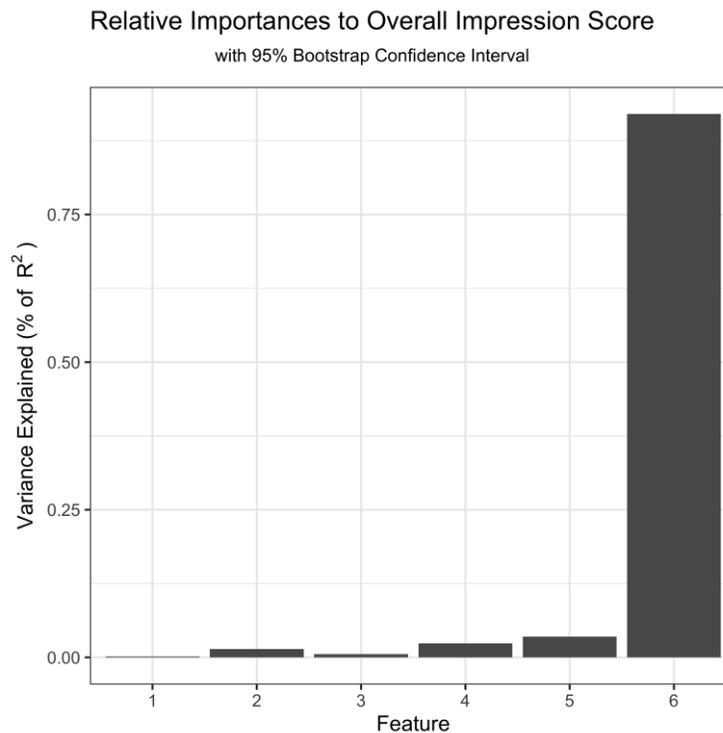
Figure 2. Relative importance of jump features to overall impression score.

DISCUSSION

The aim of this study was to investigate the relationship between the number of rotations and the judged score by sex and take-off side, within each individual jump feature. Results showed a significant relationship, where the number of rotations, along with take-off side and sex is a strong predictor of its respective judged score. This finding not only aligns with the previous study that found an effect of rotation on judged score (Muñoz et al. 2018) but adds further clarity on the underlying mechanism. In our study, we looked at each jump feature individually instead of the final judged score which includes the overall impression score. By excluding the overall impression score and investigating the relationship within each individual jump, it allows us to determine the relationship between jump trick difficulty (i.e. number of rotations) and judging score. The coefficient of determinant of the model is considered statistically low at 0.28, however it reflects that we are investigating only one judging consideration, of the larger "*difficulty*" criteria (i.e. rotation), which is part four judging criteria (execution, amplitude and variety and progression).

The positive relationship between the number of rotations and score varies based on take-off side of each jump trick and is different between men and women. In women, scoring converges to approximately 60 points irrespective of take-off side for jumps performed at low rotations (< 360°). The rate of scoring reward to rotation is the highest for switch backside take-off up to 900° (where there are no higher magnitude data points for switch backside take-off). Thereafter, at high magnitude of rotation, switch frontside take-off scores higher points. This suggests that there should be less attempts with high difficulty tricks, hence higher score is rewarded for the novelty of it as evident from observation between switch frontside vs back take-off at high rotation tricks (1080°: n = 3 vs. 14, 1260°: n = 1 vs 5). However in men, switch backside and backside take-off tend to have higher scores than frontside and switch frontside take-off at lower rotations (< 720°). As rotation increase, scores increase at different rates for the different take-off sides. Switch frontside take-off

shows the biggest increase in score with rotations. The rate of score reward for switch frontside and switch backside take-off in men intersects at 1440°, and at very high difficulty (>1620°) switch frontside take-off appeared to be rewarded with higher point for its difficulty and not novelty of the trick as both take-off sides had 11 attempts.

We found that the last feature, usually a jump feature, had the highest relative importance (92.02%) to overall impression score. This might in part be accounted for by tendencies in course design, where the last jump feature is often the largest and potentially offers greater scale for trick difficulty, perhaps resulting in a magnification of the influence of the recency effect (on human perception and thereby judging). With 40% of overall impression score and 10% of the last feature score, doing well on the last jump secures nearly half (46.8%) of the final score which is consistent with previous studies showing that last jump is highly predictor of final score (5).

