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How do aerial freestyler skiers land on their feet? A situated analysis of athletes' activity related to new forms of acrobatic performance

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Summary Based on the course-of-action theory, this study performed a situated analysis of three elite aerial freestyle skiers' activity. Data were collected by observation, videotaping and self-confrontation interviews retrospectively build the athletes' activity. The analysis identified units of action, thought, and feelings and described their relationships during each leap. Comparisons of the different courses of action revealed six components of freestyle skiers' activity: (1) pick up speed in the descent, (2) manage the curve of the tremplin, (3) take-off, (4) manage the exit of the tremplin, (5) perform rotations, and (6) organize the landing. This study revealed the dynamic and situated property of acrobatic activity. As the leap unfolded, the athletes step-by-step enhanced their knowledge of what was occurring and what they would have to do to perform their best and land on their feet. Points of convergence and divergence with other acrobatic performances are discussed.

Introduction

Since the 1980s, new forms of acrobatic performance have been developed, leading to the emergence of unprecedented performances and differing from the more traditional skills observed and studied in gymnastics.[1] Modifications in the situation in which they occur (the running phase, take-off and landing) have been designed to provide athletes with the opportunity to enhance acrobatic performance. Aerial freestyle skiing is one of the new forms of acrobatic practice. It consists of performing a leap from a running track using a tremplin and finishing in a controlled and safe position on a landing track (see Fig. 1).

Although some might view these acrobatic performances as the faithful execution of fixed routines defined in relation to a stable situation,[2] strong evidence points to the need for athletes to be active as each performance unfolds: the natural setting in which these feats are performed implies unexpected modifications in the situation and an instability between trials. From this perspective,

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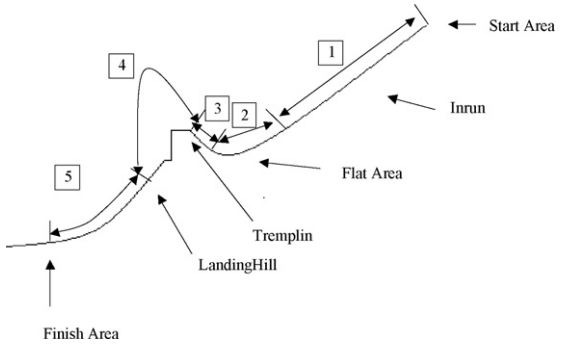

Figure 1 Environment for the aerial freestyle skier's performance.

performance is not merely a motor program implemented independently of the actual situation but can be seen as the athlete's manner of interacting with the situation.[3] As situated cognition approaches suggest, each situation offers new possibilities for acting, acquiring information about the situation and modifying the subsequent course of activity because action and situation are conceived as linked through a codetermination process.[4]

In the field of acrobatics, researchers have identified the importance of this linkage.[5,6] They demonstrated that acrobats performing somersault must conjointly control the timing of the actions and the braking of the rotation to achieve a correct landing. The visual motion cues used by acrobats were identified as the major component of activity and were located at the end of the leap in relation to the action timing. Acrobatic activity consists of the efficient adjustment of angular momentum in relation to the estimation of the time to contact. However, none of these studies took into account the entire activity. Instead, they studied only the activity and its efficiency in relation to a safe landing. Performers had also to control and adjust their leaps not just during the landing phase but at other moments as well, suggesting complementary ways to perform.[7–9]

These elite trampolinists' course-of-action studies address these neglected aspects of elite performance and contribute to a better understanding of the action-situation linkage in naturalistic acrobatic fields. They indicated that the typical actions of trampolinists were regular sequences of transformation of body position followed by assessment of these sequences with regard to the position on the trampoline bed during all the flight and contact with the trampoline bed. trampolinists' activity during an exercise was shown to comprise 'getting ready during one move to perform the next move', 'orienting oneself in the general unfolding of the exercise' in order to decide whether or not the upcoming moves will need to be modified, and 'making general assessments' about how well certain components of the exercise have been performed.

