Biomechanics in Arts of Dance: How an internal focus of attention influences a dancer's biomechanics

Maximilian Stasica[1], Celine Honekamp[2], Martin Puttke[3], Carolin Fritsch[1], Patrick Frost[1], Jasper Konrad[1], Katharina Saßen[1], Felix Schorer[1], Nehle Steffens[1], and André Seyfarth[1]
[1]Lauflabor Locomotion Laboratory, Institut für Sportwissenschaft, Centre for Cognitive Science, Technische Universität Darmstadt, Germany
maximilian_alexander.stasica@tu-darmstadt.de
[2]Sensorimotor Control and Learning, Centre for Cognitive Science, Technische Universität Darmstadt, Germany
celine.honekamp@tu-darmstadt.de
[3]DANAMOS® - Dance.Art.Master.System, Berlin, Germany
puttke.martin@gmx.de

1 Introduction

Didactics in classical arts are usually based on the expert knowledge of well known teachers [1] as well as personal experience of the teacher. Science on the other hand is based on empirical data and systematic investigations. Classical dance and science rarely get together [2] [3]. To overcome this and to make expert knowledge accessible to science as well as providing biomechanical expertise to practitioners we investigated the use of internal focuses of attention [5] which were strongly advocated by [4]. Since the results of our previous assessment were promising and provided empirical backup for novel teaching methods [5] we now aim to transfer the findings to non-expert trainers and non-expert dancers. We therefore conducted an experiment in which we provided a new external focus of attention to healthy young participants without any previous experience in dancing. We chose to use a different focus and a different movement than in our previous studies [5] to account for our non-trained participants' abilities. We decided to use a battement tendu jeté à la seconde (BTJ) (see fig. 1) as it is a seemingly simple but sufficiently demanding movement, which also is a core element of classical dance. In dance it is desirable that the pelvis of the dancer stays as close to horizontal as possible as any shift in the pelvis can destabilise the upper body of the dancer [1], however beginners tend to rotate their pelvis in frontal plane during a BTJ. We expected the external focus to reduce this rotation to obtain a more aesthetically pleasing and technically correct movement.

2 Method

Eight healthy young participants (4 female, 4 male) took part in our experiment. They were between 20 and 22 years of age and ranged from 163 cm to 186 cm in body height. We recorded the joint kinematics and respective angles with a 12 camera Qualisys Oqus motion capture system at a sampling rate of 500 Hz. We placed 24 passive reflective mark-

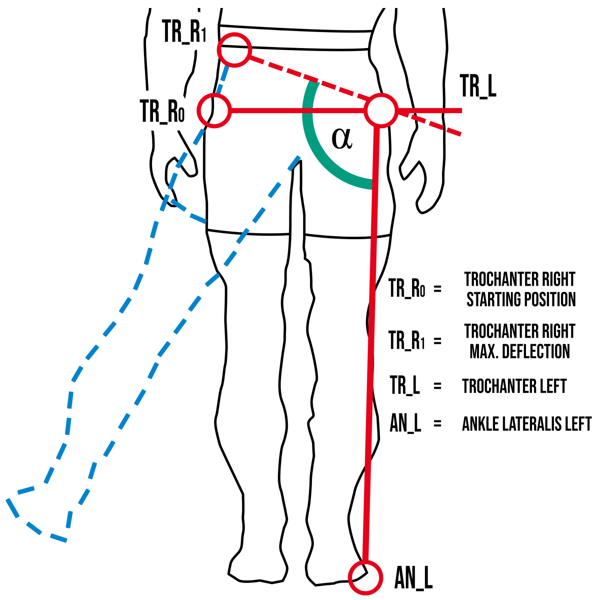

Figure 1: Scheme of the expected change in the pelvis angle α with respect to both pelvis joints (TR_R, TR_L) and the ankle (AN_L).

ers on the participant and calibrated the system as specified. To calculate the angle α between the pelvis and the leg we focused our analysis on the Trochanter Major (TR) and the Ankle (AN) (see fig. 1). After exclusion of one male and one female participant we obtained complete datasets from six participants. None of our participants had any professional background in dancing. We asked our participants to perform 5 sets of 3 BTJs based on a schematic drawing of the movement (pre condition). After each trial, they were able to take a short break. After this first part of the experiment, we asked the participants to imagine that they would only have one leg (the standing leg) and one moving foot. They were tasked to move the foot in a lateral direction with this imagination in mind. With this new instruction they again

