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ORIGINAL ARTICLE

Motor performance indicators of the Dollyo-chagi Taekwondo kick

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ABSTRACT

Taekwondo is a combat sport where the perfect execution of the athletes' kicking skills is essential for a good sports motor performance in recreational to elite sports. The aim of this study was to examine the athletes motor control: behavior, learn and development when they performed one Taekwondo kick technique, namely – Dollyo-chagi. The sample was composed of 14 senior men Taekwondo practitioners, five observers for observers' panel data, 44 event configurations, and 55 alphanumeric codes as observational conducts. The results were analyzed with Cohen's Kappa agreement index, intra-observer referring to observer 1 and inter-observer related to the other observers. The Theme 5.0 software programme (T-Patterns) was used to detect the temporal patterns, and a previously published observational tool (OSTPI-C) was also employed. The results show a high value of intra-observer reliability of 0.994, and inter-observer accuracy of 0.961 by conduct criterion. The contact moment was the observational instant in which greater stability was verified in the foot contact zone. The T-Patterns analysis did not reveal any gestural stability significantly different from other event configurations. The results of this study showed that the athletes' performance meets the measurement requirement of motor behavior and motor development.

Keywords: Performance analysis, Combat sport, Technical training, Motor behaviour, Observational methodology.

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INTRODUCTION

Taekwondo is a Korean martial art, and a modern combat sport, in which the perfect execution of the athletes' kicking skills execution is essential for a good sports motor performance. This combat sport originated in medieval or similar cultures. Today it is a sports activity conditioned by safety rules (Sousa et al., 2022). *Dollyo-chagi* is a Taekwondo kicking technique, which involves a semi-circular upward kick from the beginning of the movement to the moment of contact with the target. At the moment before contact, there is internal rotation of the contact leg, and a simultaneous outward pivot of the support leg. The contact of the foot area with the target, is made with the distal area of the sole, i.e., the distal plantar tip of the metatarsal bones of the foot (called háp djuk – in the Korean language).

The Dollyo-chagi is a direct and typical Taekwondo kick and can be aimed at the opponent's middle or upper zone. This action is accompanied by a 180° pivot movement of the support leg. The impact is made with the instep of the contact foot. Elite Taekwondo athletes successfully change the target zone, the trajectory of execution, and adjust the foot path, in less time, earlier and with higher speed than beginner athletes (Shaw, 2013). The authors Kim et al. (2013) identifies four phases during the Dollyo-chagi technique: Start (A), Toe off (B), Maximum Knee Flexion (C), and Impact (D); and three moments: Push, Lift, and Strike. They concluded that higher kicks need increased vertical separation of the right and left arm (elbow and wrist) separation in the release phase. In order to perform a longer kick at body level, elbows should be more vertically apart, and wrists should be more horizontally apart while the leading shoulder initiates the forward movement. The characteristics of the arm swing at different target heights and distances are informative to both attackers and counter attackers in Taekwondo athletes. No bilateral difference was found for any of the variables in the knee flexion and extension assessment (Barnamehei and Safaei, 2017). The authors Gavacan and Sayers (2017) also describe four phases to analyse the technical kicking process. The preparation phase was defined as occurring from the toe down of the support leg until the toe off of the kicking leg. The chamber phase started at the end of the preparation phase and continued until the beginning of the knee extension in the kicking leg. The extension phase followed and continued until there was contact with the target.

Effective roundhouse kicking performance was characterized by rapid pelvic axial rotation, hip abduction, hip flexion, and knee extension velocities, combined with rapid movements of the centre of mass towards the target (Gavacan and Sayers, 2017). Barnamehei and Safaei, (2017) state that athletes show a pattern during the Taekwondo roundhouse kick which starts from the foot take-off, followed by hip and knee flexion and then extension of the leg, with a continuous movement until the end (Barnamehei and Safaei, 2017). In Taekwondo as a martial art and combat sport, the sporting outcome depends largely on technical perfection. The athletes' kicking skills are essential for a good sports motor behavior, motor development and motor performance, which seeks a masterly presentation. All top athletes adapt their technique according to their morphological, physiological, and mechanical characteristics. The goal of training in recreational and elite sports is about far more than just increasing physical performance, it matters whether the athlete's role is successful in the long term or not (Tannheimer, 2023).

The authors Sousa et al., (2022) designed, validated, and published an observational tool namely: Observation System for Technical Performance Indicators - Chagi (OSTPI-C) to analyze the critical and success moments of the Taekwondo kick process. This tool was designed to avoid the Taekwondo traditional training methods - "*eyeballing*" With this observational instrument the Taekwondo coaches, athletes and practitioners can easily use it, and improve the athletes motor performance (Sousa et al., 2022).

The aim of this study was to analyse the athletes motor behavior when they execute the Taekwondo kick technique namely *Dollyo-chagi*. For this reason, a previous published tool (OSTIP-C) was used.

MATERIALS AND METHODS

Study design

According to Mason, this article presents qualitative research (Mason, 2002), with an observational methodology. To use this methodology, it is essential to design an *ad hoc* instrument with the necessary flexibility to adapt to the flow of conducts and context, where the construction of field formats and recording of the observation units under study are inserted into a system of alphanumeric and decimal codes (Anguera, 1993, Blanco and Anguera, 2000, Anguera and Blanco, 2003). For this reason, we used an observational tool design and published by Sousa et al., (2022) called OSTPI-C. The study design was nomothetic (Anguera, 2011, Anguera and Mendo, 2013) because we studied fourteen Taekwondo men athletes performing a cycle of ten kicks in a certain period of time. It was a follow-up study (Anguera et al., 2011, Anguera and Mendo, 2013, Arnau and Gómez, 1990, Anguera and Hernández-Mendo, 2015, Anguera et al., 2017) because each ten-kick cycle, in a period of time, was analyzed separately (inter-sessional) and each kick was recorded frame by frame (intra-sessional). Finally, we sought the hidden T-patterns with Theme 5.0 analysis software (Magnusson, 2000, 2004). The observation unit of this study focused on Dollyo-chagi, analyzing the athletes' motor performance.

Dataset

The data set consisted of the sample athletes' data, the sample observers' panel data, and the sample observational data.

Sample athletes' data

The practitioners sample consisted of 14 senior men Portuguese Taekwondo athletes from the Taekwondo discipline of Olympic combat; M_{age} = 20.3 ± 2.6 years; M_{weight} = 68.9 ± 10.4kg; M_{height} = 177.7 ± 7.0cm; BMI = 21.1 ± 3.2; $M_{practice\ years}$ = 7.7 ± 3.7. Weight Categories (U54kg - n = 1; U58 kg - n = 1; U68 kg - n = 1; M80 kg - n = 4). Taekwondo DAN degree (1st DAN - n = 3; 2nd DAN - n = 4). The athletes had been members of the elite Portuguese team at least once. Participants were actively impaired in this dollyo-chagi kick technical program on September 23, 2023. The research study project was approved by a scientific committee of the University of Extremadura, Cáceres, Spain. Before their participation all the athletes were informed of the procedures used, nature, and purpose of the study, filled out an informed consent form and signed.