These findings emphasise the usefulness of studying the linkage between action and situation in relation to what individuals are able to perceive, feel, know and do within unfolding situations. 'Course-of-action theory'[10] provides a means to study this linkage at a meaningful level for the actor: the activity is constituted by personal experience, which can be studied using self-confrontation interviews. During the interviews, agents are placed face to face with the physical traces of their activity and show, tell about and comment on the episode they have experienced. In doing so, they reveal how they handled it on-line by building new meanings or activating pre-existing ones. The verbalisation elicited differs from traditional verbal reports and aims at making the prereflexive phenomena of activity appear. Conceived in a semiotic and enactive paradigm, the data collected are not comparable to those obtained with cues retrospective report or stimulated recall of cognitive processes.[10,11] Data reveal the linkage between action and situation: the intentional state of the actor that corresponds to the field of possible actions he or she can undertake (i.e., Object); the situation-related judgments of a proprioceptive, perceptive or memory-based nature (i.e., Representamen); and the elements of knowledge drawn from past cognitions that the actor brings to bear in the here and now (i.e., Interpretant). A triadic sign links an Object to a Representamen through an Interpretant and leads to the emergence of an elementary unit of meaning (EUM).[10] An EUM is the smallest unit of action that is meaningful for the actor at a given moment and represents the state of the actor's action—situation linkage. The course of action is the flow of EUMs representing the dynamics or the unfolding of an actor's action—situation linkage.

To resume, in this study, we expected to identify a specific organisation of elite aerial freestyle skiers' activity that allow performance of rotations in a step-by-step manner calibrated to lead them to a safe and balanced landing on their feet.

Method

Participants

Three elite aerial freestyle skiers volunteered to participate in the study. Their average age was 24.3

years (range 22—26 years). They were among the top 20 in the world at the time of the study and had been participating for more than 10 years in national competition and for at least 3 years in the different stages of the World Cup. Informed consent was obtained from the participants.

Data collection

Data were collected during the 2005—2006 season. A set composed of diverse backward somersaults such as simple ($n = 12$), double ($n = 18$) and triple ($n = 30$), with or without one to five twists, was considered. The leaps were performed during training on a waterjump and on snow, and during snow competition. For each leap, three types of data were collected:

(a) *Field notes and observations*. A trained researcher was responsible for the field notes and observations. The observations provided documentation for the interviews.
(b) *Videotapes of the athletes' behaviours*. The recordings of the performances were made using a camera with a wide-angle lens. The videotapes of the athletes' behaviours while performing leaps provided support for the post-action self-confrontation interviews.
(c) *Video-recorded verbalisations elicited during self-confrontation interviews*. The self-confrontation interviews were video-recorded in order to check the correspondence between verbalisations and the recordings of the performance that were commented on. They were held within a week of the performance. The athletes were asked to describe and comment upon their own activity related to their recorded performance. In order to eliminate pre-formed experiences, athletes were involved in an attitude of evocation. Athletes should not repeat coaches' description of their performance but the way they had experienced it. Behaviour indicators such as hesitations in the stream of language, unstructured sentences or the inward-turned stare are used as indicators of evocation.

Data analysis

The data were processed in three steps:

(a) *Identifiying and labelling the EUMs*. This process was accomplished on the basis of the performance videotapes and the athletes' verbalisations. We used an action verb followed by a direct object, an adverb, or another complement. The label reflected the athletes' activity in relation to acting, feeling or thought components of activity as they appeared in the recordings and self-confrontation data.
(b) *Examining and labelling coherence relationships among these units*. Each coherence relationship between units was made up of units that formed a chain around a meaningful theme for the athlete. Each theme reflected a specific concern during the performance forming a sequence of activity. Sequences were labelled by using a verb that reflected the athletes' mode of involvement in the situation with a direct object for the meaningful theme.
(c) *Comparing the composition of the different courses of action*. Common types of organisation were detected in the sequences and units of these courses of action. They were labeled as such when they occurred systematically and were assumed to correspond with the typical organisation of the activity.

Trustworthiness of the data and analysis

Two coders familiarised with the performance scored 20% of the protocols. Reliability was assessed using Bellack's agreement rate[12] and ranged from 78 to 90% between coders for the different components of activity. Disagreements were resolved by discussion between the researchers. Since the inter-coder reliability was sufficiently high, one coder scored the remaining protocols.

Results

Six typical sequences of activity were identified. Three took place during the running and three during flight: (a) pick up speed in the descent (Fig. 1, Zone 1); (b) manage the curve of the tremplin (Fig. 1, Zone 2); (c) take off (Fig. 1, Zone 3); (d) manage the exiting of the tremplin (Fig. 1, Zone 4); (e) perform rotation (Fig. 1, Zone 4); and (f) organize the landing (Fig. 1, Zones 4 and 5). They were observed during each leap (Figs. 2—4).

