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RELATIONS BETWEEN DIFFERENT TECHNICAL AND TACTICAL APPROACHES AND OVERALL TIME AT MEN'S WORLD CUP GIANT SLALOM RACES

POVEZAVE MED RAZLIČNIMI TEHNIČNIMI IN TAKTIČNIMI PRISTOPI TER KONČNIM ČASOM NA MOŠKIH TEKMOVANJIH ZA SVETOVNI POKAL V VELESLALOMU

Abstract

This work presents a comparison between two computer-aided video analyses of the men's World Cup races in giant slalom held in Sölden in 2004/05 and 2005/06. Six of the best WC racers in Sölden 04/05 and seven in 05/06 were analysed. For the purposes of our study, in both cases the course was split into nine similar sections according to the terrain configuration and the course setup. The overall time, section time, section time differences, relative percentage differences and the theoretical fastest time were considered. We show that analysing the best WC racers' performances during a series of course and terrain variations can yield very different conclusions due to their different technical skills and tactical abilities which are these days playing the main role in ski racing. Further, this work reveals that the time variances in certain sections can be as high as 10%.

Key words: alpine skiing, World Cup racing, giant slalom, computer video analysis, technique, tactics

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Izvleček

Delo predstavlja primerjavo med dvema računalniško podprtima video analizama moških tekem za Svetovni Pokal v veleslalomu v Söldnu za sezono 2004/05 in 2005/06. Analizirali smo šest najboljših tekmovalcev za Svetovani pokal v Söldnu za sezono 04/05 in sedem za sezono 05/06. Progo smo za potrebe naše analize razdelili na devet odsekov glede na konfiguracijo terena in postavitev proge. Obravnavali smo končni čas, čas odseka, razlike v odsekih, relativne razlike v odsekih in teoretično najhitrejši čas. Analiziranje nastopov najboljših tekmovalcev za Svetovni Pokal na različnih konfiguracijah terena in postavitvah proge razkrije velike razlike med njihovim tehničnim znanjem in taktičnimi sposobnostmi. Ravno tehnično znanje in taktične sposobnosti pa imajo danes ključno vlogo v tekmovalnem smučanju. Poleg tega delo razkrije, da so razlike med najboljšimi tekmovalci v določenih odsekih lahko velike tudi 10 %.

Ključne besede: alpsko smučanje, Svetovni pokal, veleslalom, računalniška video analiza, tehnika, taktik

INTRODUCTION

Alpine ski racing is one of the most complex top-level sports. Many factors such as physical training, motor ability, nutrition, psychological preparation, appropriate racing equipment including its preparation and tuning, snow and terrain properties, weather conditions (temperature, visibility, humidity, wind etc.), technical skills, tactical abilities through to the course set up and terrain/snow properties etc. are very important for winning a race. Further, carving skis have entered the world of World Cup (WC) racing (Specifications for competition equipment 2002/2003, 2002) and it has been scientifically proven that the carving technique is far different to the classical 'side skidding' technique (e.g., Howe, 1983; Kugovnik, Nemec, & Supej, 2000; Mueller, Schiefermüller, Kroll, & Schwameder, 2005; Raschner, Zallinger, Hofer, Brunner, & Müller, 2001; Supej, Kugovnik, & Nemec, 2002). Nowadays, athletes in WC races are performing carving and pivoting (side skidding) turns (Supej, Kugovnik, & Nemec, 2005). In addition, it is already known that the two different techniques of single motion and double motion (Supej, Kugovnik, & Nemec, 2002) are not equally fast when performing pivoting or carved turns (Supej, 2004). Normally it is better to use the double motion technique in pivoting turns and the single motion technique in carving turns.

