ATHLETE RESPONSES TO USING A REAL TIME OPTICAL NAVIGATION FEEDBACK SYSTEM DURING SKI TRAINING

Richard Kirby*

*** Advanced Racing Computers, McMinnville, OR USA**

1 INTRODUCTION

Feedback has been shown to be important for all aspects of motor behavior (Shea et al., 1993) and is our brain's link to the body and to the environment. Müller states "Numerous investigations in the area of motor learning and technical training have indicated in concert that suitable feedback systems can significantly contribute to shortening acquisition time according to the principle of objectively supplementing rapid and immediate information" (Müller et al. 2007).

To date, sport scientists have used video analysis of alpine ski racers as the primary tool for providing athletes with feedback related to technique and tactics. However, many racers and coaches perceive the delay between performance and video feedback (often many hours) as detrimental to the effectiveness of video as a feedback tool.

One of the characteristics of a fast turn in alpine skiing is that the skier executes the turn with a minimum amount of lateral displacement. Lateral displacement in alpine skiing produces braking forces and while braking is sometimes required, the best racers are able to minimize the amount of braking force due to lateral displacement. This project investigated athlete responses to using a system that measured lateral displacement and provided audible feedback to the athletic in real-time relative to the amount and timing of their lateral displacement.

2.1 METHODS - APPARATUS

The real-time audible feedback system consists of two articulated "shuttles" (Fig 1) mounted on the inside edge of each ski. These shuttles follow the surface of the

snow and use an Optical Navigation System (ONS), to optically track displacement of the skis inside edge of the ski across the surface of the snow. The ONS measures forward speed and lateral displacement using high speed (6500 fps) CMOS photo-sensor arrays linked to a pattern-tracking engine. The pattern-tracking engine detects optical patterns in the snow surface and follow those patterns.

Figure 1

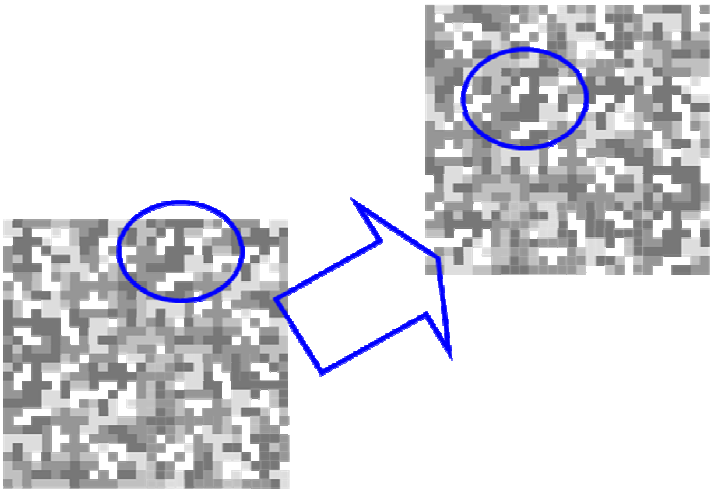

Figure 2

Fig 2 shows two successive images taken by the high speed CMOS photo-sensor array and a pattern that is being tracked.

Each shuttle wirelessly transmits forward speed and lateral displacement to a receiver (Fig 3) that the athlete wears. The receiver converts lateral displacement into a series of beeps. Each beep indicates a certain amount of lateral displacement. At the highest sensitivity setting, each beep signifies 0.5 mm of lateral displacement.

Figure 3

2.2 METHODS – DATA COLLECTION

Twelve racers participating in summer race camps at Mt Hood, Oregon, USA were randomly selected. Selected racers had 5 to 15 years of racing experience with 11 of the racers between the age of 13 and 18 years old. One 43 year old master ski racer also participated. The average age of the racers were 18.9 years old and consisted of 5 girls and 7 boys.

Each racer went through a series of familiarization drills to learn how to use the device and to become accustomed to the feedback. Racers were than asked to train for two hours in gates using the system. Racers filled out a survey after their training and were interviewed for subjective comments. Where possible, the racer's coach was also interviewed for subjective comments.

3 RESULTS

Results from the questionnaire are summarized in Table 1. These results showed that 83% of subjects stated that real-time audible feedback of their lateral displacement definitely helped them to better understand their carving skills. In addition, 50% of subjects stated that the real-time feedback definitely helped them improve their carving skills on the first day they used the system.

Table 1 Subject responses following the use of a real-time optical navigation system attached to the skis during training

Did having the device attached to your skis affect your skiing?	Frequency (%)
1. Definitely	0
2. Probably	0
3. Not sure	0
4. Probably not	0
5. Definitely not	100

Did the real time feedback help you better understand your carving skills?	Frequency (%)
1. Definitely	83
2. Probably	17
3. Not sure	0
4. Probably not	0
5. Definitely not	0
Did the real time feedback help you improve your carving skills?	Frequency (%)
1. Definitely	50
2. Probably	33
3. Not sure	17
4. Probably not	0
5. Definitely not	0
How often would you like to use real time feedback in training (9 responses)?	Frequency (%)
1. > 70% of the time	11
2. 30% to 70% of the time	88
3. < 30% of the time	11
How satisfied were you using real time feedback for training?	Frequency (%)
1. Very satisfied	58
2. Somewhat satisfied	33
3. Neither satisfied nor dissatisfied	9
4. Somewhat dissatisfied	0
5. Very dissatisfied	0

4 DISCUSSION

The perceived benefits of real-time feedback were clearly demonstrated with 100% of subjects stating that real-time feedback had definitely or probably helped them better understand their carving skills and 83% of subjects stating that the real-time feedback definitely or probably helped them improve their carving skills after only one two-hour session.

While we were not able to evaluate if performance actually improved, we interviewed several of the coaches who believed that they saw improvements in their athletes after the two-hour test. A more in-depth and longer term study that measures actual performance improvements would be a logical next step.

Several comments made by racers during the follow-up interviews help to explain the results. One racer stated that using the real-time feedback system was like "watching a video of myself while I was skiing". This racer felt he was getting the same feedback that he normally gets watching video, but while he was skiing, allowing him to make immediate corrections to his technique and have immediate feedback that identifies if the results were what he was looking to achieve.

Another racer stated that "I've been racing for 10 years and I didn't know I slipped that badly at the initiation of my turn." This particular racer had been getting feedback from her coach concerning her drifted turn initiation, but thought she had it under control. In this case the real-time feedback was a validation that her coach's feedback was correct and she still needed work on her turn initiation.

While the intent of the study was to determine if real-time feedback could help skiers improve technique, one skier stated that the real-time feedback "really helped me understand the issues I have with the timing of my turns". This skier was initiating her turns too early and was forced to drift out to get around the gate. While she was aware of this tactical issue, the real-time feedback made it clear to her in each gate what she was doing.

Several skiers made comments similar to "the audio feedback was distracting at first". Many racers are highly tuned to certain things, often pressure on their feet and a new form of feedback is difficult to assimilate. It appeared that skiers that were more familiar with computer or video games were better at adapting to the feedback. This

comment also highlighted the importance of the familiarization process. The familiarization process was intended to get the racers accustomed to the feedback without all the difficulties associated with running gates. A longer, more in-depth and more controlled familiarization process prior to allowing skiers to train in gates may significantly improve the benefits of the feedback.

REFERENCES

1 *Müller, E., Lindinger, S., Sattlecker, G., Schwameder, H., and Stöggl, T. (2007) Science and Nordic Skiing, 21.*

2 *Shea, C.H., Shebilske, W.L., and Worchel, S. (1993). Motor Learning and Control. Published by Englewood Cliffs, NJ: Prentice Hall 204-231.*