FACILITATION EFFECTS OF A PREPARATORY SKATEBOARD TRAINING ON THE LEARNING OF SNOWBOARDING

Stefan Künzell[1,2] and Simon Lukas[1]

[1]*Justus-Liebig-University Gießen, Institute for Sports Science Gießen, Germany*
[2]*University of Augsburg, Institute for Sports Science, Augsburg, Germany*

Original scientific paper
UDC 796.015.28:796.694:796.947

Abstract:

Surfing's progeny, snowboarding and skateboarding, present similar positional, visual, and kinesthetic reafferential aspects. Such aspects lead us to the assumption of a positive knowledge transfer from skateboarding to snowboarding. In this investigation we analyzed the probability of and theories for the transfer effect under field conditions. Students of the experimental group received five skateboarding lessons. They then joined a student control group for a six-day school snowboarding trip. Both groups were videotaped on the second and sixth days of the trip. Experts rated snowboarding performance of subjects pertaining to either of groups on a scale of one (*very bad*) to ten (*excellent*) points. Inter-rater reliability was very good. While there were no significant differences between the groups on the second day, the students of the experimental group significantly outperformed students of the control group in snowboarding on the sixth day ($M_{control}$=4.80, $SD_{control}$=2.10; M_{treat}=6.56, SD_{treat}=2.10; T=-1.78, df=16, $p_{one\text{-}tailed}$=.045, d=-.83). Given a common underlying structure of skateboarding and snowboarding, skateboarding lessons that develop that structure have a facilitation effect on learning how to snowboard successfully.

Key words: *transfer of learning, facilitation, motor learning, structural learning, snow sport*

Introduction

The 1960s introduced "sidewalk surfing" as a way to experience the surf feeling at low sea swell (von Krosigk, 2006). From then on, skateboarding became a popular American pastime. In the 1970s, Californian surfers invented snowboarding as a way to transfer their favorite sport from the oceans to the mountains in order to experience a comparable winter lifestyle (Brisick, 2004). Snowboarding then ran the gamut from being on the extreme sport fringes to becoming a proper Olympic sport in the Winter Games of 1998.

This common "surfing" root provides a reasonable basis for assuming an affinity between skateboarding and snowboarding. These activities share common terminology, similar fashion trends, and, most importantly, salient commonalities in movement patterns. Such motor affinity often leads to the tacit assumption that previous motor experience on a skateboard would transfer positively to learning how to snowboard (and vice versa). Indeed, this assumption has often been postulated in literature (e.g. Hebbel-Seeger, 2001; Kleh, 2003; Memmert, 1999). Moreover, the so-called cross-training on the skateboard is advised for advanced or professional snowboarders in the summer time (Hebbel-Seeger, 2001). However, this assumption of positive transfer still lacks empirical support (Magill, 2007).

In this article we examine whether previous motor and sensory experiences in skateboarding have a facilitative effect on learning an elementary technique in snowboarding, i.e. the basic turn. An empirical answer to this question is especially important for winter school trips, because the available time to acquire the basic skills of snowboarding is relatively short and should be optimized. For this reason, we investigated transfer effects in a field study during a school trip.

Most transfer assumptions are based upon the "law of identical elements" formulated by Thorndike and Woodworth in 1901. They claimed that "the spread of practice occurs only where identical elements are concerned" (Thorndike & Woodworth, 1901, p. 250). The crucial factor remains: determining the exact meaning of "elements."

From a cognitive motor control perspective, these "elements" are functional or neuronal structures in the central nervous system (CNS) like motor programs, output modules, or neural networks which control movement performance. Following Schmidt (1975), classes of movements are controlled by generalized motor programs (GMPs), invariant structures which are specified by sequencing, relative timing, and relative forces and the metrics which are scaled by the assignment of movement parameters, such as absolute force and absolute timing. Schmidt predicts a high positive transfer within the same motor program. A transfer between different motor programs cannot be substantiated (Schmidt & Young, 1987). Though skateboarding and snowboarding movements are morphologically similar, they cannot be seen as a single, differently parameterized GMP. The necessary vertical movement in snowboarding, which is not present in skateboarding, may serve as evidence. In fact, from the GMP standpoint, there should be no transfer of learning between skateboarding and snowboarding.

