POSSIBILITIES OF THE CARVING TURN IN SKIING AND SNOWBOARDING

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Abstract:

Nowadays, skiers and snowboarders leave drifted turns behind. Carving is a password to enter all winter resorts. Ski and snowboard equipment is produced in such a way as to comply as much as possible with the developing trends in both skiing and snowboarding techniques. This paper is a comparison of classical skis and Alpine snowboard, in other words, a comparison between the old and the new. It also initiates a discussion on lateral balance which influences both skiers and snowboarders. In the measurements, classical slalom skis and a slalom snowboard were used. The goal was to point out the different possibilities of the carving turn performance. The intention was to emphasize the contribution of snowboarding technique to skiing. The results presented indicate the better racing performance on a snowboard compared to classical non-carving slalom skis. Though skis are faster in a straight run, the snowboard proved to be faster in the turns. This may be a guideline for coaches to analyze the technique of their team members and take into account the results when creating a workout.

Key words: *ski turn technique, snowboard turn technique, 2D kinematic analysis, inter-individual and intraindividual comparison of turn technique*

MÖGLICHKEITEN DES CARVING-SCHWUNGES IM SKIFAHREN UND SNOWBOARDEN

Zusammenfassung:

In der Technik der Ski- und Snowboard-Schwünge ist eine deutliche Reduzierung der Rutschbewegung von Skiern, bzw. vom Snowboard bemerkbar. Carving ist ein Kennwort, mit dem man alle Wintersportörte betritt. Die Ski- und Snowboard-Ausrüstung ist dem progressiven Trend der Schwungtechnik maximal angepasst. Unsere Studie stellt einen Vergleich zwischen den Schwüngen auf klassischen Skiern und den Schwüngen auf dem alpinen Snowboard dar, nämlich, einen Vergleich zwischen der alten und der neuen Fahrtechnik. Sie befasst sich auch mit der Problematik der Lateralität, die sowohl die Skifahrer als auch die Snowboarder beinflusst. In den Messungen wurden die klassischen Skier und das Slalom-Snowboard angewandt. Das Ziel der Studie war, sowohl auf die unterschiedlichen Möglichkeiten des Carving-Schwunges als auch auf den geleisteten Beitrag der Snowboardtechnik zu Skifahren aufmerksam zu machen. Die dargestellten Ergebnisse deuten auf bessere Snowboard-Fahrleistungen im Vergleich zu den klassischen nicht-carving Slalom-Skiern. Obwohl die Skifahrer auf klassischen Skiern schneller fuhren auf der schnurgeraden Strecke, war das Snowboard schneller in den Bögen. Diese Ergebnisse könnten den Trainern helfen, sowohl die Schwungtechnik ihrer Mannschaftsglieder zu analysieren als auch die in dieser Studie erhaltenen Ergebnisse in Betracht zu ziehen, wenn sie das Trainingsplan gestalten.

Schlüsselwörter: *Skischwungtechnik, Snowboardschwungtechnik, zweidimensionale kinematische Analyse, inter- und intraindividueller Vergleich der Schwungtechniken*

Introduction

A carving turn is the highest peak both of downhill skiing and snowboarding techniques. A skier/snowboarder alters direction fluently and reduces speed loss. The current construction of carving skis, bindings and snowboards enables a skier/snowboarder to create optimal pressure on the inner edge, so that it can adequately carve the snow surface with minimum friction and speed loss. Considering the extent of motion we believe there is a better precondition for making "more carved" and faster turns on a snowboard. The more extensive the motion, especially the lateral motion of the center of gravity, the more it helps to switch the board onto the inner edge. Similarly, the edge switch may be done faster by a snowboarder avoiding a drifting. We evaluated the ability to perform laterally balanced turns to both sides.

Materials and methods

We carried out the inter- and intraindividual 2D kinematics analyses (Hellebrandt & Slamka, 1998) along with an independent time measurement for two athletes who had mastered both skiing and snowboarding to a professional technique level (average age – 28 yrs, height - 183cm, weight – 79kg). B. O. had a regular stance, a stronger left lower limb and a more coordinated right lower limb. M. P. had a goofy stance, stronger right lower limb and a more coordinated left lower limb.