Pick up speed in the descent

Pick up speed in the descent emerged during the running phase. This sequence was composed of units of 'slide on the track' while the Object corresponded to 'be aware of the speed increase'. The athletes adopted a low tuck position on their skis. The Representamens were directed at 'the slide of their skis on the snow' or on 'the track of the waterjump', 'the atmospheric conditions' and 'the speed

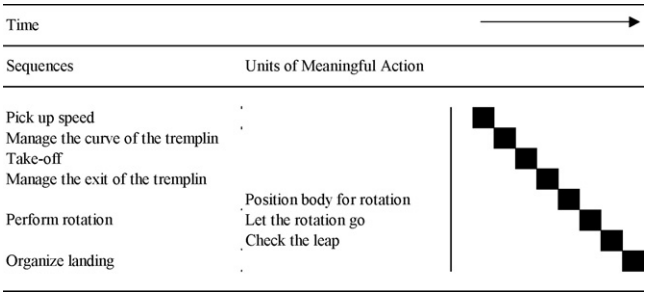

Figure 2 Sequences and units of meaningful action during a simple somersault.

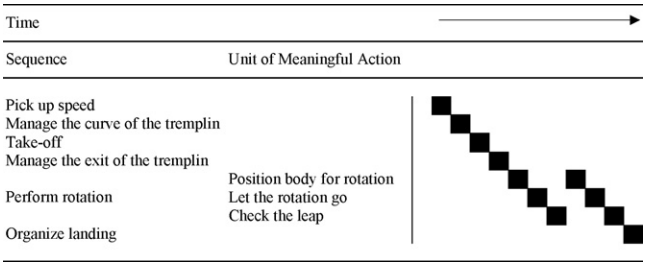

Figure 3 Sequences and units of meaningful action during a double somersault.

with which they arrive at the area they defined before the tremplin'. As the descent unfolded, they gained knowledge about 'the way they are using the running area' and 'the way they are arriving on the tremplin in relation to the preceding jump'.

Manage the curve of the tremplin

Then the athletes crossed an area called flat zone that set off a sequence labelled 'link the past descent phase to future take-off'. The athletes' involvement was focused on 'the future take-off'. They straightened up and pulled their arms up. They focused on 'the balance of the body position'. At the same time, they did not completely forget 'the preceding activity of the descent phase'. Thus, they knew whether or not they had to 'modify the way they expected to perform their leap' in relation to 'the feeling of this just-past activity and those of past trials'.

Take off

The flat area is followed by the tremplin per se. The sequence focused on 'the adoption of an ideal position for the take-off'. The athletes threw up their arms or kept them raised, and inclined their bodies in relation to the expected effects of the rotations. These actions were performed in relation to the knowledge built with the sequence 'pick up speed' and 'manage the curve of the tremplin'. However, this activity unfolded in a short time and was organised not by trying to adjust the athlete's own position but by 'building strong resistance to any deformation of the body position'. Athletes were in a situation of anticipating the real effects of what they would obtain during flight. Their knowl-

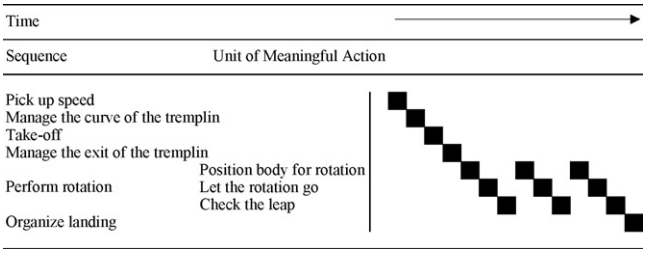

Figure 4 Sequences and units of meaningful action during a triple somersault.

edge comprised a zone of uncertainty that would only be resolved during the next sequence.

Manage the exit of the tremplin

After the take-off, the athletes focused on an enquiry of how to begin the leap. The athletes' feelings were focused on the shift related to the change in situation from an upright walking position to an aerial situation. These feelings were associated with feelings of the speed of rotation. Thus, they acquired more knowledge on how the leap they were performing should begin.