Sample observers' panel data

The sample observers' panel was ensured by the observer panel, which was formed by five observers, one of whom was an international expert (observer 1) with more than 25 years' experience, with a national coach level of G3, European coach level and a 7th DAN Taekwondo Black Belt. The others four observers were, one with 10 years' national coach level of G2 experience and a 3rd DAN Taekwondo Black Belt (observer 2), two with 15 years' national coach level of G2 experience and 4th DAN Taekwondo Black Belts (observers 3 and 4) and one with 20 years' national coach level of G3 experience and a 5th DAN Taekwondo Black Belt (observer 5). The "*DAN*" word means the step of knowledge of the Taekwondo mastering practitioners. The DAN system starts at 1st to 9th DAN.

Sample observational data

The sample observational was characterised by 44 event configurations and 55 alphanumeric codes, previously defined in the technical observation systems of the skill under study. For the sample observation data, we used a published *ad hoc* observational instrument, namely the *Observation System for Technical Performance Indicators - Chagi (OSTPI-C)*, (Sousa et al., 2022).

Study variables

The variables took the form of performance of characteristic conducts subdivided into conduct criteria (composed by contact and support leg) and aggregate criteria (composed by head, trunk, and left and right arm).

Table 1. OSTPI-C - Variables and alphanumeric codes of conduct criteria and aggregate criteria by contact leg, support leg, head, trunk, left arm and right arm.

Variables	Criteria		Alphanumeric Codes
(*V1*) - Foot take-off (*V2*) - Knee lift (*V3*) - Start of leg extension (*V4*) - Contact moment (*V5*) - Start of leg flexion (*V6*) - Thigh extension	**Conduct criteria**	Contact leg (CL)	1CL1 - In trunk extension; 1CL2 - Back; 1CL3 - Facing front; 1CL4 - Facing forward; 1CL5 - Facing out; 1CL6 - Straight flexion of the thigh and leg; 1CL7 - Acute flexion of the thigh and leg; 1CL8 - Obtuse flexion of the thigh and leg. 2CL1 - Straight leg flexion; 2CL2 - Acute flexion of the leg; 2CL3 - Obtuse flexion of the leg; 2CL4 - Facing forward; 2CL5 - Facing backward; 2CL6 - Facing in; 2CL7 - Facing out; 2CL8 - Extension; 2CL9 - Obtuse flexion; 2CL10 - Tiptoe of the foot with flexion of finger; 2CL11 - Dorsum of the foot; 2CL12 - Inner part of the foot; 2CL13 - Outside of the foot; 2CL14 - Sole of the foot; 2CL15 - Heel of the foot. 3CL1 - Facing out; 3CL2 - Facing down; 3CL3 - Facing forward; 3CL4 - Facing in; 3CL5 - In trunk prolongation; 3CL6 - Forward.
		Support leg (SL)	1SL1 - With obtuse flexion; 1SL2 - In extension; 1SL3 - Facing out; 1SL4- Facing forward; 1SL5 - Facing in; 1SL6 - Extension; 1SL7 - Obtuse flexion; 1SL8 - Facing out; 1SL9 - Facing in less than 90º; 1SL10 - Facing in more than 90º. 2SL1 - With obtuse flexion; 2SL2 - In extension; 2SL3 - Facing out in external rotation less than 90º; 2SL4 - Facing out in external rotation less than 180º; 2SL5 - Facing in in internal rotation more than 180º; 2SL6 - Extension; 2SL7 - Obtuse flexion; 2SL8 - On tiptoe; 2SL9 - On the sole; 2SL10 - Backward in external rotation less than 90º; 2SL11 - Backward in external rotation less than 180º; 2SL12 - Backward in internal rotation less than 270º; 2SL13 - Backward in internal rotation more than 270º. 3SL1 - With obtuse flexion; 3SL2 - In extension; 3SL3 - Facing out in external rotation up to 90º; 3SL4 - Facing out in external rotation up to 180º; 3SL5 - Facing forward; 3SL6 - Facing out to 90º; 3SL7 - Facing out more than 90º.
	Aggregate criteria	Head (H)	1H1 - Extension; 1H2 - Flexion. 2H1 - Extension; 2H2 - Flexion. 3H1 - Extension; 3H2 - Flexion.
		Trunk (T)	1T1 - Front; 1T2 - Diagonal; 1T3 - Lateral. 2T1 - Front; 2T2 - Diagonal; 2T3 - Lateral. 3T1 - Front; 3T2 - Diagonal; 3T3 - Lateral.
		Left arm (La)	1La1 - Arm and forearm in obtuse flexion; 1La2 - Arm and forearm in acute flexion. 2La1 - Arm and forearm in obtuse flexion; 2La2 - Arm in trunk prolongation and forearm flexion; 2La3 - Arm in hyper-extension and forearm extension. 3La1 - Arm and forearm in trunk prolongation; 3La2 - Arm in trunk prolongation and forearm flexion.
		Right arm (Ra)	1Ra1 - Arm and forearm in obtuse flexion; 1Ra2 - Arm and forearm in acute flexion. 2Ra1 - Arm and forearm in trunk prolongation; 2Ra2 - Arm in trunk prolongation and forearm flexion; 2Ra3 - Arm in hyper-extension and forearm extension. 3Ra1 - Arm and forearm in trunk prolongation; 3Ra2 - Arm in trunk prolongation and forearm flexion.

Note: V1 ... V2 – Variables.

Procedures

Athletes

The procedures for data collection were carried out at the "*Rio Maior City, Portugal*" – Taekwondo Gym. Previously a briefing session was held with all the athletes on the conditions of the protocol, objectives of the study and the measurements that would be taken. The protocol for the analysis of the technical gesture consisted of the execution of "*a cycle of ten kicks*" at maximum speed without an oral command, against a boxing punch bag, and the athletes were requested to perform the action with their dominant leg.

For data collection, the camcorder was placed diagonally 45º to the right, relative to the action of the athletes and 350cm from the starting point of the technique, and perpendicular to the boxing punching bag on the contact leg side. The image covered the entire area of intervention and technical execution of the athlete.

For image/video recording we used a Casio ZR200 camcorder with 10x Optical Zoom, and the digital images were made and captures with Match Vision Software and viewing in AVI format.