Therefore, technical skills and tactical abilities are becoming ever more important. But if one wants to be good in tactics it is not enough to be excellent only in the technique which is of the utmost important, but as regards all of the factors listed above. This work mostly deals with the relations between technical skills and tactical abilities and all the other factors will be taken as a constant for all the racers included in a race. Further, it is interesting to know how big the differences between elite racers are and to identify their strengths and weaknesses. Are the differences truly as small as they have appeared in several races in the past few seasons?

In order to answer some of these questions and to ascertain the relations among techniques and tactics we performed detailed video computer-aided analyses of seven WC top-level Giant Slalom racers in Sölden 2005/06 (B. Miller, B. Raich, M. Blardone, F. Nyberg, H. Maier, K. Palander and T. Grandi). We compared these results with the results of the previous year's Sölden giant slalom (season 2004/05) race where six top-level racers were analysed (B. Miller, K. Palander, M. Blardone, H. Knauss, T. Grandi and B. Raich).

METHOD

Participants

The sample of our analysis encompassed six men racers in the first run of the 2004/05 race (see Table 1) and seven of the 2005/06 race (see Table 2). They all belonged to the top 15 World Cup giant slalom group.

Table 1: Analysed racers in the first run of the 2004/05 Soelden race

Surname	Name	Nationality	Starting No.	Rank (1st run)	Birth year	Skis
Miller	Bode	USA	5	1	1977	Atomic
Palander	Kalle	FIN	3	2	1977	Atomic
Blardone	Massimiliano	ITA	1	2	1979	Salomon
Knauss	Hans	AUT	10	5	1971	Fischer
Grandi	Thomas	CAN	9	5	1972	Rossignol
Raich	Benjamin	AUT	2	10	1978	Atomic

Table 2: Analysed racers in the first run of the 2005/06 Soelden race

Surname	Name	Nationality	Starting No.	Rank (1st run)	Birth year	Skis
Miller	Bode	USA	7	1	1977	Atomic
Raich	Benjamin	AUT	5	2	1978	Atomic
Blardone	Massimiliano	ITA	3	3	1979	Salomon
Nyberg	Fredrik	SWE	15	4	1969	Fischer
Maier	Hermann	AUT	1	5	1972	Atomic
Palander	Kalle	FIN	6	8	1977	Atomic
Grandi	Thomas	CAN	4	21	1972	Rossignol

Instruments

A video comparing-measuring method using SX Video Compare 3.3[pro 1] was used. A live broadcast from the national TV of the WC giant slaloms Sölden 2004/05 and Sölden 2005/06 was recorded on to a computer and split into one-run long AVI video files.

Procedure

Six racers in the first run of the 2004/05 race (see Table 1) and seven of the 2005/06 race (see Table 2) were simultaneously analysed using SX VC 3.3pro (see Figure 1). Three independent stopwatches were running for each racer. The first one always measured the time starting at the 1st gate. The second stopwatch measured the section time, while the third one measured the time behind the fastest racer in that section. The time resolution was ±0.02s and the estimated section error due to the time resolution was approximately 0.3%. Both of the 1st run analysed courses were divided into nine sections according to the terrain configuration and gate setup. The main stopwatch and, accordingly, the first section time starts with the first giant slalom gate (not the starting gate). All the section times are divided as follows:

1st time: most of the first flat slope

2nd time: last part of the flat before the first pitch that ends with a short compression (glacier road)

3rd time: first half of the first steep pitch

4th time: second half of the first pitch including the compression (short flat) and (only 04/05) entrance to the second long pitch

5th time: first part of the long steep pitch (ends close to the official intermediate time)

6th time: second half of the long steep pitch

7th time: entrance to the long flat slope

8th time: first part of the long flat

9th time: last few gates on the flat ending with the finish line

RESULTS

All the results from the analysis were converted into two datasheets as presented in Table 3 (2004/05 race) and Table 4 (2005/06 race). The tables present the overall time starting from the first gate (T0), section time (T1), time relative to the fastest section time (T2), and relative percentage difference of the time difference behind the theoretical fastest course time (T2 rel,). The last parameter (sum) was calculated as the sum of all time differences behind the fastest section times.

