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Why They Don't Step on Each Other's Toes: Motion Capture Analysis of Backward Tango Steps

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Tango argentino is an improvised couple dance in which one person takes on the role of couple leader with the other being the follower. Both move together building on a learned movement repertoire, both limited so as to allow dancing with any other person also trained in this movement repertoire and yet flexible enough to always create new dance experiences through improvisation.

One of the basic rules of tango movement is that the couple progresses counterclockwise on the dancefloor with the leader walking mostly forwards and the follower backwards. The dancers walk in close proximity and in front of each other because of their close embrace hold, therefore their steps overlap in space; where the follower's foot was just situated, the leader's foot is now headed. For beginner dancers, this is a great challenge to master, and stepping on each other's toes is often enough part of the learning process. For myself, as a tango dancer who has gone through decades of learning, the question is which movement techniques tango dancers deploy to avoid toe collisions while simultaneously making it look so effortless.

RESEARCH APPROACH

This research falls within the scope of a larger project entitled "Tango Danceability of Music in European Perspective," sponsored by the Austrian Science Fund FWF (project V423). The project lasted from 2015-2019 and aimed at exploring the relations between tango music and dance from a transdisciplinary perspective. Data was collected through observing participation, formal and informal interviews, an online survey, and several experiments. To determine the basic principles of *tango argentino* movements, we worked with three professional tango dance couples with each well-known for their distinctive dance styles. Their movements were recorded with an optical motion capture technique and analyzed with MATLAB. We mainly deployed the Mocap Toolbox (version 1.5) by Burger and Toiviainen (2013). An important foundation for exploring the relations between music and movement involved analyzing the tango movement repertoire to further understand the limits and options tango dancers have in their embodied movement system.

MOVEMENT PRINCIPLES IN TANGO

The tango movement repertoire is based on simple concepts. While connecting through a held embrace, the dancers combine steps (forwards, backwards, sideways) and pivots into an almost unlimited number of step-turn combinations. Some of these possible combinations have become standard basics and been labelled with names like "ocho" (eight) (see Stepputat, 2021). Though the combinations can be quite complex, they are always assembled out of simple steps and pivots as the locomotive basics. This ensures dancers enjoy a high level of freedom for improvisation while simultaneously enabling embodied communication between the partners based on the joint movement repertoire (see also Kimmel, 2019).

My research was able to demonstrate how a tango forward step is carried out differently to regular walking forward steps. Dancers actively move their free leg into a fast acceleration and slow down towards the floor contact. This contrasts with regular walking where the free leg swings dynamically to minimize the effort expended (see Levine, Richards and Whittle 2012). At the same time, the root speed (the horizontal torso velocity) remains more stable, which is in accordance with the aesthetic tango movement ideal of a gliding, smooth horizontal movement through the dance space. These two short films[2] show a visual impression of tango walking with Yanina Quiñones demonstrating both forward (*adelante*) and backward (*atrás*) tango steps. In the following, I set out how the technique for forward steps and backward steps differs to thereby enable collision-free walking even within the limited space provided within the couple in close embrace, while progressing smoothly forward over the dancefloor.

STEP TECHNIQUE ANALYSIS

Figure 1 below displays the visualization of the motion capture data for backward step gait cycles for the three followers (Yanina, Cristina, Maja) in the top row, and the data for the forward step gait cycles of the respective leaders (Neri, Homer, Marko) in the bottom row.[3] The figures in the top and bottom row vertically align by the smallest ankle distance, which is the point at which a tango step starts (thus, with the feet closed).[4] The grey line and area show the ankle distance throughout one gait cycle with the blue line and area depicting the heel speed. The figure conveys how the heel speed graphs of the three followers are similar in shape. Likewise, the graphs of the three leaders bear strong similarities in shape. However, there is an obvious difference between the graphs of the forward steps (executed by the leaders) and those of the backward steps (by the followers), particularly concerning the moment of maximum acceleration. Followers reach their maximum acceleration at 58, 59 and 61% whereas the leaders attain their maximums considerably later at 85, 86 and 87% of the gait cycle. These differences in acceleration times result from a change in the distance between the leader's and the follower's free foot: Followers accelerate earlier in their steps and slow down later, hence, creating more space between their free foot and the free foot of the leader during the step's swing phase. Towards the end of the step—the next floor contact—the leaders catch up. Through this delayed acceleration, they leave as much space as possible, and for as long as possible, to enable the follower to move their free foot away from the very same space where they are about to place their foot.

The motion capture data, here visualized as film in *Mokka*,[5] show Homer Ladas (leader) and Cristina Ladas (follower) demonstrating tango walking in a couple. The same recording is seen in both films, once with all the markers and once with only the four toe markers. The recording clearly portrays how the distance of the toe markers changes from the smallest distance when the feet are on the floor to the longest distance at around the middle of the swing phase.