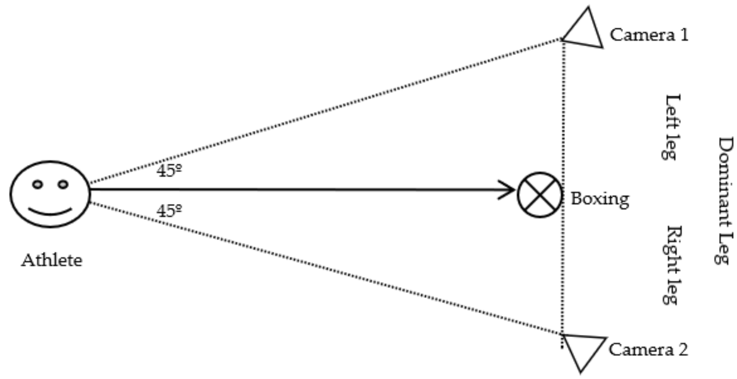


Figure 1. Representation of image collection, authors' creation.

Observers' training

After collecting images of the ten-kick cycles executed by the athletes, the training phase of the observers began. All observers received an observation training workshop according to recommendations by Anguera and Blanco, (2003). When a person is invited to be an observational instrument they must learn "*to see what they are really asked to see*" (Medina and Delgado, 1999). For the training of observers, we followed the methodological recommendations proposed by Heyns & Zander (1959) and upgraded by Medina and Delgado, (2000). The observers' training is subdivided in two phases: (1) preparation, and (2) observation training. The goal of the preparation phase is known and understand the behaviour to be observed (theory and practice). The content of the observation training phase is to provide all observers keep records on the conduct to be observed until reach a high agreement concordance among the panel observers (Anguera and Blanco, 2005, Anguera et al., 2011, Anguera and Mendo, 2013, Arnau and Gómez, 1990, Anguera et Mendo, 2015, Anguera et al., 2017, Magnusson, 2000, Magnusson, 2004, Medina and Delgado, 1999).

The main objective of this process is to improve the accuracy of records on human conduct (Medina and Delgado, 1999, García-Martín et al., 2016, Gamonales et al., 2018a, Gamonales et al., 2018b). This procedure ensures that the data collection system meets the reliability requirements (objectivity) (Magnusson, 2004, Medina and Delgado, 1999, García-Martín et al., 2016, Gamonales et al., 2018a, Gamonales et al., 2018b, García-Santos and Ibáñez, 2016, Gómez-Carmona et al., 2020, García-Ceberino et al., 2020, González-Espinosa et al., 2017, Escobar-Pérez and Cuervo Martínez, 2008). The researchers used Cohen's Kappa agreement index for the intra- and inter-observer reliability analysis. The value found should be more than 0.80 (Escobar-Pérez, 2008, Louro et al., 2009).

Presentation of the results

To relate the sample quality control data, the categories were calculated using the observed and expected probabilities of agreement among the evaluators. For the study of precision, data were then crossed between the expert and observers. The results were treated criterion by criterion, using Cohen's Kappa agreement index. GSEQ 5.0 - Agreement software was used to measure the agreement in each criterion behaviour. Expert records were analysed with among themselves (test and retest method) (Garganta, 2001). To determine the quality of the data studied, reliability through intra-observer agreement and accuracy through inter-observer agreement were calculated with Cohen's Kappa agreement index, and SIDS-GSEQ software.

The categories calculation was carried out from the observed and expected probabilities of agreement among observers:

$$\kappa = \sum_{1}^{i} \frac{p_{obs} - p_{esp}}{1 - p_{esp}}$$

Cohen's Kappa index must be performed with categorical data when the answers are nominal and/or multi-nominal thus obtaining the agreement among the observers, which must be calculated individually. For precision, the authors crossed the data between observer 1 and the other observers (test and retest). The results were treated criterion by criterion with reference to a selected athlete. Cohen's Kappa index was used to measure agreement on each criterion behaviour.

Theme software 5.0 was used for detecting and analysing hidden patterns in human behaviour in continuous action (Magnusson, 2000, 2004). People (particularly coaches) seem to have much difficulty detecting at least some types of patterns in time (Magnusson, 2000, 2004). Theme software is a powerful tool used for detection and analysis of hidden pattern behaviour and detects a very general type of such patterns, called t-patterns; and this software is an evolution programme that uses a single algorithm (Magnusson, 2000). It gradually detects complex patterns as combinations of simpler ones, and deals with combinatorial explosions through competition between patterns (Magnusson, 2000, 2004). Consequently, only the most complete patterns survive and are retained, while all partial patterns are discarded (Magnusson, 2000, 2004). The T-patterns analysis included an overview of all patterns identified in the data, including their moment of occurrence, the number of coded events involved, as well as the length, frequency, complexity, structure, actor identity, behavioural content, duration, and number of levels of the pattern (Magnusson, 2000, 2004).

Instrument, characteristic conducts, and alphanumeric codes

The observation instruments should guarantee coherence and accuracy in the recording of data, and it is important to ensure proper construction and validation. The observation instrument OSTPI-C used in this study is a published tool and was designed and validated by Sousa et al. (2022). The observation depends on four fundamental elements that interact with each other: perception, interpretation, technical behaviours, and prior knowledge of the sport [Taekwondo], adapted by Garganta (2001). In building the system we focused on four principal issues: the degree of acceptability and reasonableness in the field test among the evaluated parameters (factual validity); expert analysis and evaluation of the content of the observation instrument (content validity); analysis and evaluation by experienced coaches regarding the athletes' performance in the field test (construct validity) (Anguera and Mendo, 2013, Arnau and Gómez, 1990); and consistency and temporal stability of the evaluators' observations, in order to verify and evaluate their understanding of the variables used in the observation instrument (reliability of observations) (Anguera and Hernández-Mendo, 2015, Anguera et al., 2017, Magnusson, 2000, 2004, Medina and Delgado, 1999, Garganta, 2001). This suggested the existence of five phases, analysing the results obtained in each of them, as follows: (1) Observer training and inter-observer and intra-observer reliability testing of the observation system. (2) Improvement of the training context observation system in the Taekwondo sport. (3) Factual validation of the new expert observation system. (4) Inter-observer reliability of the new observation system. At this stage the consistency of the observations was tested. To test the consistency of the observations, the observers were trained according to the observation methodology. (5) Intra-observer reliability with respect to the observation system. In this period, it was intended to verify the existence of temporal stability in the observations, through the test-retest technique. Observer 1 (expert) viewed the video at two different times, setting the observation moments at a two-week interval (Louro et al., 2009, Louro et al., 2010).