Contrary to Schmidt's (1975) Schema Theory, the separation between invariants and parameters is eliminated in the Internal Model Theory (Jordan & Rosenbaum, 1989). Movements are controlled by their anticipated effects – as long ago formulated by Lotze (1852). In combination with the environmental state, movements "emerge" out of the dynamics of a neural network, which acts as an internal inverse model. At the same time, the anticipation of sensory consequences emerges from another neural network that acts as a forward model. It also processes the environmental state, plus a copy of the efferences, produced by the inverse model (Hossner & Künzell, 2003; Jordan & Rumelhart, 1992; Kawato, 1990; Künzell, 1996).

Contrary to the GMP-theory, transfer of learning is gradual in the Internal Model Theory. Following the neural network metaphor, two different but similar movements are controlled by a pool of neurons that are activated in both movements and another pool of neurons that are activated specifically. The commonly used neurons substantiate the transfer assumption. It seems plausible that similar movements activate shared neurons. In contrast to Schmidt's Schema Theory, transfer can be assumed when there are similar perceptional patterns, similar movement patterns, or similar movements' outcomes.

Empirical investigations concerning motor transfer are executed in two domains, visuomotor or force-field adaptation and sequence learning (Seidler, 2010). Many studies report a transfer in visuomotor adaptation (Bock, Schneider, & Bloomberg, 2001; Braun, Aertsen, Wolpert, & Mehring, 2009; Seidler, 2004, 2007; Welch, Bridgeman, & Browman, 1993) and force-field adaptation (Ahmed & Wolpert, 2009; Darainy, Mattar, & Ostry, 2009; Kurtzer, DiZio, & Lackner, 2005; Malfait, Gribble, & Ostry, 2005; Shadmehr & Mussa-Ivaldi, 1994). In sequence learning, a positive transfer could be demonstrated for different loads (Mühlbauer, Panzer, & Shea, 2007), different movement ranges (Dean, Kovacs, & Shea, 2008; Wilde & Shea, 2006) and different effectors (Verwey, Abrahamse, & Jimenez, 2009).

In all of these experiments, artificial, low-dimensional tasks were used, assuring constant conditions and a high internal validity. Whether or not these findings can be generalized to real world motor skills remains unclear. In transfer from skateboarding to snowboarding there are at least two of the previously mentioned transfer tasks combined in one exercise setting. The forces that act on the skateboarder are presumably similar to those that act on the snowboarder, although biomechanical evidence is still lacking. Nevertheless, they are different in some aspects. While the frictional force perpendicular to the driving direction is relatively high in skateboarding and assumed to be infinite in mathematical models of skateboarding (Kuleshov, 2007; Hubbard, 1980), the same force varies in snowboarding and is dependent on the inclination angle between the board and the piste (Kaufmann, 1988; Fetz & Müller, 1991). The higher the inclination, the higher is the frictional force. So, transfer from skateboarding to snowboarding comprises force-field adaptation. On the other hand, the similarity of the movement structures suggests that a transfer of movement sequences is also comprised. In this study, we investigate if transfer assumptions still hold in complex real world motor tasks.

Methods

The theories mentioned previously lead us to the hypothesis that novices who received prescriptive skateboard training will demonstrate better performance in an upcoming snowboard course for novices.

Participants

In this study, 24 students (16 males and 8 females) between 14 and 18 years of age (M=16.6, SD=1.0) out of three schools in Hessen, Germany, took part in the experiment. They had no experience either in skateboarding or snowboarding. They were matched by gender and average PE grades from the last two semesters. Due to illness and injury only 18 students could take part in the tests: 9 in the skateboard group (1 female) and 9 in the control group (4 females).