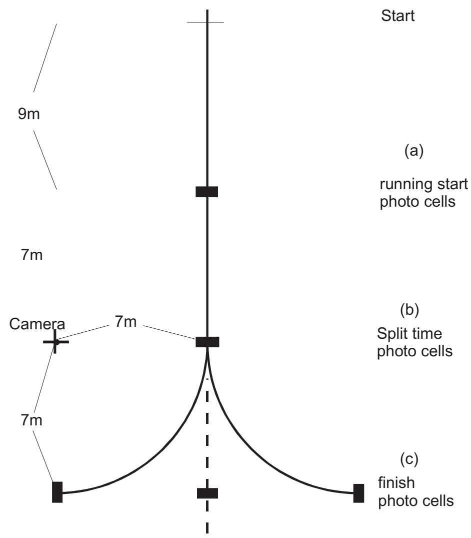

Figure 1. Scheme of the off-falline turn.

Such lateral behavior has been already mentioned by Oberbeck (1989). To test both strength and coordination preference, two methods, out of the ten-item set by Fischer (1988), were used, namely, a ball kick and a step-up on a chair. The recorded course was a part of a circle. A camera was located in the middle of the circle. In such a geometrical setup a recorded motion is viewed as straight, so that, therefore, the 2D analysis could be used. The rotation of the camera was compensated for by terrain calibration with the help of solid points. The recording frequency was 50 images per second. One complete off-slope turn and off-falline turn were tested. Gates were used to mark the courses in both the cases presented (Fig. 1 and 2). The independent time measurement was to compensate for some of the kinematic discrepancies in the analysed turns. We compared the time values in the turns to those of 14-metre-long straight runs. After the training runs, the tested athletes ran each course three times. In measurements, taken in 1999, classical slalom skis and a slalom snowboard were used. We wanted to point out the different possibilities of the carving-turn performance. We also intended to emphasize the contribution of the snowboarding technique to skiing. The fastest run became the subject of analysis presented. The types of starts were the same in both skiing and snowboarding in each case presented. The skiers/snowboarders started by turning their skis or snowboard over the edge of the starting platform. They could not assist themselves with any additional movement made with either their lower or upper limbs.

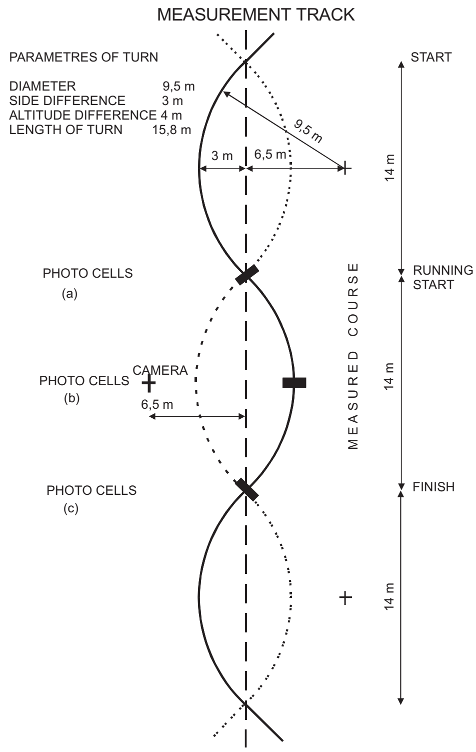

Figure 2. Scheme of the off-slope turn.

Results

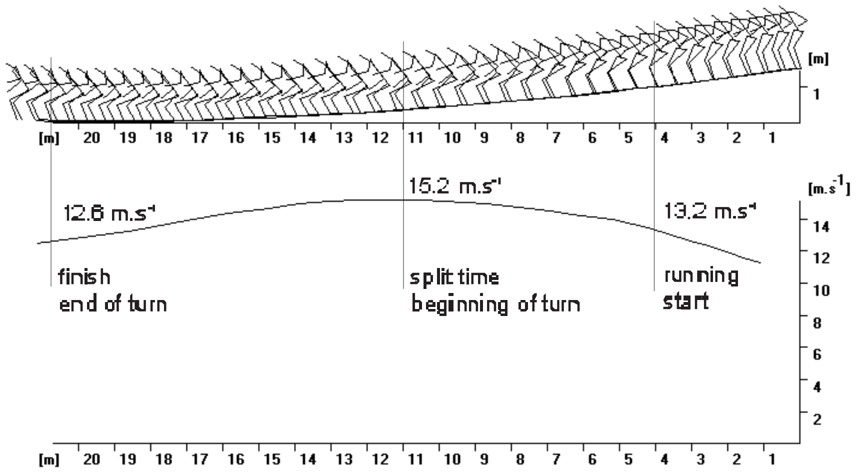

Figure 3. Kinematic analysis of snowboard off-falline turn to the left.