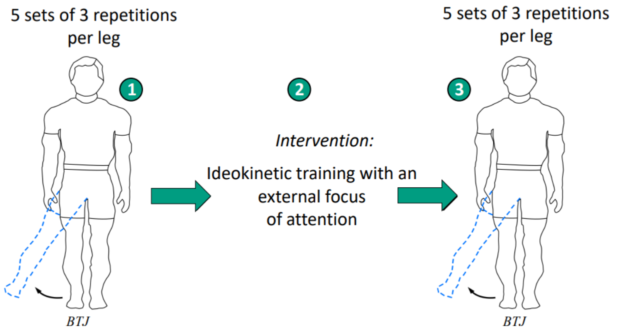

Figure 2: Sketch of the experimental procedure. The participants performed 5 sets of 3 BTJs based on a neutral basic drawing of the movement. Afterwards they received the external focus of attention and repeated the 5 sets.

performed 5 sets of 3 BTJs (post condition).

3 Results

We calculated the pelvis angle between the right and left pelvis joint and the left ankle joint as well as the opposite pelvis angle. With that we created angle-angle diagrams for all participants (see fig. 4) and calculated the values of α at the moment the swinging leg was deflected by 25 degrees. These values of pelvis-angle α were used to compute t-Tests on an individual level and overall. The overall t-Test yielded no significant results (t (5) = 0.32, p = 0.62). On an individual level, only participants 3 (t (14) = 5.83), $p < 0.001$) and 4 (t (14) = 2.65), $p < 0.01$) showed significant differences between the pre and the post condition (see fig. 3). Further, we calculated the relation Δ between the angle of the swinging and the standing leg and found non-negligible changes in participant 01 and participant 05 (see table 1).

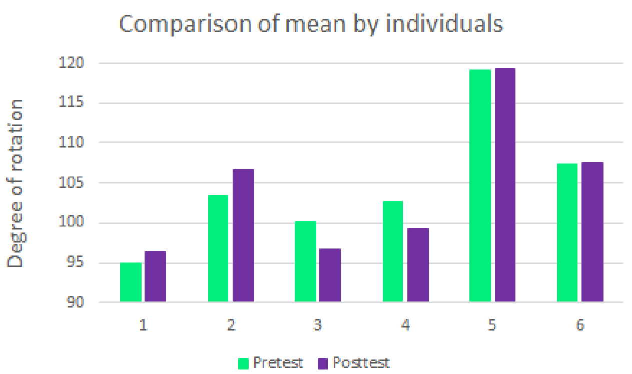

Figure 3: Mean angular deflection of the supporting leg of each participant in the pre (green - $\mu = 104.63, sd = 8.19$) and post test (purple - $\mu = 104.27, sd = 8.24$). Participants 3 and 4 showed significant effects.

4 Discussion

The results did not show consistent effects over all participants. For two participants we found a significant reduction in the pelvis angle α. Two participants showed a shift

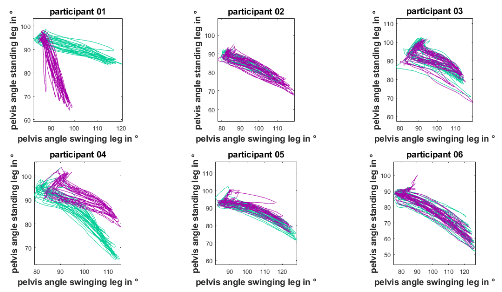

Figure 4: Individual angle-angle diagrams. Green lines denote the angular relations in the pre condition, while purple lines represent the post condition. It is clearly visible that the relations changed in participants 01 and 04.

Table 1: Overview over the relations Δ between the pelvis angle of the swinging and the pelvis angle α of the standing leg. Note the changes of participant 01 and 05.

participant	01	02	03	04	05	06
Δ pre	3.6	2.8	1.7	2.1	3.6	3.2
Δ post	0.5	3.3	1.8	2.0	5.2	3.2

in their Δ coefficient, which could indicate that the external focus changed their individual vision of the movement. However there was no conclusive evidence in their individual presets which could explain why these participants profited from the instruction. Interestingly there were no consistent changes in the joint kinematics, presumably because none of our participants had any background in dancing and our instructors had no background in pedagogy or practical experience. In our previous investigation [5], the instruction was provided by an experienced dance pedagogue which was experienced in setting the external focus. This leads us to the conclusion that expert knowledge cannot be simply adapted to be used by non-experts highlighting the experience of a teacher. This indicates the potential that a collaborative work of practitioners together with scientists could have for both science and practice, taking advantage of biomechanical measurements to investigate, understand, and improve teaching methods in dance and in sports in general.

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