Design

Experimental group participants received five 90-minute skateboard lessons. Control group participants received no skateboard lessons and, instead, completed 90 minutes of general physical education. During the school trip, both the control and the experimental group took part in a six-day snowboard course. Tests of the snowboard skills were executed on the second and sixth day of the snowboard course.

Skateboard treatment (experimental group only)

Skateboard lessons took place in the schoolyard and were divided into sections of self-regulated free exercises and sections of organized instruction. The organized instruction included board familiarization exercises, basic perceptual movement techniques, and elemental snowboard movements. In Table 1 the key goals and exercises of each lesson are presented (2005).

Snowboard treatment

Physical education teachers from the participating classes conducted snowboard lessons in accordance with the curriculum of the German Association for Skiing Curricula (DVS & Interski Deutschland). Each class contained participants from both the treatment and control groups. Teachers were not informed of the students' group identities.

Table 1. Treatment of the skateboard group

DAY	CONTENT/FOCUS	EXERCISES	PURPOSE
1	• basics • initial experience with the board • sensorimotor perception	• testing of the students' laterality (by giving each other a soft push or individual sliding) • shifting the center of gravity (individually and in pairs on several surfaces) • being pushed/pulled while standing on the board by a partner • being pushed by a partner and letting the board coast to a stop • 'pushing' and coasting • cyclic 'pushing' • safe stopping by stepping off the board in motion direction	• to acquire fundamentals for comprehensive kinesthesia • safety issues
2	• theoretical and practical issues of controlled turning	• getting to know the different axes of the board and the body • trying out ways of turning by using different combinations of those axes • introduction of the edging (movement around the center line of the board) • experimenting with different edging amplitudes and the resulting radii by imitating different curve patterns • controlling curves using the 'tic-tac' technique • game: slalom relay	• to playfully gain experience in controlling turns under different conditions and focuses in order to improve motor skills (improving safety, reducing anxiety) • to understand the common elements of controlling turns with skate- and snowboards • to experience each of the different TOOLS by performing the techniques of edging and 'tic-tac'
3	• controlling turns rhythmically • rolling downhill	• slalom course • navigating through the slalom course with homogenous radii (using different postures and muscle tone) • consolidating rhythmical ride by using auditory signals, e.g. counting, singing • first downhill experiences + safety issues • rhythmical downhill turns	• to raise awareness and understanding of rhythmical control of turns using sensorimotor and auditive support • to experience downhill-slope force at an early stage (coping with anxiety) • to lower the center of gravity during the ride in order to achieve a safe position on the board thus a smooth ride
4	• vertical movement & rotation	• 'Skateboard-Limbo' (vertical movement by bending the knees instead of bending the upper body forward) • 'Skateboard-Limbo' contest • exercising vertical movement and rotation by picking up objects from in front and setting them down in the back along the ride • distributing pressure towards the nose of the board	• to experience pressure distribution towards the nose (in order not to fall off the back of the board while riding under the 'limbo rubber band') • to experience a motion sequence needed for control the turn which is similar to the technique of controlling a snowboard turn (vertical movement + rotation) • to consolidate the patterns for a fluent sequence of turns
5	• vertical movement & rotation during a downhill ride • vertical movement & rotation during a rhythmical sequence of turns • sensorimotor perception • dynamical straightening of the body	• previous exercise (vertical movement & rotation; see above) now performed during a downhill ride • juggling a balloon while moving on the skateboard • riding blindfolded (with a supporting partner) • forcing rotation of the upper body by throwing and catching a ball during the ride • picking up and setting down objects in every other apex of the turns during a slalom ride (forcing vertical movement & rotation while riding homogeneous radii) • exercising a dynamical straightening of the body by jumping off the board and onto an obstacle higher than the board during a slow ride	• multifarious combinations of the previous contents, aiming at applying all tools during a downhill ride • distribution of the pressure towards the nose of the board • improving the sensorimotor perception of the riding surface, the board and one's own body by adding distracting stimuli or blocking out the visual perception

Data acquisition

Participants were videotaped on the second and sixth day of the snowboard course. Their task was to demonstrate a free ride and to focus on a fluent, rhythmical, dynamic but controlled run. We chose a part of the slope that was clearly visible in its full length (2nd day: 100m, 6th day: 250 m). The video camera was positioned on half of the run, so the participants were videotaped from the front, laterally as well as from the back.