1 The SX Video Compare v3.3pro is a video-comparing software package product built in Viplam s.p., Trzin, Slovenia.

Figure 1: Simultaneous analysis of top-level alpine ski racers in Sölden 2005/06 using SX Video Compare 3.3[pro]. All the racers are shown at the same overall time: 27.08 s.

Table 3: All the times measured and parameters calculated for the Sölden 2004/05 giant slalom race

	Miller				*Palander*				*Blardone*				
	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	Best
Sec.	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]
1	8.32	8.32	0.00	0.0	8.56	8.56	0.24	2.9	8.60	8.60	0.28	3.4	8.32
2	12.72	4.40	0.00	0.0	13.20	4.64	0.24	5.5	13.20	4.60	0.20	4.5	4.40
3	18.52	5.80	0.12	2.1	19.08	5.88	0.20	3.5	19.00	5.80	0.12	2.1	5.68
4	25.04	6.52	0.20	3.2	25.56	6.48	0.16	2.5	25.96	6.96	0.64	10.1	6.32
5	33.08	8.04	0.08	1.0	33.84	8.28	0.32	4.0	33.92	7.96	0.00	0.0	7.96
6	42.64	9.56	0.28	3.0	43.36	9.52	0.24	2.6	43.20	9.28	0.00	0.0	9.28
7	52.64	10.00	0.04	0.4	53.32	9.96	0.00	0.0	53.16	9.96	0.00	0.0	9.96
8	58.28	5.64	0.00	0.0	59.00	5.68	0.04	0.7	58.92	5.76	0.12	2.1	5.64
9	65.60	7.32	0.00	0.0	66.40	7.40	0.08	1.1	66.48	7.56	0.24	3.3	7.32
		sum:	0.72			sum:	1.52			sum:	1.60		64.88

	Knauss				*Grandi*				*Raich*			
	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.
Sec.	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]
1	8.60	8.60	0.28	3.4	8.64	8.64	0.32	3.8	8.48	8.48	0.16	1.9
2	13.20	4.60	0.20	4.5	13.24	4.60	0.20	4.5	13.16	4.68	0.28	6.4
3	19.00	5.80	0.12	2.1	18.92	5.68	0.00	0.0	19.12	5.96	0.28	4.9
4	25.48	6.48	0.16	2.5	25.44	6.52	0.20	3.2	25.44	6.32	0.00	0.0
5	33.60	8.12	0.16	2.0	33.60	8.16	0.20	2.5	34.08	8.64	0.68	8.5
6	43.28	9.68	0.40	4.3	43.28	9.68	0.40	4.3	43.84	9.76	0.48	5.2
7	53.64	10.36	0.40	4.0	53.56	10.28	0.32	3.2	54.00	10.16	0.20	2.0
8	59.48	5.84	0.20	3.5	59.48	5.92	0.28	5.0	59.96	5.96	0.32	5.7
9	66.84	7.36	0.04	0.5	66.92	7.44	0.12	1.6	67.32	7.36	0.04	0.5
		sum:	1.96			sum:	2.04			sum:	2.44	

Note: The analysed racers are: B. Miller, K. Palander, M. Blardone, H. Knauss, T. Grandi and B. Raich.

Table 4: All the times measured and parameters calculated for the Sölden 2005/06 giant slalom race