Perform rotation

Three typical units of meaningful action composed this activity:

(a) *Position body for rotation*. This unit consisted of adopting a body position in relation to the leaps to perform (e.g., arms locked around the body). These actions focused the athletes on the effects of what they were doing (e.g., feeling the speed of rotation). At the same time, this focus allowed them to know if the action was unfolding normally.
(b) *Let the rotation go*. This unit consisted of waiting for a particular moment in the rotation. While body position was maintained, the athletes focused on ways to 'attain a particular expected moment'. These moments were ''he end of the rotation' or 'the possibility of locating oneself in flight and in the rotation'. 'Let the rotation go' was active waiting because it was directed toward a particular moment that was on the athletes' mind.
(c) *Check the leap*. This unit consisted of checking how the leap was unfolding. The actions were 'slow down the speed of rotation' by 'opening arms' or 'look at the reception area'. The Object consisted of 'check the value of the feelings formerly experienced', 'form a hypothesis about the unfolding of the whole leap' or 'diagnose unexpected events'. Thus, the activity consisted of 'check the expectations' built on earlier actions and also 'identify the indices of how the leap is unfolding'.

Organise the landing

This sequence consisted of 'opening the arms to slow down the speed of rotation' and 'preparing the legs for contact with the track'. The Object was related to 'estimating the time to contact'. The athletes focused on 'a visual point on the landing track' and 'the future straightness of the body'. When they finally saw the landing area, they were almost completely sure of 'how the leap is unfolding': they were not totally sure of the quality of their future landing, but they were sure of the quality of the preparation of this phase of the leap in relation to the preceding phases.

Discussion

The analysis of elite aerial freestyle skiers' activity suggest that the balanced landings of these elite performers probably resulted from several processes, rather than from the final adjustment of the angular momentum to the time to contact on the landing hill.[5,6] Results indicate that performing rotations with a safe landing was supported by different states of the specific action-situation linkage that progressively led the athletes in their leaps. It is notable that each action furnished the conditions for the deployment of the next actions. Thus, the athletes' ability to land on their feet could not be attributed only to the final step of the leap but to the overall activity of the entire leap. In addition, it is important to underline that the leap was specifically segmented by the activity. Each state of the action-situation linkage provided a track that oriented the performance. For example, if the athletes felt that the rotation was too slow at the beginning of a somersault, they modified the way they engaged the next part of the leap. The sequencing and their activity demonstrated that the final step of the leap that consisted of landing on the feet was the result of a progressive process that began at the very start of the leap.

The results showed that the elite aerial freestyle skiers displayed specific actions and further demonstrated how this new form of practice differs from other acrobatic practices. In trampolining, for example, other sequences were identified during an exercise.[7,8] These differences can be attributed to the specific components of the situation (e.g., trampoline bed versus tremplin, inrun with height versus in-run with speed, etc.) and the aim of the performance (i.e., a series of 10 uninterrupted leaps in trampolining versus one leap in aerial skiing). Being an acrobat means being an acrobat in situation. However, the specificity of this acrobatic activity was contained in the action—situation linkages that framed the actual rotation (i.e., pick up speed in the descent, manage the curve of the tremplin, take off, manage the exit of the tremplin and organise the landing). The sequence 'perform rotation', which consisted in 'position body', 'let the rotation go' and 'check the leap', could be

analysed as a typical composition of the acrobatic performance during flight. Because the sequence is also observed in trampolining,[7,8] we consider it to be a point of convergence between different acrobatic practices. In addition, our results showed that this sequence corresponded to each somersault in skiing (Figs. 2—4), while in trampolining this sequence corresponds to each leap independently of the number of somersaults per leap. This suggests that, while the general organisation of the acrobatic activity could be considered in this typical sequence, each form of practice proposes a specific display of them. A more detailed analysis of different types of leaps might be useful to enrich and specify this model suggesting future research.

By identifying this on-line progressive construction of performance, we present evidence that activity is not limited to the invariant execution of an entire planned leap. At a high level of expertise, aerial freestyle skiers acquire the ability to improvise during the leap; that is, to interact efficiently with the situation as it evolves.

Practical implications

- The description and modelling of athletes' experience could be a point of entry for coaches' interventions to understand success and failure.
- The routine that consists of an acrobatic leap to 'position the body for rotation', 'let the rotation go' and finally 'check how the rotation is unfolding' should be the basis of the acrobatics learning.
- Individualised mental training program could be enhanced in accordance to the unfolding of athletes' experiences during performance.

Acknowledgements

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