Figure 3 shows a concept of the 2D analysis of the snowboard off-falline turn to the left. Figure 4 presents the ski off-falline turn with the same skier. Table 1 displays the time delays in the turns compared to the straight runs. Table 2 presents the instant speed reached on the timed lines and their percentage changes in off-falline turns. Table 3 presents the same course with the off-slope ski turn. In all off-falline turns we found a less relative speed decrease in the snowboard runs compared to runs on classical slalom skis. In most off-slope turns the athletes achieved a greater relative acceleration at the end of the turn. Due to the small sample the results are of limited validity. The intraindividual analysis has a higher value. The inter-individual analysis may just have a comparative meaning.

Discussion

Off-falline turns

Both athletes achieved laterally better balanced **off-falline** turns on skis. M. P. performed a better snowboarding technique and showed a laterally balanced off-falline turn on the snowboard, too. B. O. showed an exactly equal performance on skis in turns to both sides, which was a 44 % time delay compared to the straight run. On snowboard, B. O. was faster in the right turn (the snowboarder has his face turned in the direction of the turn). The time delay was 42.8 %. In the left turn the time delay was 47 % (Table 1). A higher lateral equality may be the result of the symmetrical stance on skis to the skiing direction. The motion of a

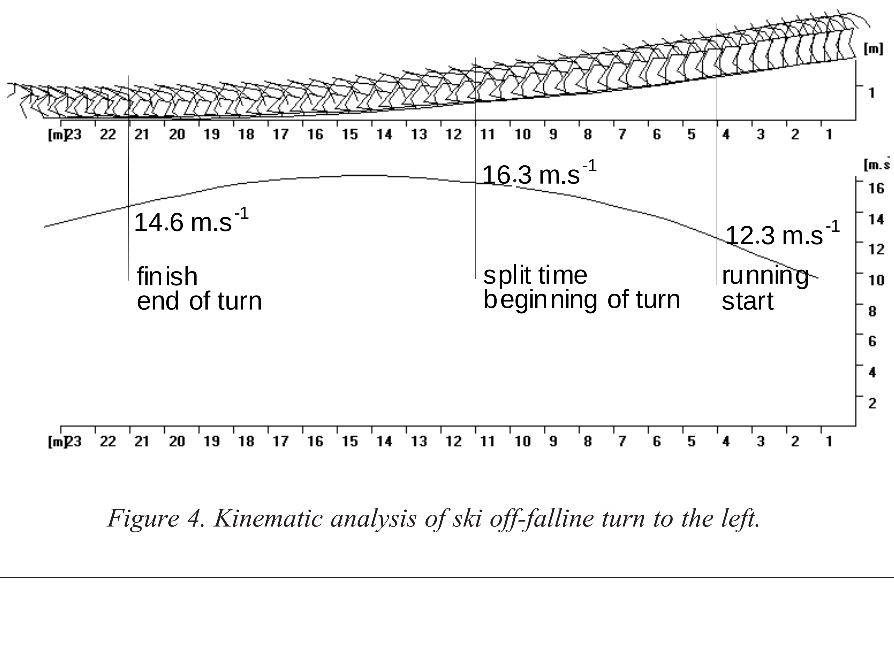

Figure 4. Kinematic analysis of ski off-falline turn to the left.

skier in such a stance is partially similar to the most natural human locomotion – walking (Zehetmayer, 1990). The faster motion on skis compared to the one on the snowboard in the straight section was probably caused by the skis' creating a larger contact surface. Consequently, there was a lower specific friction on the ski bases. In the course of the run, on the split-time line, the speed reached on the snowboard and the speed reached on skis were approximate to each other, and on the finish line the snowboards were definitely faster. Compared to the ski turns the actual snowboard off-falline turns were less drifted, which means that the turns were performed faster.

turn (the snowboarder has his face turned in the direction of the turn) where the time delay was 19.3 %. The time delay in the left turn was 31 % (Table 1).

The tested snowboard off-slope turns were faster than the ski turns in all the runs. Similarly, the acceleration measured between the start and finish lines was higher on the snowboard in three runs out of four. The better performance of both snowboarders when making the turn to the right may be explained by different bending into the turn. In the left turn a snowboarder bends over his heels which are, compared to the toes, less sensitive. When making the left turn, namely, when his back is turned in the direction of the turn), the snowboarder has limited visual control, which means he can not substantially control the edging of the board (Tables 2 and 3). This is also an answer to the higher lateral differences in the snowboard turns compared to the ski turns.

