

CHARACTERISING SUCCESSFUL AND UNSUCCESSFUL AERIAL MANOEUVRES IN PROFESSIONAL SURFING COMPETITIONS

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Although aerials are an effective way for a competitive surfer to increase their score during surfing competitions, less than half of aerial attempts are landed successfully during competition. This study aimed to identify which characteristics of performing an aerial during competition were associated with either a successful or unsuccessful landing. Video images of 121 aerials performed during the finals series of the 2015 World Championship Tour season were qualitatively analysed. The Frontside Air Reverse was found to be the most commonly performed aerial, with critical features of landing, particularly features that improved a surfer's balanced landing position, significantly associated with successful aerials. These results provide evidence upon which coaches can modify a surfer's technique to encourage higher successful aerial completion rates.

KEY WORDS: surfing, performance, aerial manoeuvres, successful, landing.

INTRODUCTION: Surfing is an international sport with over 37 million individuals participating in either a recreational or competitive context. In fact, the International Surfing Association recognises 98 national governing bodies that participate in and organise professional surfing competitions. During these competitions, surfers are judged on their ability to surf a wave, and the degree to which they perform successive manoeuvres with speed, power and flow, risk, and innovation. One of these innovative and risky surfing manoeuvres is the aerial.

To perform an aerial manoeuvre a surfer drives their surfboard up the face of the wave to then project him or herself off the wave's lip into the air, before reaching the peak of the flight and then controlling the surfboard during its descent to land on the water. Although aerial manoeuvres have become a staple of a modern surfer's skill repertoire, less than 50% of aerial manoeuvre attempts are landed successfully during competition (Ferrier et al., 2015; Lundgren et al., 2014). This low completion rate, is matched by a higher scoring potential, whereby successfully performing an aerial manoeuvre can improve a surfer's single wave score by an additional ~2 out of 10 points (Lundgren et al., 2014). Due to the low completion rate but higher scoring potential associated with performing successful aerial manoeuvres, it is imperative that surfers and surf coaches are aware of which features of the skill are likely to affect a surfer's chances of successfully landing an aerial. Therefore, the purpose of this study was to identify which characteristics of performing an aerial during competition were associated with either a successful or unsuccessful landing.

METHOD: Every wave from the finals series (i.e. quarterfinals, semi-finals and final heats) of the 2015 World Surf League (WSL) World Championship Tour (WCT) was viewed using the Heat Analyser function, which is available on the WSL website (World Surf League, 2015). All attempted aerial manoeuvres were identified. The type of aerial manoeuvre performed and whether it was successfully or unsuccessfully landed, were recorded. A global movement analysis framework was then developed and applied to the three key phases (take-off, airborne, and landing) of each aerial, irrespective of aerial type or completion success (see Figure 1). Each phase of every aerial attempt was qualitatively assessed to identify critical features that were likely to influence the performance outcome of the aerial attempts. There were 55 critical features characterising the posture and segmental alignment of the participants during each phase (e.g. lead (front) and trail (rear) foot

alignment, ankle and knee angles at landing, trunk flexion angle), as well as position of the board relative to the wave (e.g. projection angle, landing zone). The number of times each critical feature was observed was tabulated. Chi-squared tests were then conducted to determine whether the frequency of each critical feature differed significantly ($p < 0.05$) between the successful and unsuccessful aerial manoeuvres (SPSS Version 21, USA).



Figure 1. The three phases of a Frontside Air Reverse: a) take-off; b) airborne; and c) and landing (adapted from World Surf League).

RESULTS: From the 11 WCT events conducted during the 2015 season, 121 aerial manoeuvres were attempted on 933 waves ridden during the quarter finals, semi-finals and finals heats. Nineteen participants (age: 28.3 ± 5.7 years, height: 179.6 ± 7.0 cm, weight: 74.6 ± 7.4 kg) attempted these aerials. Of these 121 aerials, 67 (55%) were successfully completed, with eight different types of aerial manoeuvres being recorded. The success rate of each of these aerial types is displayed in Figure 2. Of the eight aerial types performed, the Frontside (FS) Air Reverse was performed most frequently (55% of aerial attempts), with a successful completion rate of 64.2% (see Figure 2).

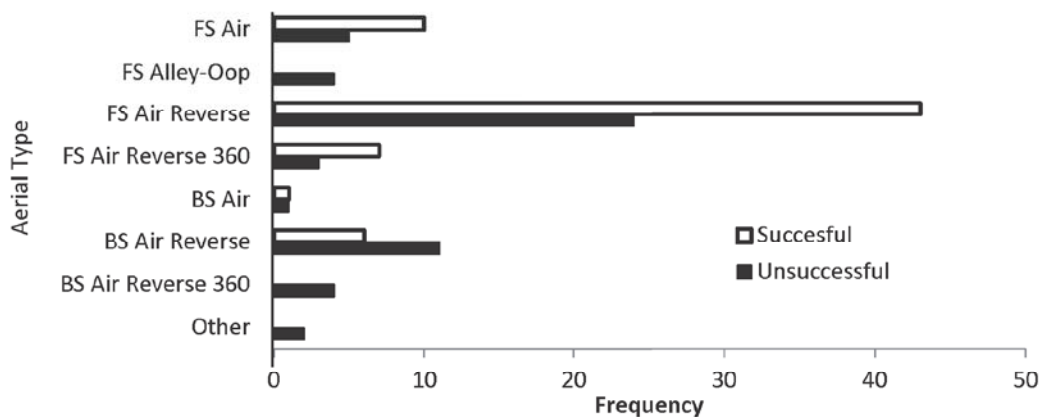


Figure 2. Number of successful and unsuccessful aerials, categorised into aerial type (FS = frontside; BS = backside).