The videotaped runs, that is, snowboard performances were rated by six experts independently and separately. Raters viewed all recordings from the second day, and then all recordings from the sixth day. The order of the individual runs was randomized for every rater. After viewing each participant's run, the raters judged different measurable aspects of the quality of the ride like safety, speed, rhythm, and an overall impression utilizing the rating criteria defined previously.

To avoid floor effects on the second day and ceiling effects on the sixth day, slopes of different steepness and difficulty were chosen for the two test times – a very easy slope for beginners on the second day and a difficult slope for intermediate snowboarders on the sixth day. Consequently, the ratings of the second and the sixth day were not comparable. An average run (rated with 5 points) on the easy slope needs fewer skills than an average run (rated with 5 points) on the difficult slope. Thus, fewer points at the 6th day's test compared to the 2nd day's test do not indicate deterioration in snowboarding skills. After completing a first round of viewings, raters watched all video runs a second time in order to have the opportunity to adjust their ratings in light of the entire group mean.

Given a positive transfer of learning from skateboarding to snowboarding, we expect a better rating for the participants in the experimental group compared to the control group for each testing day.

Results

At first we analyzed the inter-rater reliability according to Wirtz & Caspar (2002). We did not find any significant interactions between the raters and the rated participants. The average intraclass correlation (ICC) for the ratings on the second day was ICC_{just}=.928 (F[21,105]=13.91; p<.0005, the bounds of the 95% confidence interval were .869 and .966, for the ratings of the sixth day the intraclass correlation was ICC_{just}=.976 (F[19,95]=32.85; p<.0005, and the bounds of the 95% confidence interval were .943 and .986. This indicates a very high inter-rater reliability.

A final score for each testing day and each participant was the average of the scores of all six raters. The different categories safety, speed, rhythm, and overall impression did not differ substantially (Table 2).

Therefore, only the results of the overall impression category were reported. To ensure the comparability, the z-transformed rater score was reported. On the 2nd day, the experimental group and the control group performed on a similar level (control group: M=5.61, SD=1.71, z-transformed scores M_z=-.20, SD_z=1.08; experimental group: M=6.26, SD=1.49, z-transformed scores M_z=.20, SD_z=.94). The performance difference between the groups was insignificant (T=-.86, df=16, $p_{one\text{-}tailed}$ =.20).

On the sixth day, the experimental group outperformed the control group ($M_{control}$=4.80, $SD_{control}$=2.10; M_{treat}=6.56, SD_{treat}=2.10; z-transformed scores $M_{z,\ control}$=-0.39, $SD_{z,\ control}$=.94; $M_{z,\ treat}$=.39, $SD_{z,\ treat}$=.94). The group differences were significant and meaningful (T=-1.78, df=16, $p_{one\text{-}tailed}$=.045, d=-.83). An effect size |d|>.8 indicates a large effect size (Cohen, 1992). In Figure 1, the z-normalized data (z-normalizing has no effect on the T-scores) are presented.

Table 2. Mean rating scores and standard deviations of different categories on a scale from 1 (very poor) to 10 (excellent)

	Test on day 2				Test on day 6			
	Controls		Experimental group		Controls		Experimental group	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Rhythm	5.60	1.60	5.86	1.71	4.37	2.50	6.42	2.20
Speed	5.90	1.85	6.15	1.64	4.58	2.22	6.37	1.93
Safety	5.57	1.57	5.97	1.62	4.32	2.08	6.63	1.97
Overall impression	5.67	1.62	6.11	1.57	4.43	2.29	6.38	2.05