The validation of the instrument (OSTPI-C) for the Dollyo-chagi technique was performed in two stages: (1) Identification of the reliability of intra-observer data, according to the number of concordances of each sub-criterion, inserted in the respective main criteria. (2) Identification of the accuracy of the inter-observer consistency analysis instrument when more than three observers are available (Louro et al., 2009, Louro et al., 2010). The observational instrument used has a combination of field formats and category systems (Louro et al., 2010).

To achieve our goal, we used the observation instrument designed, validated and published by Sousa et al. (2022) called *Observation System for Technical Performance Indicators - Chagi (OSTPI-C)* to characterize the observation moments for analysis of the Dollyo-chagi technique performance cycle and, from these, create the motor behaviour events of the Taekwondo athletes for data analysis in Taekwondo (observation criterion). Thus, we followed the procedure recommended by Sousa et al. (2022) which includes three phases with six moments of observation.

RESULTS

The results are presented in the same order as in the study design.

Results and validation of the observational instrument (OSTPI-C)

The OSTIP-C observational instrument could be used in the Olympic and Paralympics Taekwondo sports environment as a valid and reliable tool for evaluation of the technical execution of the Taekwondo kicking process (Sousa et al., 2022).

Results of agreement index referring to the five observers

For validation of the observer panel, the five observers analysed the 2nd cycle of the ten kicks requested from the athletes' sample. Using Cohen's Kappa index the inter-observer result was 0.968, and we found a very high intra-observer average, regarding observer 1 of 0.994.

Table 2. Agreement percentages, analysed with Cohen's Kappa agreement index, intra-observer referring to observer 1 and inter-observer referring to observers 1, 2, 3, 4 and 5, by conduct criterion of the same athlete.

	Concordance Value				
Conducts	Observer 1	Observer 2	Observer 3	Observer 4	Observer 5
CL1	1	1	0.97	1	1
CL2	0.97	1	1	0.90	0.90
CL3	1	1	0.90	1	1
SL1	1	0.93	1	1	1
SL2	1	1	1	0.93	0.93
SL3	1	1	1	1	1
H1	1	1	1	1	1
T1	1	1	1	1	1
La1	1	1	1	1	1
Ra1	1	1	1	1	1
CL4	1	0.83	0.97	1	0.87
CL5	0.97	1	1	0.87	1
CL6	1	1	0.93	0.93	1
CL7	1	1	1	1	1
SL4	1	1	1	1	1
SL5	1	0.87	1	1	1
SL6	0.97	1	1	0.77	0.90
SL7	1	1	0.93	0.93	0.93
H2	1	0.83	0.97	0.83	0.83
T2	1	1	1	1	1
La2	1	1	1	1	1
Ra2	1	1	1	1	1
CL8	1	1	0.97	1	1

CL9	0.93	0.97	0.97	0.97	0.93
CL10	1	0.93	1	0.93	1
SL8	1	1	0.93	1	0.93
SL9	1	0.93	0.97	0.93	0.96
SL10	1	1	1	1	1
H3	1	0.87	0.97	0.87	0.87
T3	0.97	0.83	0.83	0.83	1
La3	1	1	1	1	1
Ra3	1	1	1	1	1
Average	0.994	0.968	0.978	0.930	0.970
Total			0.968		

Table 3. Total frequency analysis and stability index values of fourteen athletes observed in the cycle of ten techniques - Dollyo-chagi.

Skill	Phases	Observation moments	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1st Phase	FOT	1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra1	56	12	0.40	1.00
			1CL2, 1CL5, 1SL1, 1SL4, 1H1, 1T1, 1La1, 1Ra1	24		0.17	
			1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra2	20		0.12	
			1CL2, 1CL5, 1SL1, 1SL4, 1H1, 1T1, 1La2, 1Ra1	12		0.09	
			1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La2, 1Ra1	8		0.06	
			1CL2, 1CL5, 1SL1, 1SL3, 1H2, 1T1, 1La2, 1Ra2	8		0.06	
			1CL2, 1CL5, 1SL1, 1SL4, 1H1, 1T1, 1La1, 1Ra2	8		0.06	
			1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La2, 1Ra2	4		0.03	
		KL	1CL6, 1SL6	88	4	0.63	1.00
			1CL6, 1SL7	44		0.31	
			1CL7, 1SL6	8		0.06	
	2nd Phase	SLE	2CL1, 2CL4, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1	28	16	0.20	1.00
			2CL2, 2CL5, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1	28		0.20	
			2CL2, 2CL5, 2SL2, 2SL4, 2H1, 2T2, 2La2, 2Ra1	12		0.09	
			2CL3, 2CL4, 2SL1, 2SL4, 2H2, 2T3, 2La2, 2Ra1	12		0.09	
			2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T2, 2La2, 2Ra1	8		0.05	
			2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1	8		0.05	
			2CL3, 2CL5, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1	8		0.05	
			2CL1, 2CL4, 2SL1, 2SL4, 2H1, 2T3, 2La2, 2Ra1	4		0.03	
			2CL3, 2CL4, 2SL2, 2SL3, 2H1, 2T3, 2La1, 2Ra1	4		0.03	
			2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T2, 2La1, 2Ra1	4		0.03	
			2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T3, 2La1, 2Ra1	4		0.03	
			2CL3, 2CL4, 2SL2, 2SL4, 2H2, 2T2, 2La2, 2Ra1	4		0.03	
			2CL3, 2CL4, 2SL2, 2SL4, 2H2, 2T3, 2La1, 2Ra1	4		0.03	
			2CL3, 2CL5, 2SL1, 2SL4, 2H2, 2T3, 2La2, 2Ra1	4		0.03	
			2CL3, 2CL5, 2SL2, 2SL3, 2H1, 2T3, 2La2, 2Ra1	4		0.03	
			2CL3, 2CL5, 2SL2, 2SL4, 2H2, 2T3, 2La2, 2Ra1	4		0.03	
		CM	2CL8, 2CL11, 2SL6, 2SL8	136	5	0.97	1.00
			2CL8, 2CL11, 2SL7, 2SL8	4		0.03	
	3rd Phase	SLF	3CL2, 3CL4, 3SL1, 3SL3, 3H1, 3T3, 3La2, 3Ra1	40	13	0.28	1.00
			3CL2, 3CL3, 3SL1, 3SL3, 3H1, 3T3, 3La2, 3Ra1	40		0.28	
			3CL1, 3CL4, 3SL1, 3SL3, 3H1, 3T3, 3La2, 3Ra1	16		0.11	
			3CL2, 3CL3, 3SL1, 3SL3, 3H2, 3T2, 3La2, 3Ra1	8		0.06	
			3CL2, 3CL3, 3SL1, 3SL3, 3H2, 3T3, 3La2, 3Ra1	8		0.06	
			3CL2, 3CL4, 3SL1, 3SL3, 3H2, 3T2, 3La1, 3Ra1	8		0.06	
			3CL2, 3CL4, 3SL1, 3SL3, 3H2, 3T3, 3La1, 3Ra1	8		0.06	
			3CL2, 3CL3, 3SL1, 3SL3, 3H1, 3T2, 3La2, 3Ra1	4		0.03	
			3CL2, 3CL4, 3SL1, 3SL3, 3H2, 3T3, 3La2, 3Ra1	4		0.03	
			3CL2, 3CL4, 3SL1, 3SL3, 3H1, 3T2, 3La2, 3Ra1	4		0.03	
		TE	3CL5, 3SL8	56	5	0.40	1.00
			3CL6, 3SL8	32		0.23	
			3CL5, 3SL6	24		0.17	
			3CL6, 3SL6	24		0.17	
			3CL6, 3SL7	4		0.03	
			Total of event patterns and alphanumeric codes observed:	**44**	**55**	-	-