As the Frontside Air Reverse was performed most frequently, this aerial type was qualitatively analysed in detail to determine which critical features were associated with a successful or unsuccessful completion. Throughout the three key aerial phases, most (72%) of the significant associations found with either successful or unsuccessful completions were during the landing phase. For this reason, critical features of Frontside Air Reverse aerials that were found to be significantly associated with the landing phase of an aerial are the focus of this paper (see Table 1).

Table 1. Critical features of Frontside Air Reverse aerials that were significantly associated with the landing phase of the manoeuvre.

Landing Phase Critical Features	Effect
Apparent gaze: at water in front of hips	↑
Apparent gaze: at nose of board	↓
Trail arm over toe-side rail of board	↑
Lead arm over toe-side rail of board	↑
Trunk flexion >45° from vertical	↑
Chest over lead limb knee	↑
Chest over trail limb knee	↓
Surfer's centre of mass over nose of board	↓
Surfer's centre of mass over centre of board	↑
Stance > hip width	↑
Trail limb knee valgus	↑
Trail limb ankle inversion	↑
Lead limb ankle dorsiflexion	↑

↑ = significantly increased the chance of a successful landing ($p < 0.05$)

↓ = significantly decreased the chance of landing ($p < 0.05$)

DISCUSSION: Results from the present study suggest that aerial manoeuvres are risky with only about half of all attempts successfully landed. Previous studies have documented approximate successful aerial completion rates of 48.5 and 43.8% (Lundgren et al., 2014 and Ferrier et al., 2014, respectively). Throughout the 2015 WCT season, the calculated success rate increased to 55.4%. This increase in successful completion rate might be, in part, due to an increase in the number of younger surfers competing on the WCT in 2015, as these younger surfers tend to perform aerial manoeuvres more than their older counterparts (Furness et al., 2015). The results of the present study have also confirmed that the most commonly performed aerial during surfing competitions is the Frontside Air Reverse (see Figure 2). The Frontside Air Reverse 360 and the Frontside Air were also performed with relatively high success rates of 70% and 66.7%, respectively.

This is the first study to identify critical features significantly associated with the successful completion of a Frontside Air Reverse. Several postural and segmental alignment characteristics, particularly during the landing phase of the skill, were common among participants when they successfully completed the manoeuvre (see Table 1). Of particular interest were critical features such as “Chest over lead limb knee” and “Stance > hip width”. It has previously been suggested, anecdotally, that surfers should be encouraged to land with their chest centred over the top of their lead limb knee to encourage the conservation of forward momentum through the landing phase of the aerial. This is achieved as the surfer moves from having their chest above their base of support, to being centred over their lead limb knee. This is the first time, however, that this characteristic has been systematically associated with successful aerial completion. Such information allows coaches to have

evidence upon which to base key coaching points to assist their surfing athletes in successfully landing a Frontside Air Reverse. A wider base of support results in greater stability when performing a discrete skill (Kreighbaum & Barthels, 1996), and this also holds true when landing aerials in surfing (i.e. stance > hip width). Widening the stance from the take-off position during the airborne phase is likely to assist surfers to project the surfboard out from the wave, as well as increasing their stability when landing. Interestingly, "Trail limb knee valgus" was also significantly associated with the successful landing of a Frontside Air Reverse. Typically seen as a risk factor for overuse injury (Myer et al., 2010), surfers have long been encouraged to display trail limb knee valgus during movements such as aerials and top turn manoeuvres due, in most part, to the aesthetic quality it provides the movement. Although this valgus posture might increase the valgus forces experienced in the trail limb knee, and in turn a surfing athlete's risk of injury, this posture is also increasing the likelihood of them successfully completing the manoeuvre.

As with any research, the present study had limitations, which must be acknowledged. A major limitation encountered in the present study was that, due to restricted camera positioning, the video images provided by the WSL sometimes failed to capture a clear view of some of the aerial performances. Furthermore, water spray associated with aerial landings obscured some of the critical features, resulting in missing data. Although the statistical design (e.g. use of Likelihood Ratios) accounted for these missing data, it might have influenced the strength of some of the statistical associations and care should be taken when interpreting the results.

CONCLUSION: This is the first study to qualitatively identify characteristics of performing an aerial manoeuvre during competition that were associated with either a successful or unsuccessful landing. Although the successful completion of aerial manoeuvres is improving, this skill is still risky with only about half of all attempts successfully landed. The critical features associated with a successful aerial manoeuvre identified in the present study, particularly those features that improved a surfer's balanced landing position, provide evidence upon which coaches can develop technique modification programs for aerial performance to encourage higher successful completion rates of aerials. This should translate to an elevated winning potential.

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