Table 1. Time values of turns

situation		turn	time delay compared to falline run			
			right turn		left turn	
			seconds	%	seconds	%
B. O.	ski	off-falline	0.66	44	0.66	44
		off-slope	0.42	28	0.47	31.3
	snowboarding	off-falline	0.62	42.8	0.68	47
		off-slope	0.28	19.3	0.45	31
M. P.	ski	off-falline	0.67	45	0.71	47.7
		off-slope	0.37	24.8	0.37	24.8
	snowboarding	off-falline	0.61	41.2	0.63	42.6
		off-slope	0.19	12.8	0.18	12.2

Off-slope turns

In the more demanding **off-slope** turns M. P. achieved a laterally well balanced performance on both skis and snowboard. This is presented by the time delays to the straight run.

Table 2. Speed values of off-falline turns

situation			running start	beginning of the turn		end of the turn	
			a	b		c	
			$m.s^{-1}$	$m.s^{-1}$	% of change (b/a-1). 100	$m.s^{-1}$	% of change (b/a-1). 100
B. O.	ski	right turn	12.6	15.3	21.4	12.9	-15.7
		left turn	12.6	15.3	21.4	13.3	-13.1
	snowboarding	right turn	12	15.5	29.2	14.1	-9
		left turn	11	15.3	39.1	14.5	-5.2
M. P.	ski	right turn	12.5	15	20	12.2	-18.7
		left turn	13.2	15.2	15.2	12.6	-17.1
	snowboarding	right turn	12.2	15.8	29.5	15.3	-3.2
		left turn	12.3	16.3	32.6	14.6	-10.4

Legend: s = seconds

It is 24.8 % on skis to both sides and 12.2 % and 12.8 % on the snowboard. B. O. also showed laterally well balanced ski turns. In the right turn the time delay was 28 %, and in the left turn 31.3 %. On the snowboard he did much better in the right

Generally, a higher speed on a snowboard is the result of the carving technique that avoids the drifting of the board's end. The snowboard's construction and the stance of the snowboarder give a greater edging and pressure on the inner edge.

Table 3. Speed values of off-slope turns

situation			beginning of the turn	middle of the turn		end of the turn		beginning-end of the turn
			a	b		c		
			$m.s^{-1}$	$m.s^{-1}$	% of change (b/a-1).100	$m.s^{-1}$	% of change (c/b-1).100	% of change (c/a-1).100
B. O.	ski	right turn	8.6	9	4.7	10.2	13.3	18.6
		left turn	8.5	9.2	8.2	10	8.7	17.6
	snow-boarding	right turn	7.6	8.6	13.6	10	16.3	31.6
		left turn	7.9	8.4	6.3	9.6	14.3	21.5
M. P.	ski	right turn	8	9.1	13.8	9.9	8.8	23.8
		left turn	8	9.3	16.3	9.8	5.4	22.5
	snow-boarding	right turn	8.6	9.7	12.8	10.3	6.2	19.8
		left turn	8.4	9.6	14.3	10.4	8.3	23.8

The results of the analysis confirmed the alleged faster turns on the snowboard. The high lateral equality of the performance on skis and, with M. P. also on the snowboard, confirmed a finding by Fetz and Werner (1981) that athletes of higher sport and technique level are laterally more balanced. In relation to the issue we are of the opinion that some movements executed in turns in snowboarding could also be applied by skiers, and that the transition of some snowboarding-technique aspects could be beneficially applied in skiing.

Conclusions

- In the case of the two tested athletes, the classical skis were faster in the straight section. On the other hand, a snowboard was faster in the turning section due to its carving performance.
- In snowboard turns, both athletes were faster when executing turn on their forehead/face side.
- Comparing right and left turns intraindividually we found that there were greater differences in the snowboard turns which may have the same cause as the issue mentioned above.

Compared to skis, the slalom board is shorter, with a larger sidecut. Thus, a snowboard gives better mechanical preconditions to perform a carving turn. These may be done by pressing the inner edge hard and edging under a wide angle. Within the very technique of motion a snowboarder is able to bend into the turn much more than a skier. The implementation of progressive mechanical and functional qualities in the production of carving skis has brought new ideas towards the future improvement of ski turn technique. Last season this trend appeared even in slalom.