Note. FOT - Foot take-off; KL - Knee lift; SLE - Start leg extension; CM - Contact moment; SLF - Start of leg extension; TE - Thigh extension; NEC - Number of event configurations; NAC - Number of alphanumeric codes; SI - Stability index; TSI - Total of stability index; CL - Contact leg; SL - Support leg; H - Head; T - Trunk; La - Left arm; Ra - Right arm.

Table 2 shows that the OSTPI-C tool is suitable for the observers to use, and no criterion revealed a problem with interpretation or formalization issues. We found a very high agreement among observers. The average results of the five trained observers were very high with 0.994 (intra-observer) and 0.968 (inter-observer).

Total observation motor behaviour values found in all athletes studied

Based on the analysis performed on fourteen athletes, the events and their occurrences were analysed and characterised at the six observation moments (see Table 3).

The total values of the frequency analysis for the observational sample and stability index event patterns and alphanumeric codes found, in the technique observed, included with 44 different event configurations and 55 alphanumeric codes. The event configuration that took take place most often was | 2CL8, 2CL11, 2SL6, 2SL8| - *n* = 136, with a stability index of 97%, which occurred in the 2nd phase of the observational moment of "*contact moment*", followed by |1CL6, 1SL6| - *n* = 88, with a stability index 63% which happened in the 1st phase of the observational moment of "*knee lift*". In third place was |1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra1| and |3CL5, 3SL8| - *n* = 56, with a stability index of 40%, which took place in the 3rd phase of the observational moment of "*thigh extension*".

Observation motor behaviour values found in one athlete

Table 4. Total frequency analysis and stability index values of athlete #5 observed in the ten-kick cycle.

Skill	Phases	Observation moments	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1st Phase	FOT	1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra2	10	8	1.00	1.00
		KL	1CL6, 1SL6	10	2	1.00	1.00
	2nd Phase	SLE	2CL3, 2CL4, 2SL1, 2SL4, 2H2, 2T3, 2La2, 2Ra1	6	10	0.60	1.00
			2CL3, 2CL5, 2SL2, 2SL4, 2H2, 2T3, 2La2, 2Ra1	2		0.20	
			2CL3, 2CL5, 2SL1, 2SL4, 2H2, 2T3, 2La2, 2Ra1	2		0.20	
		CM	2CL8, 2CL11, 2SL6, 2SL8	10	4	1.00	1.00
	3rd Phase	SLF	3CL1, 3CL4, 3SL1, 3SL3, 3H1, 3T3, 3La2, 3Ra1	6	9	0.60	1.00
			3CL2, 3CL4, 3SL1, 3SL3, 3H1, 3T3, 3La2, 3Ra1	4		0.40	
		TE	3CL6, 3SL8	8	3	0.80	1.00
			3CL5, 3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	**10**	**36**	-	-

The total values of observational frequency analysis for athlete #5 present 10 event configurations and 36 alphanumeric codes. This athlete showed a perfect stability index (100%) in the following moments: at the time of observation moments of phase one "*foot take-off*" instant |1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra2| - *n* = 10 and "*knee lift*" instant |1CL6, 1SL6| - *n* = 10, and at the time of observation moments of phase two "*contact moment*" instant |2CL8, 2CL11, 2SL6, 2SL8| - *n* = 10.

T-Patterns events (athlete #5)

Theme 5.0 software is an analysis method to detect temporal patterns (T-Patterns) using an algorithm and is the best and most widely used observational methodology technique.

Through the T-Patterns informative potential analysis (Figure 2), we can observer in the above figure the conduct corresponding to one of the patterns, (1) 2cl1, 2cl4, 2sl7, 2sl8, 2h1, 2t3, 2la2, 2ra1, (2) 2cl1, 2cl4, 2sl6, 2sl8, 2h1, 2t3, 2la2, 2ra1, and (3) 2cl3, 2cl4, 2sl6, 2sl8, 2h1, 2t3, 2la2, 2ra1), occurrences = 2, length = 3, duration = 175 and percentage of duration = 4, of events detected. In the overall analysis of the ten-kick cycle, we investigated 55 event types. The total number of events recorded was 840 with a mean frequency of occurrence of 50.83 for each event type.

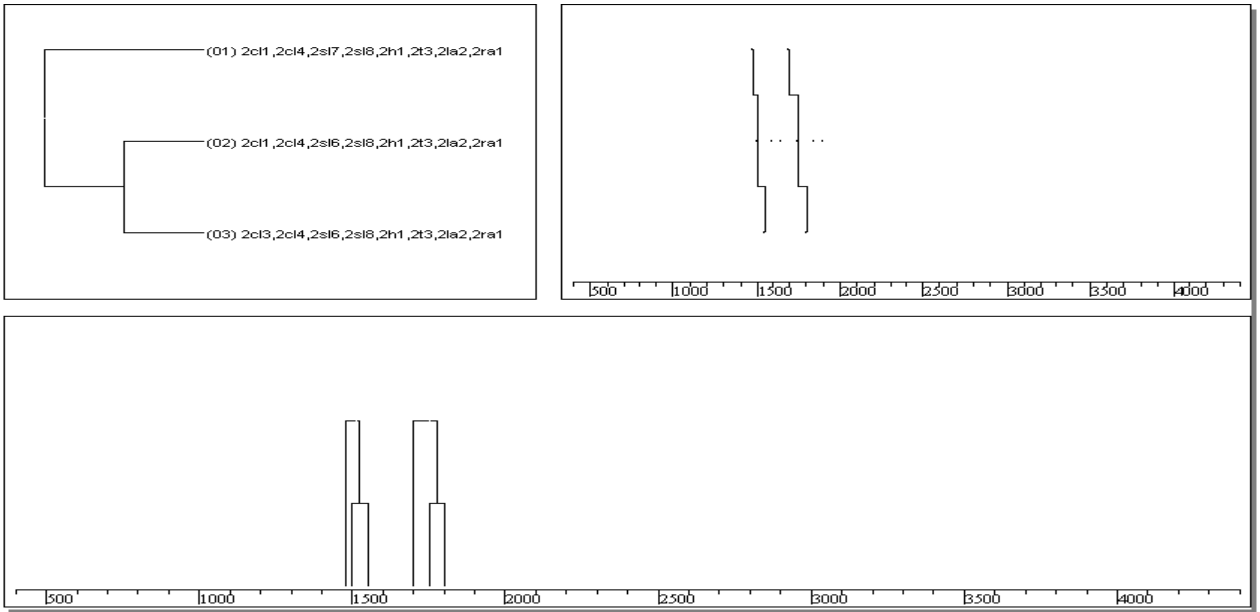


Figure 2. Dendrogram string patterns of events found in athlete #5.