We found a significant difference in the number of rotations performed in the last 3 jump features in both men and women. For men, the tricks performed in feature 6 were of 387° greater rotation than feature 4 ($p < .001$) but no difference was found between feature 5 and 6 ($p = .1452$). For women, no difference was found between features 4 and 5 ($p = .9994$) but tricks done on feature 6 were approximately 180° more rotations than both feature 4 and 5 ($p = .0364$ and $p = .0876$ respectively). There are 14 runs in which athletes attempted progressively greater rotation tricks from feature 4 to feature 5 (288° and 180° more rotations for men and women respectively) and feature 5 to feature 6 (198° and 360° more rotations for men and women respectively). It is also worth noting that there are 6 runs with lower rotation tricks attempted from feature 4 to 5 (180° less rotations for both sex), but later attempted higher rotation tricks from feature 5 to 6 (360° and 420° for men and women respectively). The discrepancies in rotation increase from feature to feature between sexes is due to a higher number of men doing higher magnitude of rotation tricks (n: feature 4/5 74.07% vs. 44.44%, feature 5/6 59.26% vs. 55.56%; difficulty: feature 4/5 405° vs 180°, feature 5/6 259° vs 306°).

It is interesting to note that athletes and coaches in the discipline of slopestyle essentially tacitly know and consider the influence of the last jump on their overall performance. The tendency for the last feature of the course in being the largest jump on the course likely creates an extraordinary emphasis on this feature due to higher magnitude tricks being more possible. This may be a desirable trend and create a sense of expectations and additional excitement as the run progresses. Indeed, the tendency for athletes to add rotation magnitude to jump tricks progressively as they move down the course suggests tactical strategy to perhaps match the size of the jumps on the course (performing bigger spins on the bigger features), but possibly also a gamesmanship for the completing the largest magnitude of rotation on the final feature. However, given the extremely high strength of the relationship between the final jump scores and the overall impression, the snowboard community can reflect on this influence and whether this influence is in fact desirable, as by nature it de-emphasizes other course features (e.g. the rail sections and jumps other than the last jump). If a more equal emphasis is desirable for overall success, than judging approaches or even course design could be considered as levers to reduce the effect of the final feature singularly on overall score.

This paper has presented useful analysis on competitive performance that are lacking in the current field, possibly due to the nature of the sport. Although understandably trick progression is individual and varied, our findings could help to generally optimise the training approach. While there is still a very limited number of studies in this sport, there is increasing focus on jump features as sporting disciplines with an aerial

acrobatics component can benefit from the available automated feedback systems (J. W. Harding, Small, and James 2007). There is however still a lack of performance analysis on rail features as it is harder to quantify difficulty. Future research could hence focus on investigating factors of difficulty in rail features, to further optimise performance. Another limitation of this study is the exclusion of fallers, not accounting for the efficacy of jump difficulty. Although we illustrated a positive relationship between rotation and score, it should be noted that many athletes who fall attempt harder tricks with more rotations (Muñoz et al. 2018), especially in Big Air events, which has the highest incidence of injuries (Torjussen and Bahr 2006) as they only have one jump to complete. The elite within this sport are masters of finding the balance between maximizing performance progression and avoiding the antithesis of progression – injury (Willmott and Collins 2015). In applying our findings, a carefully planned approach is hence recommended in elite snowboarding training, allowing for periods of learning and trick progression, followed by periods of consolidation and execution with simultaneous maintenance of existing repertoire (Willmott and Collins 2017).

CONCLUSIONS

The results of our study determined the relationship between the number of rotations in jumping tricks and score for various take-off side and sex. We also found that the last jump feature has the highest influence on the overall impression score. These findings help in identifying some of the key performance metrics in both Slopestyle and Big Air events, in hope of allowing athletes and coaches to better design training interventions and competition strategy, and for the contest organizers to consider judging and course design considerations.

AUTHORS CONTRIBUTIONS

Tsai and Sheppard conceived and designed the experiments. Tsai and Chua performed the data collection and analysis. All the authors wrote the paper and approve the final submission.

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DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

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