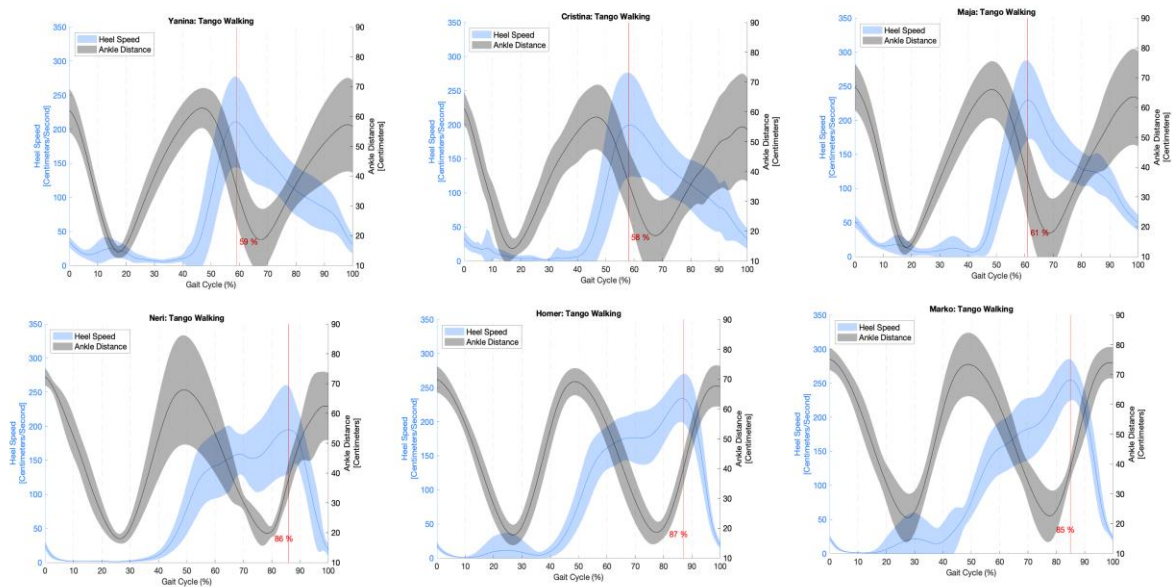


Fig. 1. Graphs detailing the ankle distance (grey) and heel speed (blue) of the backward steps of the three followers (top row) and the front steps of the respective leaders (bottom row). The figures of the leader and corresponding follower are vertically aligned at the smallest ankle distance (beginning of a tango step). The red vertical line indicates the moment of reaching maximum heel speed. All graphs display one gait cycle performed by one leg. Graphic by Kurt Schatz.

CONCLUSION

Tango dancers embody the movement repertoire to the extent that they are able to undertake even simple steps in ways that suit both tango aesthetics and the pragmatic considerations necessary to avoiding collisions while walking in a couple. Hence, the forward and backward steps in tango are carried out in ways that create a maximal distance between the free feet in the swing phase and return to the shortest distance when the feet have floor contact. This difference in distance is achieved by heel speed variation: followers train to accelerate quickly (“get out of the way”) while leaders learn to accelerate later (“catching up”).

Through my motion capture analysis of the backward and forward step movement technique, I was able to convey how tango walking is not “just walking” but rather a meticulously trained way of walking. For myself as a researcher, understanding the mechanics of tango forward steps and backward steps sheds light on how movement aesthetics and pragmatics in tango overlap. For myself as a tango dancer and dance teacher, understanding how the forward and the backward step complement each other helps to focus on relevant aspects of the technique I practice, thereby enabling better and eventually—while learning and teaching dance—faster access to collision-free tango walking in a couple.

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NOTES

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[2] Yanina Quiñones demonstrates forward (*adelante*) (<https://phaidra.kug.ac.at/o:121096>) and backward (*atrás*) tango steps (<https://phaidra.kug.ac.at/o:121097>). Both filmed and edited by Neri Píliu, 2021.

[3] The visualized averaged gait cycle of each dancer is based on the detected number of steps from four recordings after having been requested to walk with simple tango steps: Cristina: 9,12,13,11; Maja: 24,41,41,44; Yanina: 6,21,12,24, Homer: 18, 24, 16, 28; Marco: 20, 35, 41, 37; Neri: 1, 5, 2, 4.

[4] Note that the figures of leader and corresponding follower identify how the followers reach the maximum ankle distance shortly after the leaders (approximately 10%). This is caused by the followers’ high heeled shoes: even when already in contact with the floor via the balls of their feet, the heel (and thereby the ankle) keeps moving slightly longer.

[5] Excerpt from a recording session in Graz in August 2017. Recording by Christopher Dick, recording visualized in Mokka (<https://biomechanical-toolkit.github.io/mokka/>), edited by Kendra Stepputat September 2022. All markers: <https://phaidra.kug.ac.at/o:129702>. Toe markers: <https://phaidra.kug.ac.at/o:129703>.

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