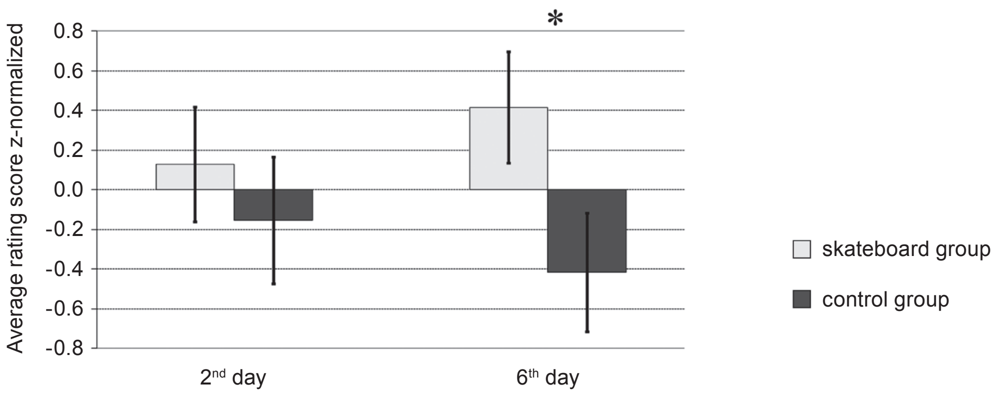

Figure 1. Z-normalized average score of the skateboard group and the control group on day 2 and day 6 of the snowboard course." Higher scores indicate higher performance. Whiskers correspond to ± 1 standard error. The asterisk stands for a significant (p<.05) difference between the groups.

Discussion and conclusions

The results show that experimental group students who were given five skateboard lessons prior to the snowboarding course, outperformed control group students without skateboard lessons on a snowboard run after six days of snowboard lessons. On the second day of snowboard lessons, there was a minor difference in favor of the experimental group which might be due to random effects. Previous skateboard treatment facilitates the learning of snowboarding. This finding contradicts the notion of motor control by generalized motor programs (GMP) that would predict no transfer of learning at all (Schmidt, 1975; Schmidt & Young, 1987). These results are also contrary to the conclusions of O'Keefe, Harrison, and Smyth (2007), who indicated a transfer from fundamental motor skills to sport-specific skills, but no transfer between sport-specific skills. Lastly, this notion is in line with findings by Weigelt, Williams, Wingrove, and Scott (2000), who found a positive transfer of learning between juggling and controlling a football.

A promising hypothesis to explain the effect found here was developed recently by Braun and his colleagues (Braun, et al., 2009; Braun, Mehring, & Wolpert, 2010). In visuomotor adaptation studies they proved that transfer in motor learning is not just due to the similarity of the sensorimotor mappings but can also depend on the detection of an underlying, common structure called "structural learning". This leads to "facilitated learning of tasks with the same structure, strong reduction in interference normally observed when switching between tasks that require opposite control strategies, and preferential exploration along the learned structure" (Braun et al., 2009, p. 352). Structural learning is presumably not restricted to visuomotor adaptation tasks. The field study here demonstrated that learning to snowboard is facilitated by the preceding lessons in skateboarding. Even though this experimental design does not address the latter two features of structural learning cited above, the results indicate that transfer from skateboarding to snowboarding still falls within the parameters of structural learning. The underlying structure between skateboarding and snowboarding is presumably not a visuomotor adaptation task but rather a combination of a force-field adaptation and sequence learning. Different force fields between skateboarding and snowboarding arise by reason of different frictional forces. The common structure could include the relation between frictional forces in movement direction and its perpendicular counterpart, which is qualitatively the same in skate-boarding and snowboarding. The common structure concerning sequence learning could be due to the similarities in the mapping of efferences as well as the environmental state and movement outcomes explained above.

The structural learning hypothesis would explain why the transfer of learning effects increase over time. In usual sequence learning transfer experiments, participants start with a great advantage, which disappears in the course of learning (Panzer, Wilde, & Shea, 2006). If structural learning is involved, the learning process is facilitated, leading to an enlarged advantage in the course of practice.

