CHANGE OF SPRINTING BIOMECHANICS IN THE ACCELERATION PHASE WHILE RESTRICTING THE VISUAL AND HEARING SENSE

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Sprinting and short acceleration phases are common movements in rugby and football. The aim of this study was to evaluate if the running movement changed while senses were restricted. Nine rugby and football player performed in three conditions (no restriction, visual restriction and audivisual restriction) a 10m sprint. Kinematic and kinetic data were captured for step 4-6. The athletes ran significant faster than in the other two conditions although the contact time and stride cycle length did not significantly differ. A change could be seen in the extension moment of the hip and the ROM in the knee, both between no- and audivisual restriction. It was concluded that sensual restrictions effects the performance in a slowdown of the movement, but that during the 4-6 step only small changes seem to appear due to the visual restriction.

KEY WORDS: 10 m sprint, contact time, angles, moment, sagittal plane

INTRODUCTION: Sprinting and short acceleration phases are common movements in team sports like rugby and football, hence this movement is often used to monitor athletic performance. This task should also be used in a future study to investigate the movement on different surface and whether the perception of knowing on which surface they perform will change the movement itself. Restricting the senses could be one possibility to keep the participants unaware of the used surface. But while this method is common for e.g. perception training, little is known on the actual change in movement when performing with restricted senses. The research available focuses on restriction senses in a walking task, but bears controversial findings. While for slow level walking and stair climbing Philbeck, Woods, Arthur, and Todd (2008) showed for healthy participants a faster walking velocity and an underestimated distance walked, Demura and Demura (2011) report a slower movement speed for the blindfolded trials when participants were restricted in their range of motion by a knee-brace. For restricting the senses for sprinting and acceleration movements there are to the author's best knowledge no studies available. Therefore the aim of this study was to investigate the kinetic and kinematic effects of restricting the visual and auditory senses in a sprinting task, to gain knowledge on the feasibility of using this method. We hypothesized a slower mean velocity due to a shorter step length and a longer contact time in the conditions with restricted senses occurs.

METHODS: 9 male university level soccer and rugby players (175.3 ± 5.3 cm, 74.5 ± 8.6 kg, 20.9 ± 3.4 yrs) participated in this study. All wore their own indoor sport shoes. Participants had to perform 10 m sprints on a Mondo surface in the three conditions: No restriction (NR), visual restriction (VR) by blindfolds and auditory and visual restriction (AVR) by blindfolds and earplugs. Prior to the testing a 10 minute warm up and habituation phase to get adjusted to the visual and audivisual restriction was given to each participant. After that they performed in each of the three conditions three valid 10 m sprints. A trial was considered valid when the participant hit with the right foot one of the two force plates and did not stop accelerating until he reached the 10 m line. Kinematic data was collected via a 15 3D infrared camera system (Vicon Nexus; Vicon Motion Systems Ltd., UK), and synchronized with two force plates (Kistler Instrumente AG, CH) implemented in the floor. Sample frequency for the kinematic data was 250 Hz and for the kinetic data 1000 Hz. The 10 m sprint time was detected with the light barrier system Smartspeed (Fusion Sport, AUS). As phase of interest the kinematic data from the 4th to the 6th step (4th – 7th meter) of the movement and kinetic data for the 5th step was analysed (Figure 1).

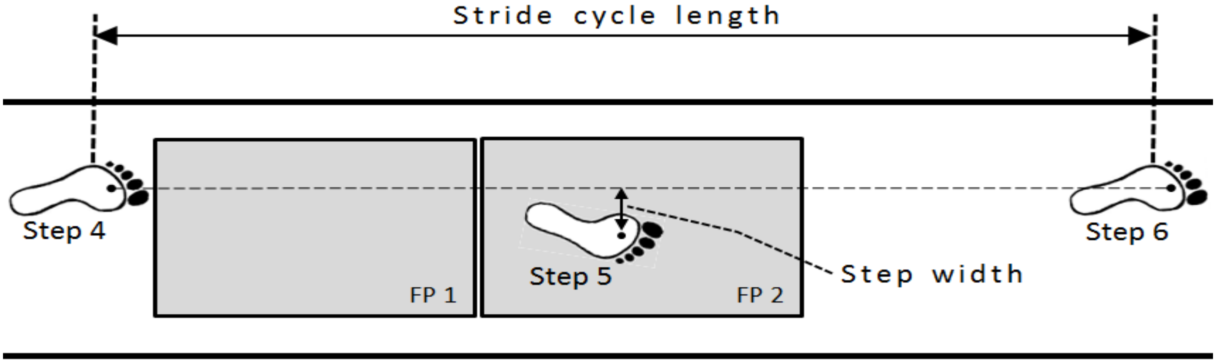

Figure 1: Schematic layout of the research area and description of stride cycle length and step width