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MOGUĆNOSTI KARVING ZAVOJA U SKIJANJU I DASKANJU NA SNIJEGU

Sažetak

Uvod

Karving zavoj najviši je doseg tehnike skijanja i daskanja na snijegu. Koristeći karving zavoj, vozač često mijenja smjer vožnje i smanjuje gubitak brzine. Postojeća konstrukcija strukiranih skija, vezova i dasaka za snijeg (monoskija) omogućuje optimalan pritisak na unutarnji rub tako da vozač može zasjeći, "rezbariti" snježnu površinu na najprimjereniji način uz minimalan otpor i gubitak na brzini. Razmotrimo li raspon samih gibanja, uočit ćemo da daske za *snowboard* pružaju bolje pretpostavke za bolji i brži karving zavoj. Veći opseg pokreta, osobito postraničnih gibanja težišta tijela, pomaže prebacivanju monoskije na unutarnji rub. Također, promjena rubljenja može biti brža ako daskaš izbjegava otklizavanja. Mi smo ocjenjivali sposobnost izvođenja lateralno uravnoteženih zavoja na obje strane.

Metoda

Proveli smo i inter- i intra-individualnu dvodimenzionalnu kinematičku analizu, kao i nezavisno mjerenje vremena vožnje dva vozača vrhunske i skijaške i *snowboarding* vještine te profesionalne tehnike vožnje. Prvi vozač imao je uobičajeni stav, jaču lijevu nogu te nešto koordiniraniju desnu nogu. Drugi je imao obrnuti stav, snažniju desnu nogu i koordiniraniju lijevu nogu. Za ispitivanje koordinacijske preferencije i snage koristili smo dvije metode: udaranje lopte nogom i penjanje na stolicu kao dio kružnog testa od deset zadataka. Kamera je bila postavljena na radnom mjestu u sredini kruga. Iz takvog položaja zadani pokret vidi se kao po ravnoj liniji. Tako smo mogli koristiti dvodimenzionalnu kinematičku analizu. Rotacija kamere bila je kompenzirana kalibracijom tla uz pomoć čvrstih točaka. Frekvencija snimanja bila je 50 snimaka u sekundi. Ispitivali smo po jedan cjeloviti osnovni zavoj i paralelni zavoj od brijega. U obje situacije označili smo vrata. Nezavisno vrijeme mjerenja korišteno je radi kompenzacije nekih kinematičkih pogrešaka u analizi vožnje zavoja. Usporedili smo vremena vožnje zavoja s vremenima ravne vožnje duge 14 metara. Svaki je sportaš nakon probnog pokušaja odvezao po tri vožnje. U mjerenjima, koja su provedena 1999. godine, koristili smo klasične slalomske skije i slalomsku dasku za snijeg. U vrijeme pojavljivanja strukiranih skija željeli smo naglasiti različite mogućnosti izvedbe karving zavoja te istaknuti doprinos tehnike daskanja na snijegu tehnici skijanja. Analizirali smo najbržu vožnju. Način starta bio je jednak i za skijanje i za daskanje na snijegu u svakoj situaciji. Startalo se okretanjem skije ili daske preko ruba startne platforme. Vozači nisu imali mogućnost izvesti ni jedan jedini dodatni pokret ni rukama ni nogama kako bi si dali početno ubrzanje.

Rezultati

U svim situacijama paralelnog zavoja od brijega utvrdili smo manji gubitak relativne brzine u vožnji na monoskiji u usporedbi s klasičnom skijaškom vožnjom. U većini situacija u izvedbi osnovnog zavoja vozači su postizali veće relativno ubrzanje na kraju zavoja. S obzirom na mali uzorak, dobiveni su rezultati ograničene valjanosti. Analiza vožnji dvaju vozača može poslužiti samo za približnu usporedbu. Oba su vozača postigla bolju postraničnu ravnotežu u paralelnom zavoju od brijega na skijama. Prvi je pokazao bolju daskašku tehniku te je postigao dobru postraničnu ravnotežu u izvedbi zavoja od brijega, a također i na monoskiji. Drugi je vozač pokazao potpuno jednaku izvedbu desnog i lijevog zavoja na skijama, što je bilo 44% vremena zaostatka u odnosu na ravnu vožnju. Drugi je vozač bio brži na monoskiji u desnu stranu, što je, u ovom slučaju, bio prednji zavoj. Vremensko kašnjenje iznosilo je 42,8%. U zavoju leđima (lijevi zavoj) vremensko kašnjenje bilo je 47%. Viša lateralna kvaliteta može biti rezultat simetričnog stava na skijama u poziciji vožnje. Pokreti skijaša u takvom stavu su djelomično slični najprirodnijem obliku ljudskog kretanja - hodanju.