The Internal Model Theory (Shadmehr & Mussa-Ivaldi, 1994; Wolpert, Ghahramani, & Jordan, 1995; Wolpert & Kawato, 1998) clearly supports the notion of structural learning. During the learning process, the forward model and the inverse model together adapt in order to minimize the performance error, i.e. the difference between the observed and the intended movement outcome. The forward model is responsible for the correct anticipation of the movement outcomes, given the environmental state and the efferences produced by the inverse model. It is also responsible for the "direction" of learning. It assigns the performance error to the output of the inverse model, or in other words, it tells what has to be changed in the movement pattern given an actual performance error (Jordan & Rumelhart, 1992). Here, we argue that a direct transfer of learning from one skill to another, which can be verified by an initial proactive effect, is caused by similar activation patterns of the previously learned inverse model. However, learning facilitation, verified by a greater learning rate, is caused by similar activation patterns of the previously learned forward model. Given that logic, structural learning in our opinion can clearly be achieved by an adaptation of the forward model. This means that, while skateboarding, the learning of the forward model is the process transferrable to snowboarding, as in pattern recognition skills (Smeeton, Ward, & Williams, 2004).

To summarize, with the help of our investigation we could show that a preparatory short course of skateboarding assists in learning how to ride a snowboard. The effects of the preparatory learning increased during the snowboard course. The question remains whether the herein observed effects are specifically caused by the design of the experiment or whether it is a general effect of transfer of learning between two structurally similar real-world tasks. This question requires further examination for clarification. At least for school trips, short skateboarding instruction as a preparatory motor activity should beneficially maximize snowboarding in multiple respects and allow students more time to "beat the biff" or "fix that flail."

References

Ahmed, A.A., & Wolpert, D.M. (2009). Transfer of dynamic learning across postures. *Journal of Neurophysiology*, *102*, 2816-2824.

Bock, O., Schneider, S., & Bloomberg, J. (2001). Conditions for interference versus facilitation during sequential sensorimotor adaptation. *Experimental Brain Research*, *138*, 359-365.

Braun, D.A., Aertsen, A., Wolpert, D.M., & Mehring, C. (2009). Motor task variation induces structural learning. *Current Biology*, *19*, 352-357.

Braun, D.A., Mehring, C., & Wolpert, D.M. (2010). Structure learning in action. *Behavioral Brain Research*, *206*, 157-165.

Brisick, J. (2004). Have board, will travel: The definitive history of surf, skate, and snow. New York: Harper Collins.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155-159.

Darainy, M., Mattar, A.A.G., & Ostry, D.J. (2009). Effects of human arm impedance on dynamics learning and generalization. *Journal of Neurophysiology*, *101*, 3158-3168.

Dean, N.J., Kovacs, A.J., & Shea, C.H. (2008). Transfer of movement sequences: Bigger is better. *Acta Psychologica*, *127*, 355-368.

Deutscher Verband für das Skilehrwesen (DVS) & Interski Deutschland (2005). *Snowboard Lehrplan*. [Snowboard curriculum.] München: blv.

Fetz, F. & Müller, E. (Eds.) (1991). *Biomechanik der Sportarten, Band 2: Biomechanik des alpinen Skilaufs*. [Biomechanics in sports disciplines. Biomechanics of alpine skiing.] Stuttgart.

Hebbel-Seeger, A. (2001). *Snowboarding: Guide to ride*. Aachen: Meyer & Meyer.

Hossner, E.-J., & Künzell, S. (2003). Uczenie sie ruchów. [Motor learning.] *Antropomotoryka*, *13*, 81-96.

Hubbard, M. (1980). Human control of the skateboard. *Journal of Biomechanics*, *13*, 745-754.

Jordan, M.I., & Rosenbaum, D.A. (1989). Action. In M. I. Posner (Ed.), *Foundations of cognitive science* (pp. 727-767). Cambridge, Mass.: MIT Press.

Jordan, M.I., & Rumelhart, D.E. (1992). Forward models: Supervised learning with a distal teacher. *Cognitive Science*, *16*, 307-354.