Therefore reflective markers were placed on the pelvis (anterior superior iliac spine, posterior superior iliac spine and iliac crest), the right femur (greater trochanter, medial and lateral epicondyle of the femur), right shank (medial and lateral malleolus) and on both feet (tuber calcanei, first metatarsophalangeal joint, first interphalangeal joint of the second toe and the fifth metatarsophalangeal joint). After labelling the data in Vicon Nexus, data was processed using Visual3D (C-Motion Inc., USA). Kinematic data were filtered with a low pass Butterworth filter with a cut off frequency of 25 Hz, the kinetic data with a cut off frequency of 40 Hz.
Captured and calculated was the 10 m time, stride cycle length, step width, contact time of the 5th pace, leg and knee stiffness and the sagittal hip, knee and ankle joint angles, moments and powers. Leg stiffness was calculated as the maximum resultant force divided by the change of leg length during the stance phase. The knee stiffness was calculated by the change of moment divided by the range of motion (ROM) during the stance phase. The stance phase was time normalized and defined as the time where the vertical component of the ground reaction force was higher than 25 N. For all parameters the mean of all three trials was taken for further analysis. Peak vertical and the minimum and maximum anterior-posterior ground reaction forces, as well as minimum and maximum sagittal ankle, hip and knee joint angles, moments and powers of the stance phase and the ROM of those angles were calculated. Sagittal joint moments, powers and leg and knee stiffness were normalized to body weight.
Due to the small sample size we did a Friedman ANOVA to compare the differences between the three conditions. The level of significance was set to 0.05. In case of a statistically significant effect a post hoc analysis with the Wilcoxon signed-rank test were made. Effect sizes were calculated according to Cohen’s d.

RESULTS AND DISCUSSION: Over all there were no significant differences in the parameters between the conditions VR and AVR. The comparison between NR to VR and between NR and AVR showed for the temporo-spatial parameters (Table 1) a significant faster 10 m sprint time in the unrestricted condition, while no significant difference were detected for the parameters contact time, stride cycle length and step width.

Table 1: Temporo-spatial-parameters

parameter	NR (mean ±sd)	VR (mean ±sd)	AVR (mean ±sd)	NR-VR (d)	NR-AVR (d)	VR-AVR (d)	sig.
10 m time [s]	1.84 ±0.11	1.91 ±0.13	1.90 ±0.10	0.60	0.55	0.14	#†
contact time [ms]	152.5 ±20.7	151.9 ±13.9	152.4 ±16.2	0.03	0.01	0.03	n.s.
stride cycle length [cm]	301.3 ±18.6	303.7 ±23.3	299.1 ±19.9	0.11	0.11	0.21	n.s.
step width [mm]	13.3 ±6.5	14.3 ±8.9	12.2 ±6.8	0.13	0.17	0.27	n.s.

Significant differences between NR and VR: #, significant differences between NR and AVR: †, no significance with n.s..

There are small but insignificant changes in the peak anterior-posterior GRF between the NR and the restricted conditions, indicating a tendency for increased forces in the unrestricted condition compared to the visual restriction (NR-VR for minimum posterior-anterior GRF (d=0.71) and maximum posterior-anterior GRF (d=0.6)). This findings are supported by Kyrolainen, Avela, and Komi (2005) who also find a higher posterior-anterior GRF for a higher running speed. Sensual restriction lead to a significant decrease in knee joint ROM for the AVR condition and a tendency (d=0.65) to decrease the ROM in the VR compared to the NR.

Due to the faster running speed a lower leg and knee stiffness could be expected (Kuitunen, Komi, and Kyrolainen (2002)) but this was not supported by our data, which showed equal leg and knee stiffness. However knee stiffness even indicated a tendency towards higher stiffness in the restricted conditions (NR-VR: d=1.18; NR-AVR: d=1.01), which might be due to the unfamiliar running situation with the restriction lead to a higher co-contraction of the thigh muscles and that to no change in knee stiffness, but showed a tendency towards.