Brža vožnja na skijama nego na dasci za snijeg u ravnoj vožnji bila je vjerojatno uzrokovana većom kontaktnom površinom skija. Posljedica toga je manje specifično trenje na skijama. Na dionici ravne vožnje, na polovici od ukupno mjerenog vremena, dostignuta brzina na skijama i na monoskiji približno je slična, dok su na ciljnoj crti monoskije bile definitivno brže. U usporedbi sa zavojima na skijama, u daskaškim zavojima bilo je manje otklizavanja, što znači da su bili brži.

Kod zahtjevniih paralelih zavoja od brijega prvi je vozač postigao dobro uravnoteženu postraničnu izvedbu i na skijama i na monoskiji. To je predstavljeno vremenom zaostatka u odnosu na ravnu vožnju koje iznosi 24.8% u obje strane na skijama i 12.2%, odnosno 12.8 % na daski. Drugi je vozač također pokazao dobre postranično uravnotežene zavoje na skijama.

U desnu stranu vrijeme zaostatka bilo je 28%, dok je ulijevo bilo 31.3%. Na monoskiji je bio znatno bolji u desnu stanu (njegov prednji zavoj), gdje mu je vrijeme zaostatka iznosilo 19,3%. Vrijeme zaostatka u lijevu stranu (zavoj leđima) bilo je 31%. Ispitivani daskaški osnovni zavoji bili su brži od svih zavoja na skijama u svim vožnjama. Slično tome, ubrzanje mjereno između startne i ciljne linije bilo je brže na monoskiji kod tri od ukupno četiri vožnje. Bolja izvedba obojice vozača na njihovoj prednjoj strani može se objasniti različitim naginjanjem u zavoju. Kod zavoja leđima (stražnji zavoj), vozač se naginje preko ravnine svojih peta, koje su, u usporedbi s prstima, manje osjetljive. Dok se naginje unatrag, vozaču je ograničena vizualna kontrola, što automatski znači da ne može dovoljno kontrolirati rubljenje daske. To je također i odgovor na veće postranične razlike u daskaškim zavojima u odnosu na skijaške zavoje. Općenito, veća postignuta brzina na monoskiji rezultat je karving tehnike kojom se izbjegava otklizavanje kraja daske. Konstrukcija daske za snijeg i stav vozača omogućuju jače rubljenje i pritisak na unutarnji rub.

Zaključak

Rezultati analiza potvrđuju navedene pretpostavke o bržim zavojima na monoskiji. Veća postranična smirenost trupa u izvedbi na skijama, a kod prvog sportaša i na monoskiji, potvrdila je nalaze da su sportaši više sportske i tehničke razine izvedbe lateralno više uravnoteženi. U odnosu na taj nalaz mi smatramo da daskaški pokreti u zavoju kod skijaša znače napredovanje, kao i da je moguć prenijeti pozitivan transfer daskaške tehnike na elemente skijaške tehnike.

- U slučaju dvojice testiranih vozača klasično skijanje pokazalo se bržim u ravnoj vožnji. S druge strane, monoskija je bila brža u zavojima zbog svoje strukirane izvedbe.
- U daskaškim zavojima oba su vozača bila brža u svom prednjem zavoju.
- Uspoređujući desni i lijevi zavoj kod svakog vozača utvrdili smo da postoji veća razlika u izvedbi daskaških zavoja, što može imati isti, gore spomenuti uzrok (prednji zavoj).

U usporedbi sa skijama, slalomska monoskija je kraća i većih rubova. Stoga daska za snijeg ima bolje mehaničke preduvjete za izvedbu karving zavoja. Oni mogu biti izvedeni jakim pritiskom unutarnjeg ruba daske i rubljenjem pod širokim kutom. U izvedbi tehnike daskaš se u zavoju može nagnuti znatno više od skijaša. Implementacija progresivnih mehaničkih i funkcionalnih kvaliteta u proizvodnji strukiranih skija urodila je novim idejama za daljnje unapređenje tehnike skijaških zavoja. U posljednje vrijeme ovaj trend javlja se čak i u slalomu.