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Infographic

INFOGRAPHIC: exploring gait coordination using the vector coding technique

ANA M. F. BARELA[1] | MELISSA L. CELESTINO[2]

[1] Institute of Physical Activity and Sport Sciences, Cruzeiro do Sul University, São Paulo, SP, Brazil
[2] Department of Physical Education, Health Sciences Center, Federal University of Pernambuco, Recife, PE, Brazil

Correspondence to: Dr. Ana Maria Forti Barela
Rua Galvão Bueno, 868
Liberdade, São Paulo, SP, Brazil, 01506-000
email: ambarela@gmail.com
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INTRODUCTION

Coordination can be understood as the organization of the elements that take part in the action, such as limbs, joints, muscles, etc., to act as a functional unit [1], resulting in the motor pattern, such as walking and running. Among different forms of investigating gait coordination, we selected the vector coding technique, which is a spatial measurement technique [2]. The focus of this technique is on the relationship between two elements, such as two body segments or two joints, in terms of angular displacement. The angles are directional and acquired from polar distributions (0° to 360°), and the gait coordination is inferred from an angle delimited from a vector connecting two successive time points relative to the right horizontal (i.e., the coupling angle, "g") [2]. Four modes of coordination are the main output of the vector coding technique: (1) in-phase: the two elements into consideration act in the same direction (angle definitions: 22.5°≤g≤67.5°, 202.5°≤g≤247.5°); (2) anti-phase: the two elements into consideration act in opposite directions (angle definitions: 112.5°≤g≤157.5°, 292.5°≤g≤337.5°); (3) proximal-element-phase: the proximal element leads the movement (angle definitions: 0°≤g≤22.5°, 157.5°≤g≤202.5°, 337.5°≤g≤360°); (4): distal-element-phase: the distal element leads the movement (angle definitions: 67.5°≤g≤112.5°, 247.5°≤g≤292.5°). It is important to note that this technique can be employed to investigate gait coordination in different body parts [3,4,5] and different populations, such as post-stroke survivors [5].

In the infographic, we exemplify the employment of the vector coding technique on the thigh (proximal) and shank (distal) segments and show a time series of the coupling angle during a gait cycle. The data presented is from a non-disabled male adult walking at a self-selected speed. In the time series, we can observe how the four modes of coordination change throughout the gait cycle. At heel strike, the shank leads the leg's movement (shank-phase mode) and as the foot moves towards the walking surface (i.e., foot flat), the thigh and shank move in the same direction (in-phase mode). From mid-stance to toe-off (approximately 35%-65% of the gait cycle) thigh and shank change the modes of coordination as they rotate to prepare for the swing period of gait. Finally, at the end of the swing period, we can observe that the thigh-shank coupling changes briefly to anti-phase mode and returns to shank-phase mode to start a new gait cycle. Even though the orientation of both segments changes, the shank remains leading the movement.

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