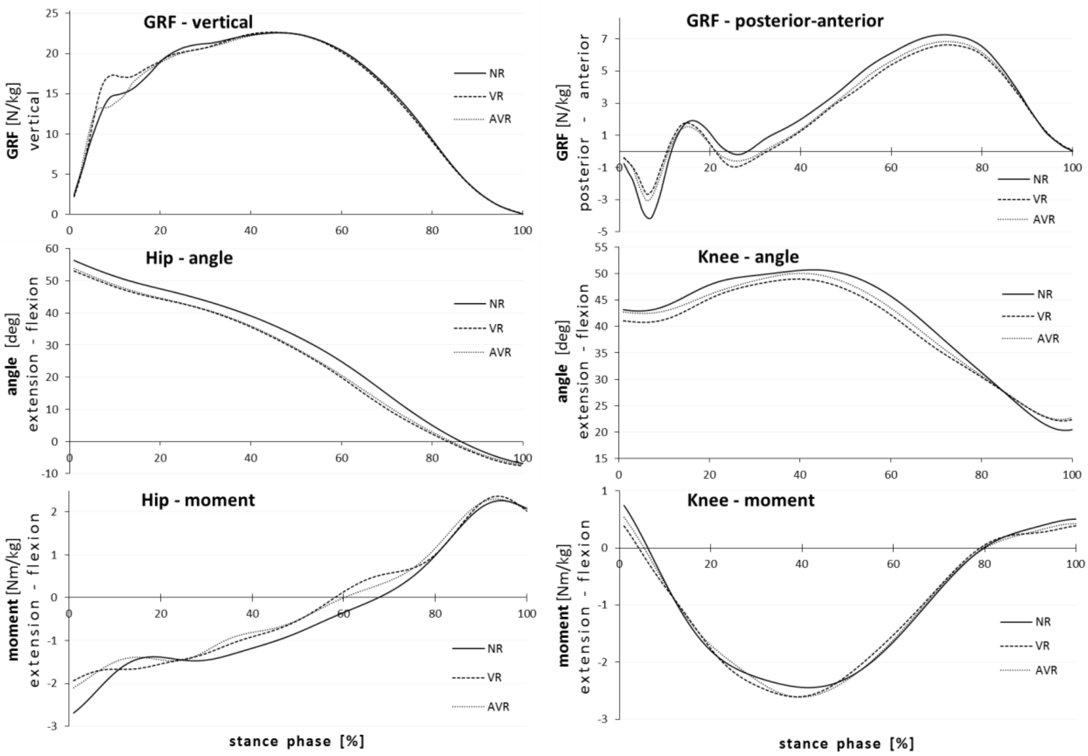

Figure 2: Ground reaction force (GRF) in vertical and posterior-anterior direction; Hip and Knee, angles and moments for the sagittal plane. Shown is the mean normalised on the stance phase

Joint moments showed only a significant lower peak hip extension moment in the AVR condition compared to the NR (d=0.9), and a tendency in the same direction for the VR condition. (d=0.8). This could be a direct response due to the slower 10 m time. The acceleration profile within a 10 m sprint time is not constant over the time. The acceleration curve for the sprint shows the highest acceleration for the first step following with a continuous decrease in acceleration for the subsequent steps (Slawinski et al. (2010)). Additionally Lockie, Murphy, Schultz, Jeffriess, and Callaghan (2013) report that the anterior GRF in the first two steps is higher than e.g. in the last contact of the 10 m of a sprint. Our measurement analyzed only the 5th step of the acceleration, hence we cannot identify if the time loss might happen on a specific step or on each step of the sprint. A difference in the joint power could not be found between any conditions.

Generally restriction the senses led to only small changes in the temporo-spatial, kinematic and kinetic characteristics of the acceleration phase. The only clear effect is a slowdown of the movement with respect to the 10 m time when being restricted. It seems due to the ground reaction force data (peak anterior-posterior force) that the participants already were slower in the phase analysed and that the sensual restriction might influence the ability to acceleration in the early phase of 10 m sprints (first steps). Generally no differences occurred between the visual and audiovisual restriction.

CONCLUSION: Restricting the visual and audiovisual sense in a 10 m sprinting task led to a significant slower 10 m sprint time, and slight changes in the sagittal knee ROM and a lower hip extension moment in the analysed phase. The small kinematic and kinetic changes do not fully explain the slower 10 m sprint time, hence the ability to accelerate might be reduced in the earlier (0-4 m) or later (7-10 m) phase of the sprint. Being aware of these few changes, restricting the visual and audiovisual sense for participants to remain unaware of the surface is a possible solution.

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