	Miller				Raich				Blardone				
	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	Best
Sec.	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]
1	7.24	7.24	0.00	0.0	7.36	7.36	0.12	1.7	7.44	7.44	0.20	2.8	7.24
2	10.76	3.52	0.00	0.0	10.92	3.56	0.04	1.1	11.20	3.76	0.24	6.8	3.52
3	18.72	7.96	0.00	0.0	19.20	8.28	0.32	4.0	19.20	8.00	0.04	0.5	7.96
4	25.88	7.16	0.00	0.0	26.52	7.32	0.16	2.2	26.60	7.40	0.24	3.4	7.16
5	34.28	8.40	0.00	0.0	35.00	8.48	0.08	1.0	35.00	8.40	0.00	0.0	8.40
6	42.84	8.56	0.20	2.4	43.60	8.60	0.24	2.9	43.48	8.48	0.12	1.4	8.36
7	51.88	9.04	0.16	1.8	52.76	9.16	0.28	3.2	52.60	9.12	0.24	2.7	8.88
8	58.24	6.36	0.04	0.6	59.08	6.32	0.00	0.0	58.96	6.36	0.04	0.6	6.32
9	65.00	6.76	0.24	3.7	65.68	6.60	0.08	1.2	65.68	6.72	0.20	3.1	6.52
	sum: 0.64				sum: 1.32				sum: 1.32				64.36

	Nyberg				Maier				Palander				Grandi			
	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.	T0	T1	T2	T2rel.
Sec.	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]	[s]	[s]	[s]	[%]
1	7.48	7.48	0.24	3.3	7.36	7.36	0.12	1.7	7.36	7.36	0.12	1.7	7.40	7.40	0.16	2.2
2	11.24	3.76	0.24	6.8	10.96	3.60	0.08	2.3	11.00	3.64	0.12	3.4	11.04	3.64	0.12	3.4
3	19.36	8.12	0.16	2.0	18.92	7.96	0.00	0.0	19.04	8.04	0.08	1.0	19.48	8.44	0.48	6.0
4	26.84	7.48	0.32	4.5	26.28	7.36	0.20	2.8	26.40	7.36	0.20	2.8	27.08	7.60	0.44	6.1
5	35.44	8.60	0.20	2.4	35.24	8.96	0.56	6.7	35.16	8.76	0.36	4.3	35.76	8.68	0.28	3.3
6	43.88	8.44	0.08	1.0	43.76	8.52	0.16	1.9	43.52	8.36	0.00	0.0	44.56	8.80	0.44	5.3
7	52.76	8.88	0.00	0.0	53.08	9.32	0.44	5.0	52.64	9.12	0.24	2.7	54.08	9.52	0.64	7.2
8	59.08	6.32	0.00	0.0	59.40	6.32	0.00	0.0	59.36	6.72	0.40	6.3	60.44	6.36	0.04	0.6
9	65.88	6.80	0.28	4.3	65.92	6.52	0.00	0.0	66.20	6.84	0.32	4.9	67.24	6.80	0.28	4.3
	sum: 1.52				sum: 1.56				sum: 1.84				sum: 2.88			

Note: The analysed racers are: B. Miller, B. Raich, M. Blardone, F. Nyberg, H. Maier, K. Palander and T. Grandi.

DISCUSSION

Sölden's giant slalom race is somewhat special. It happens a month before the rest of the season starts and it is stationed at an altitude of around 3,000 m above sea level. On the other hand, the terrain configuration is extremely difficult and this makes it ideal for our study. It starts with a very flat slope and then breaks over into a short, steep pitch. This section ends with a short radius (short flat) over a glacier road and is followed by a break over into the long steep pitch. At the bottom of the steep pitch, the terrain slowly turns into a long flat where the last few gates of the course are almost completely flat. This complex terrain configuration guarantees the need for both pivoting (side skidding) as well as carving turns (e.g., Howe, 1983; Kugovnik, Nemec,

& Supej, 2000; Mueller et al., 2005; Raschner et al., 2001; Supej, Kugovnik, & Nemec, 2002) along with the single and double motion techniques (Supej, Kugovnik, & Nemec, 2002).