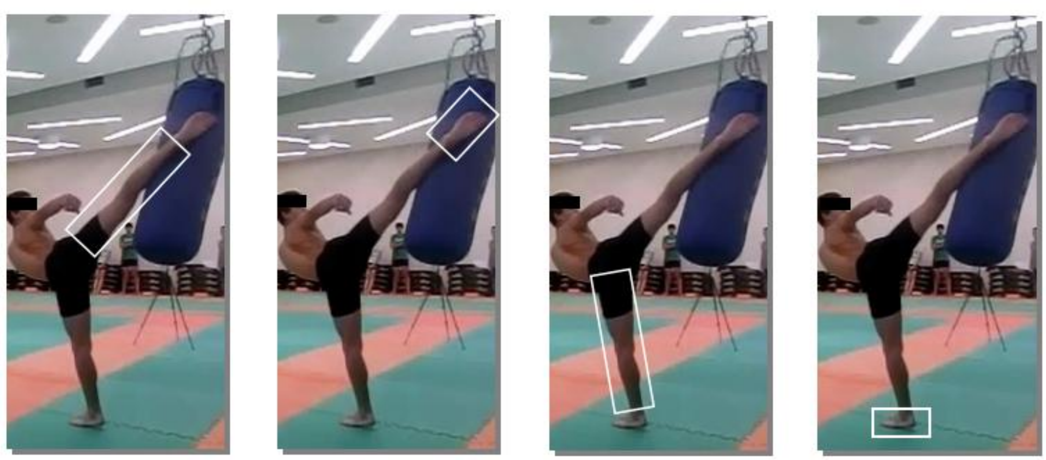
DISCUSSION

The main aim of the present study was to verify if, during technical skill implementation, the athletes perform technical motor behavioural stability in one Taekwondo technique, called *Dollyo-chagi*. The results obtained by Sousa et al., (2022) were a high confidence intervals percentage (relevance, univocity, and importance = 95%) and a high value for reliability (Cronbach's alpha = 0.90). These high values of relevance, univocity, importance and reliability are in accordance with most of the results presented by the coders (Medina and Delgado, 1999, García-Martín et al., 2016, Gamonales et al., 2018a, Gamonales et al., 2018b, García-Santos and Ibáñez, 2016, Gómez-Carmona et al., 2020, García-Ceberino et al., 2020, González-Espinosa et al., 2017, Escobar-Pérez and Cuervo-Martínez, 2008).

For validation, the panel of five observers analysed the 2nd cycle of the ten-kick cycles requested from the athletes' sample. This study used three more observers than the study by Ibáñez et al. which used only two observers (Ibáñez et al., 2016). Cohen's Kappa was used to measure the agreement index on each criterion behaviour (Cohen, 1986), and SIDS-GSEQ software. According to Bakeman and Quera (2011), and Losada and Arnau (2000) Cohen's Kappa index must be performed with categorical data when the answers are nominal and/or multi-nominal thus obtaining the agreements among the observers. The results were treated criterion by criterion referring to a selected athlete (Anguera, 1993, Blanco and Anguera, 2000, Anguera and Blanco, 2003). Using Cohen's Kappa index, the inter-observer results (0.968) showed a very high average value (almost perfect conformity) (Cohen, 2016), and a value of 0.994 for the intra-observer analysis of observer #1. This value is in accordance with (Blanco and Anguera, 2000, Anguera and Mendo, 2013, Blanco, 1993). The values found were selected from 0.930 to 1.00, and the lowest value (0.930) was found in the conduct SL8 - support leg position at the start moment of leg flexion. From observers 1, 2, 3, 4 and 5 (inter-observer) the results also show a high average, although lower than that found in the inter-observer analysis, of 0.968. The values found in our study are in accordance with those of Ibáñez et al., which range from 0.905 to 0,991 (Ibáñez et al., 2016), more than those presented by Anguera et al. (2017) and in line with Escobar-Pérez and Cuervo-Martínez (2008) who present similar results to ours. In this regard, we obtained

0.77 as the lowest value and the highest of 1.00. Conduct SL6 - support leg position (verified in observer 4) is the one that obtained the lowest value (0.77) between observer 1 and the other observers. Higher Cohen's Kappa index values were obtained in all categories, ranging from 0.77 to 1.00 in the OSTPI-C. These values indicate the existence of high levels of inter-observer reliability, according to Louro et al. (2009) and Louro et al. (2010). Cohen's Kappa (κ) was used to calculate intra- and inter-observer reliability. Values between 0.00 and 0.20 show weak conformity, values between 0.21 and 0.40 show slight conformity, values between 0.41 and 0.60 show moderate conformity, values between 0.61 and 0.80 show strong conformity, and values between 0.81 and 1.00 show almost perfect conformity, following previous studies. The inter- and intra-observer results yielded Cohen's Kappa values >0.85, showing an almost perfect conformity (Blanco, 1993, Menescardi et al., 2019). Thus, we can conclude that the values found, in the intra-observer and inter-observer analysis, agree with Blanco and Anguera (2000), Anguera and Blanco (2005), Louro et al. (2010), Blanco (1993), Menescardi et al. (2019) with the OSTPI-C instrument showing almost perfect conformity. Because the value of the reliability and precision are high, we can conclude that the observational instrument is adequate for the object of study.

After validation of the published instrument by Sousa et al. (2022) through the intervention of the observers' panel, we conducted the observation motor behaviour data analysis on the events that occurred in the technical gestures of each athlete, in order to try to understand the stability of the movement. The patterns found in the Dollyo-chagi Taekwondo technique allow us to have a global view of the behavioural interaction between phases, offering us the stability index of the "*ten-kick cycles*" analysed. Based on the analysis of the athletes, we characterised the events and occurrences in the six instants of observation of the ten-kick cycle of the technique under study. As shown in Table 3 we observed that it is at the observation moment - *"contact moment*", that less differences occur in event configurations. Moreover, it is at this moment that greater stability is verified, regarding the area of contact of the foot with the target, presenting a very high stability index of 97%. As reported by Louro et al. (2009), Louro et al. (2010) this finding proves, without doubt, the consistency of the instrument.