Kawato, M. (1990). Feedback-error-learning neural network for supervised motor learning. In R. Eckmiller (Ed.), *Advanced neural computers* (pp. 365-372). Amsterdam: North-Holland/Elsevier.

Kaufmann, C. (1988). Alpiner Skilauf. [Alpine skiing.] In K. Willimczik (Ed.), *Biomechanik der Sportarten* (pp. 349-362). Reinbek.

Kleh, C. (2003). *Snowboarden. Vom Boardhandlung zum 360*. [Snowboarding: From board handling to 360.] Stuttgart: Pietsch.

Kuleshov, A. S. (2007). Mathematical model of a skateboard with one degree of freedom. *Doklady Physics*, *52*, 283-286.

Künzell, S. (1996). *Motorik und Konnektionismus. Neuronale Netzwerke als Modell interner Bewegungsrepräsentationenn*. [Movement science and connectionism. Neural networks as a model for internal motor representations.] Köln: bps.

Kurtzer, I., DiZio, P.A., & Lackner, J.R. (2005). Adaptation to a novel multi-force environment. *Experimental Brain Research*, *164*, 120-132.

Lotze, H. (1852). *Medicinische Psychologie oder Physiologie der Seele*. [Medical psychology or the physiology of the soul.] Leipzig: Weidmann'sche Buchhandlung.

Magill, R. A. (2007). *Motor learning and control*. (8th ed.) New York: McGraw-Hill.

Malfait, N., Gribble, P.L., & Ostry, D.J. (2005). Generalization of motor learning based on multiple field exposures and local adaptation. *Journal of Neurophysiology*, *93*, 3327-3338.

Memmert, D. (1999). Snowboarden im Sportunterricht. [Snowboarding in physical education lessons.] *Sportunterricht*, *48*, 453-460.

Mühlbauer, T., Panzer, S., & Shea, C.H. (2007). The transfer of movement sequences: Effects of decreased and increased load. *Quarterly Journal Of Experimental Psychology*, *60*, 770-778.

O'Keeffe, S.L., Harrison, A.J., & Smyth, P.J. (2007). Transfer or specificity? An applied investigation into the relationship between fundamental overarm throwing and related sport skills. *Physical Education and Sport Pedagogy*, *12*, 89-102.

Panzer, S., Wilde, H., & Shea, C.H. (2006). Learning of similar complex movement sequences: Proactive and retroactive effects on learning. *Journal of Motor Behavior*, *38*, 60-70.

Schmidt, R.A. (1975). A schema theory of discrete motor skill learning. *Psychological Review*, *82*, 229-261.

Schmidt, R. A., & Young, D. E. (1987). Transfer of movement control in motor skill learning. In S.M. Cormier & J.D. Hagman (Eds.), *Transfer of learning* (pp. 47-79). San Diego: Academic Press.

Seidler, R.D. (2004). Multiple motor learning experiences enhance motor adaptability. *Journal of Cognitive Neuroscience*, *16*, 65-73.

Seidler, R.D. (2007). Aging affects motor learning but not savings at transfer of learning. *Learning & Memory*, *14*, 17-21.

Seidler, R.D. (2010). Neural correlates of motor learning, transfer of learning, and learning to learn. *Exercise and Sport Science Reviews*, *38*, 3-9.

Shadmehr, R., & Mussa-Ivaldi, F.A. (1994). Adaptive representation of dynamics during learning of a motor task. *Journal of Neuroscience*, *14*, 3208-3224.

Smeeton, N.J., Ward, P., & Williams, A.M. (2004). Do pattern recognition skills transfer across sports? A preliminary analysis. *Journal of Sport Sciences*, *22*, 205-213.

Thorndike, E.L., & Woodworth, R.S. (1901). The influence of improvement in one mental function upon the efficiency of other functions (I). *Psychological Review*, *8*, 247-261.

Verwey, W.B., Abrahamse, E.L., & Jimenez, L. (2009). Segmentation of short keying sequences does not spontaneously transfer to other sequences. *Human Movement Science*, *28*(3), 348-361.

von Krosigk, H. (2006). *Alles über Skateboarding – History, Basics, Tricks, Material*. [Everything about skateboarding – history, basics, tricks, material.] Berlin: Tropen.