The 2004/05 and 2005/06 races had a similar number of gates (45 and 46, respectively) and turning gates (44 and 43, respectively) (International Ski Federation [FIS], 2004, 2005). Nevertheless, the 2005/06 race had shorter gate distances ranging in some places from 24 m up to 31 m. The second run on the 2005/06 race was spoiled by clouds which created flat light for some of the competitors. Consequently, the four fastest times for the 2nd run where achieved by racers lying between 21st and 27th place after the first run (T. Ligety, A. Schiepaty, T. Grandi and M. Matt). The exception to this was H. Maier who achieved the same time - 4th place - as M. Matt with the help of nature that gave him some sun rays and consequently better light. These are largely the reasons we took only the 1st run into consideration and not the second one. Even though K. Palander and T. Grandi did not post good results in the first run on the 2005/06 race, we included them in the analysis because of their good performances in the 2004/05 Sölden race.

Looking at the results of both analysed races, it is clear that performance differences among the top-level WC racers are not as small as they appear at first glance. In Table 3 and Table 4, several results are marked in bold font meaning that the skiers were at least 5% slower than the best time for that section. We reiterate here that only the best WC racers were analysed. For example, K. Palander achieved the second-best time in the analysed group in 2004/05. However, in the second section he was more than 5% slower than the fastest skier. M. Blardone was more than 10% slower than the fastest skier in section 4 but he achieved 3rd place in the first run. Fortunately, this occurred on the shortest timed section measured on the course. However, to put this into perspective, a 10% time differential means six seconds in a 60-second-long run. It is even more interesting that H. Maier won the 2005/06 race by a 0.05% differential (0.07s in a 2:17:60 two run race [FIS, 2005]) despite being in one section 5.0% and in another 6.7% behind the fastest skier in the first run (see Table 4). When analysed in this manner, the differences become more apparent and are truly much greater than they appear when applying visual or basic analytical tools. The reason is that the skiers are not equally fast on different terrain and/or different course configurations and/or different snow conditions. This is, on one hand, mainly due to different technical skills, being better or worse using the single motion technique in carving turns and being better or worse using the double motion technique in pivoting turns. On the other hand, the differences appear due to better or worse tactical abilities and/or tactical plans. For example, B. Miller is normally the fastest on flat slopes where carving or skiing without side skidding plays the main role where the single motion technique and optimal gliding are the most important. In the Sölden race, this is especially evident in sections 1, 2, 8 and 9 where he had the fastest section times in the 2004/05 race (see Table 3). It was somewhat of a surprise that this year he was not so fast on the last, flat section. But when examining the 9th (last) section in detail, it can be seen that he made a mistake just a few gates before the finish line, where he lost control of his outside ski. Therefore, his gliding was not so optimal – losing some speed, he finished the turn too much under the gate and consequently lost almost 0.25 s in a distance of only one and a half gates. On the other hand, his performance on the steepest slopes is often not exceptional (Sölden sections 4 – 6). This is the case especially when he is unable to perform carved turns without side skidding, because pivoting could be his weakest part. Sometimes he achieves his best times also on the steepest slopes when he is able to alternate between carved and pivoting turns. In this case he

can win some time by carving and lose it by pivoting, but overall he is still fast. M. Blardone is a completely different type of skier who is always fast on the steepest slopes, especially when carved turns are impossible (Sölden sections 5 – 7) with his tight pivoting turns and generally slower on the flat slope where carving and optimal gliding are necessary.

The key question arises: 'How to win a race using this knowledge?' Unfortunately, there is no simple answer to this question. There are several strategies that are not the same for all racers. As we can see from the results, they have different abilities. In addition, each race has its own unique specifications. But, at the end, the winner is the racer who puts together the lowest sum of all section times. Theoretically, this means that it is not important if you are randomly the fastest on any of the sections. Instead, you can still win a race by developing a tactical plan which capitalises on your strengths and athletic abilities and overlays that against the demands of the race course. We all know this normally does not happen in a race but if we just take a look at K. Palander's 2004/05 and B. Raich's 2005/06 1st run results we see that they only had one fastest section among the group and yet they posted second place. On the other hand, even if a racer had several of the fastest sections he can still stay away from the podium, e.g. H. Maier had three of the fastest sections in the 1st run 2005/06 and he ended up in 5th place after the 1st run.