2CL8 2CL11 2SL6 2SL8

Figure 3. Event configuration framework that has a value of 97% in relation to observation instant - V4: "*contact moment*".

At the observation instant "*contact moment*" we found only two event configurations, one of |2CL8, 2CL11, 2SL6, 2SL8| - *n* = 68 and another of |2CL8, 2CL11, 2SL7, 2SL8| - *n* = 2, with a stability index of 97% and 3% respectively. Our finding agrees with Jung et al. (2022) who say the most important factor in Taekwondo fast kicks is the contact velocity at the time of striking. Thus, we can say that the athletes have stability in their action execution technique because the event configuration had a value of 97% (Louro et al., 2009, Louro et al., 2010, Jung and Park, 2022). The data revealed that the athletes have the contact leg in extension (2CL8) and the contact is made by the instep or dorsum of the foot (2CL11), the support leg is in extension (2SL6) and the support leg foot is on tiptoe (2SL8).

In contrast, where more different event configurations occurred was at the observation moment "*start of leg extension*". We found the following event configurations: |2CL1, 2CL4, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1| - *n* = 14 and |2CL2, 2CL5, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1| - *n* = 14, both with a stability index of 40%. |2CL2, 2CL5, 2SL2, 2SL4, 2H1, 2T2, 2La2, 2Ra1| - *n* = 6 and |2CL3, 2CL4, 2SL1, 2SL4, 2H2, 2T3, 2La2, 2Ra1| - *n* = 6, with a stability index of 18%. |2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T2, 2La2, 2Ra1| - *n* = 4, |2CL3, 2CL4, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1| - *n* = 4 and |2CL3, 2CL5, 2SL2, 2SL4, 2H1, 2T3, 2La2, 2Ra1| - *n* = 4, with a stability index of 15%. Additionally, we observed nine event configuration patterns with *n* = 2, that demonstrate a very low stability index result of 3% each (all together 27%). Thus, coming in third place with the most verified force (event configuration), in this case with a negative effect. This finding could be associated with the fact that at this stage of the technical execution there is instability (Louro et al., 2009, Louro et al., 2010) due to the athletes being in a single-leg position.

Athlete #5 (Table 4) was the subject who presented greater motor behaviour stability during the ten-kick cycle of the technique under study, with ten observed event configurations and thirty-six alphanumeric codes. He also presented a single event pattern (total stability) in the following observation moments: foot take-off, knee lift and contact moment. According to Table 4, the following events and respective variation can be observed: 1st instant of observation (foot take-off): |1CL2, 1CL5, 1SL1, 1SL3, 1H1, 1T1, 1La1, 1Ra2| - *n* = 5, with a stability index of 100%. This event configuration tells us, and we can conclude, that the contact leg is back, and the foot is facing out, the support leg is in obtuse flexion and the foot is facing out, the head is in extension, the trunk in front, the left arm and forearm are in obtuse flexion, and the right arm and forearm are in acute flexion. The 2nd instant of observation (knee lift): |1CL6, 1SL6| - *n* = 5, with a stability index of 100%, shows us that the contact leg is in straight flexion with the thigh and leg, and the support leg is in extension. The 4th instant of observation (contact moment): |2CL8, 2CL11, 2SL6, 2SL8| - *n* = 5, showed a stability index of 100%. This event configuration reveals that the contact leg is in extension and the contact is made by dorsum of the foot, the support leg is in extension and the support foot is on tiptoe. The value found in this athlete is in accordance with that of the study by Louro et al. (2009) and Louro et al. (2010). The results of the contributions of the body segments are similar to those of Jung et al. who present the thigh rotation with the highest value (39.8%), showing the most significant contribution in all types of footwork, calf rotation (34.6%), trunk movement and rotation (20.4%), more than the contribution of foot rotation (2,9%) (Jung and Park, 2022).

Theme 5.0 analysis software was developed by Magnusson, with the goal of finding patterns in real time, and hidden patterns to detect, through an algorithm, the temporal patterns, and their informative potential (Anguera and Mendo, 2013, Arnau and Gómez, 1990, Anguera and Hernández-Mendo, 2015, Anguera et al., 2017, Magnusson, 2000, 2004, Pattern Vision, 2004). This algorithm detected temporal patterns based on binomial probability that permitted identifying the sequential system and temporal data (Magnusson, 2000, 2004). In our case, to detect the motor behaviour patterns in real time and to identify the hidden patterns during the ten-kick cycle of Dollyo-chagi execution by each athlete, we used Theme 5.0 software because this tool offers a different and complex relation vision in a given sequence of events (Arnau and Gómez, 1990, Anguera and Hernández-Mendo, 2015, Anguera et al., 2017, Magnusson, 2000, 2004, Patterson Vision, 2004, Camerino et al., 2012). In this study we found ten correspondent ramifications as absolute pattern which show one line of events for each different instant of observation. The temporal pattern is made up of diverse events, must present two sub-patterns, and each ramification request two independent events. In the overall analysis of the ten-kick cycle, we analysed 55 event type configurations and the total number of events recorded was 840. The T-Patterns analysis did not reveal any event configurations that had significantly more gestural stability than any other event. The dendrogram results (Figure 2) revealed how athlete #5 adapted his technique execution, his motor behaviour stability, and where he had more instability in the second phase of observational - "*start of leg extension*" instant. The value found in this athlete is similar to all the athletes in the sample. This finding is in agreement with those of Louro et al. (2009), (2010), Blanco, 1993 and Camerino et al. (2012). The authors Ibáñez et al. (2019) design and validate the Basketball Learning and Performance Assessment Instrument (BALPAI) that assesses simultaneously decision making, technical execution and efficacy. To validate the BALPAI a group of 13 experts participated by Ibáñez et al. (2019) are less than the OSTIP-C tool who participated 19 experts' judges. The OSTIP-C measure the performance indicator for execution, effectiveness, and performance (Sousa et al., 2022 and Ibáñez et al., 2002). The BALPAI tool assesses also for decision making and these taxonomy of table of contents was planned by Ibáñez et al. (2002). Díaz et al. (2021) design an observational instrument that allows analyse how points are concluded in Padel (IPAAFP) with, only, 10 Padel expert judges.

The results of this paper support the use of OSTIP-C as a tool to analyse, in the training environment, the motor behavioural, motor development and motor performance in Taekwondo athletes' kicking process.