Weigelt, C., Williams, A.M., Wingrove, T., & Scott, M.A. (2000). Transfer and motor skill learning in association football. *Ergonomics*, *43*, 1698-1707.

Welch, R.B., Bridgeman, S.A., & Browman, K.E. (1993). Alternating prism exposure causes dual adaptation and generalization to a novel displacement. *Perception & Psychophysics*, *54*, 195-204.

Wilde, H., & Shea, C.H. (2006). Proportional and nonproportional transfer of movement sequences. *Quarterly Journal of Experimental Psychology*, *59*, 1626-1647.

Wirtz, M., & Caspar, F. (2002). *Beurteilerübereinstimmung und Beurteilerreliabilität: Methoden zur Bestimmung und Verbesserung der Zuverlässigkeit von Einschätzungen mittels Kategoriensystemen und Ratingskalen*. [Inter-rater consistency and inter-rater reliability. Methods for identification and improvement of ratings by means of category systems and rating scales.] Göttingen: Hogrefe.

Wolpert, D.M., Ghahramani, Z., & Jordan, M.I. (1995). Are arm trajectories planned in kinematic or dynamic coordinates? An adaption study. *Experimental Brain Research*, *103*, 440-461.

Wolpert, D.M., & Kawato, M. (1998). Multiple paired forward and inverse models for motor control. *Neural Networks*, *11*, 1317-1329.

Submitted: March 24, 2010
Accepted: April 28, 2011

Correspondence to:
Prof. Dr. Stefan Künzell
Universität Augsburg
Institut für Sportwissenschaft
Universitätsstr. 3, 86135 Augsburg
Phone: 0049 821 5982824
E-mail: stefan.kuenzell@sport.uni-augsburg.de

TRANSFER NAUČENOGA U PRIPREMNOME TRENINGU DASKANJA (*SKATEBOARDING*) NA UČENJE MONOSKIJANJA (*SNOWBOARDING*)

Potomci jahanja ili daskanja na valovima (engl. *surfing*) – monoskijanje ili daskanje na snijegu (engl. *snowboarding*) i daskanje (engl. *skateboarding*), slični su prema pozicijskim, vizualnim i kinestetičkim aspektima. Takvo stajalište dovelo je do stvaranja pretpostavke kako je moguće očekivati pozitivan transfer naučenoga sa *skateboardinga* na *snowboarding*. U ovome istraživanju analizirali smo vjerojatnost i teorijske osnove za efekte transfera u terenskim uvjetima. Studenti iz eksperimentalne grupe proveli su 5 treninga daskanja (*skateboaring*). Nakon toga su se priključili kontrolnoj skupini ispitanika na šestodnevnom školskom putovanju na učenje monoskijanja (*snowboarding*). Ispitanici obiju grupa su snimljeni tijekom monoskijanja drugoga i šestoga dana izleta. Eksperti su ocijenili izvedbe ispitanika iz obiju grupa pomoću skale od 1 (vrlo loše) do 10 (izvrsno) bodova. Pouzdanost mjernoga instrumenta bila je vrlo dobra. Nije bilo statistički značajnih razlika između grupa u inicijalnome testiranju provedenom drugoga dana, dok su u drugom mjerenju, provedenom šestoga dana izleta, zabilježene statistički značajne razlike između grupa u korist eksperimentalne grupe (M_{kont}=4,80, SD_{kont}=2,10; $M_{eksperim}$=6,56, $SD_{eksperim}$=2,10; T=-1,78, df=16, p=0,045, d=-0,83). S obzirom na slične osnovne strukture kretanja u daskanju i monoskijanju, treninzi daskanja su omogućili svladavanje zajedničkih struktura kretanja, čime su proizveli olakšavajuće efekte u učenju daskanja na snijegu.

Ključne riječi: *transfer, olakšavajući, motoričko učenje, strukturno učenje, zimski sport*