Taking the foregoing into account, theoretically there are two 'good' strategies. The first would be: the racer should not lose much on his weakest sections (sections exposing his weaknesses) and gain as much as possible on those sections suited to his strengths (e.g. Miller and Blardone). The second one is to be very close to the best results in all sections as Palander (see Table 3) and Raich (see Table 4) did. It is even possible to be far behind in certain sections and to still win a medal (e.g. Maier), but this is normally not very likely. Now possessed with this tactical insight, what does this mean when it comes to execution? A racer should be able to perform at least two essential turn techniques – carving and pivoting. These two types of turns are physically (mechanically) so different that the execution of the techniques is also different (e.g., Mueller et al., 2005; Supej et al., 2002; Supej 2004). Beside both techniques, the tactics of using one and the other should be keenly calculated for each unique set of terrain, course setup and snow conditions. Racers are not equally good in all circumstances. Some of them are better in one type of circumstance and others are better elsewhere. The worst thing that can happen is that a racer loses time everywhere. This was the case of T. Grandi this year. He was slow in all sections, except section 8. He could have had a bad day or bad run but if this is his level of skiing it is very unlikely he will win a WC race.

The points stated above also give an insight into the reasons for the significant advantage of more than 1 second that sometimes happens in a WC race. To better define this situation, we need to keep in mind that 1 second is a mere 1.5% of a 65-second-long run. Looking at the measuring results from Tables 3 and 4, this is not such a big surprise when the differences of the top-level racers can even be up to 10% in certain sections. This can also be further accentuated by the results of total time differences for each racer. For example, we can see that B. Miller was in both 2004/05 and in 2005/06 about 0.7 second (1.1%) behind the theoretical fastest time and, additionally, by comparison about 1.5 seconds (2.3%) for the 2nd and 3rd fastest times (K. Palander and M. Blardone in 04/05, B. Raich and M. Blardone in 2005/06).

Performing such an analysis also provides insights into improvements by the best racers from year to year. Let us examine the most popular three of them. B. Miller is still very fast on the

flat slope, like he was in the previous year (sections 1& 2). He is even one of the fastest on the steeper pitch, being the fastest this year from the 3rd to the 5th sections. He is even very close on the steepest pitch from sections 5 to 7, where he was trailing by around 2%. On the other hand and not surprisingly given his technical competence, B. Raich looks very consistent in all sections – not losing much. He won only one section this year, like last year. But he is definitely losing much less on the steepest slope compared to last year (see sections 3, 5 and 6). It is interesting that, last year as well as this year, he was less than 2% behind in the 1st section, however, only last year more than 6% behind in the 2nd section just before the 1st steep pitch. H. Maier cannot be compared to the last year but he is fast mostly on the flatter sections (sections 4, 8 and 9) and slower on steeper sections (sections 5 and 7). Probably his orientation to faster disciplines works better on flatter parts where gliding and carving are important.

Conclusions

As we know there are several factors that influence results in WC racing alpine skiing. Nevertheless, technical skills and tactical abilities seem to be the most important these days. But to be able to perform excellent techniques and subjectively perfect tactics all other factors such as motor control, physical strength, psychological preparation etc. must be on a suitably high level. Further, we can see that even different technical skills and tactical abilities can lead to a podium position. Generally, it can be stated that being able to perform both the carving as well as the pivoting technique and being able to build a proper strategy/tactics give a racer much greater chances of achieving top-level results. It should be pointed out that the mechanics of both principle techniques are the same for all racers even though the execution sometimes looks different because of racers' specific morphological properties and their other abilities. But only when a skier is capable of performing good carving and pivoting techniques can the best tactic be possible. Therefore, racers should first learn both techniques and only later focus on tactical skills.

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