Limitations

We found some limitations to our study. One related to the sample size and the other related to the fact that only the athletes' dominant-leg skills were analysed. In future studies (1) it would be useful to use a bigger sample, (2) analyse the non-dominant leg actions, and (3) compare women vs. men athletes. Finally, the authors believe that the results found respond to the assumption of the study and will help to enhance the observation of technical gesture cycles by coaches, athletes, and practitioners.

CONCLUSIONS

This gestural cycle observational methodology study has attempted to verify the athletes motor behaviour: learn and development of the basic technical movements performed in one Taekwondo technique, namely Dollyo-chagi.

According to Cohen's Kappa agreement index the observers' panel result found was high (inter-observer) and the highest average found was with reference to observer 1 (intra-observer). The observational sample has characterised by event configurations and alphanumeric codes. The contact moment is the momentum where less differences occur in the event configurations, showing athletes strength motor behaviour and performance. Athlete #5 was the one who has presented the best technical motor performance (ten-kick cycles). This study showed that the athletes' presentation meets the measurement requirement of motor behaviour: learn, development and performance.

AUTHOR CONTRIBUTIONS

Conceptualization, J.L.S., H.L. and J.M.G.; methodology, J.L.S., H.L., V.H-B. and J.M.G.; formal analysis, J.L.S, H.L. and J.M.G.; investigation, J.L.S. and J.M.G.; data collection, J.L.S. and H.L.; writing: original draft preparation, J.L.S. Writing: review and editing, S.J.I., J.M.G., V.H-B. and H.L.; funding acquisition, S.J.I. All authors have read and agreed to the published version of the manuscript.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the University of Extremadura (67/2017).

INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects involved in the study. Informed consent was obtained from all subjects involved in the study.

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APPENDIX A

Total frequency analysis and stability index values of each athlete observed in the ten-kick cycle.

Athlete #1

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La2,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL7	6	3	0.60	1.00
			1CL6,1SL6	4		0.40	
	2	SLE	2CL1,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	6	10	0.60	1.00
			2CL1,2CL4,2SL1,2SL4,2H1,2La2,2Ra1	2		0.20	
			2CL3,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	8	9	0.80	1.00
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL8	10	2	1.00	1.00
			Total of event patterns and alphanumeric codes observed:	11	37	-	-

Figure A1 - Event configurations performed by athlete number 1.

Athlete #2

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	4	11	0.40	1.00
			2CL2,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T2,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	10	8	1.00	1.00
		TE	3CL5,3SL6	4	4	0.40	1.00
			3CL5,3SL8	4		0.40	
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	13	39	-	-

Figure A2 - Event configurations performed by athlete number 2.

Athlete #3

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La2,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL7	6	3	0.60	1.00
			1CL6,1SL6	4		0.40	
	2	SLE	2CL1,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	6	10	0.60	1.00
			2CL1,2CL4,2SL1,2SL4,2H1,2La2,2Ra1	2		0.20	
			2CL3,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	8	9	0.80	1.00
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL8	10	2	1.00	1.00
			Total of event patterns and alphanumeric codes observed:	11	37	-	-

Figure A3 - Event configurations performed by athlete number 3.

Athlete #4

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	4	11	0.40	1.00
			2CL2,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T2,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	10	8	1.00	1.00
		TE	3CL5,3SL6	4	4	0.40	1.00
			3CL5,3SL8	4		0.40	
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	13	39	-	-

Figure A4 - Event configurations performed by athlete number 4.

Athlete #5

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra2	10	8	1.00	1.00
		KL	1CL6,1SL6	10	2	1.00	1.00
	2	SLE	2CL3,2CL4;2SL1,2SL4,2H2,2T3,2La2,2Ra1	6	10	0.60	1.00
			2CL3,2CL5;2SL2,2SL4,2H2,2T3,2La2,2Ra1	2		0.20	
			2CL3,2CL5;2SL1,2SL4,2H2,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL1,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	6	9	0.60	1.00
			3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	4		0.40	
		TE	3CL6,3SL8	8	3	0.80	1.00
			3CL5,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	10	36	-	-

Figure A5 - Event configurations performed by athlete number 5.

Athlete #6

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La1,1Ra2	4	11	0.40	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra2	2		0.20	
			1CL2;1CL5,1SL1,1SL3,1H2,1T1,1La2,1Ra2	2		0.20	
			1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra2	2		0.20	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL4;2SL2,2SL4,2H1,2T3,2La2,2Ra1	6	10	0.60	1.00
			2CL3,2CL4;2SL2,2SL3,2H1,2T3,2La2,2Ra1	2		0.20	
			2CL3,2CL4;2SL2,2SL4,2H1,2T2,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	4	11	0.40	1.00
			3CL2,3CL4,3SL1,3SL3,3H2,3T3,3La2,3Ra1	2		0.20	
			3CL1,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL6	8	3	0.80	1.00
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	16	42	-	-

Figure A6 - Event configurations performed by athlete number 6.

Athlete #7

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL4,1SL1,1SL3,1H1,1T1,1La1,1Ra2	6		0.60	
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La1,1Ra2	2	10	0.20	1.00
			1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra2	2		0.20	
		KL	1CL6,1SL7	10	2	1.00	1.00
	2	SLE	2CL3,2CL4;2SL2,2SL4,2H1,2T3,2La1,2Ra1	2		0.20	
			2CL3,2CL4;2SL2,2SL4,2H2,2T3,2La2,2Ra1	2		0.20	
			2CL3,2CL4;2SL2,2SL4,2H2,2T3,2La1,2Ra1	2	12	0.20	1.00
			2CL3,2CL4;2SL2,2SL4,2H1,2T2,2La1,2Ra1	2		0.20	
			2CL3,2CL4;2SL2,2SL3,2H1,2T3,2La1,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H2,3T2,3La1,3Ra1	4		0.40	
			3CL2,3CL4,3SL1,3SL3,3H2,3T3,3La1,3Ra1	4	10	0.40	1.00
			3CL2,3CL4,3SL1,3SL3,3H1,3T2,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL8	4		0.40	
			3CL5,3SL6	2		0.20	
			3CL6,3SL6	2	5	0.20	1.00
			3CL5,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	17	44	-	-

Figure A7 - Event configurations performed by athlete number 7.

Athlete #8

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La2,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL7	6	3	0.80	1.00
			1CL6,1SL6	4		0.20	
	2	SLE	2CL1,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	6		0.60	
			2CL1,2CL4,2SL1,2SL4,2H1,2La2,2Ra1	2	10	0.20	1.00
			2CL3,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	8	9	0.80	1.00
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL8	10	2	1.00	1.00
			Total of event patterns and alphanumeric codes observed:	11	39	-	-

Figure A8 - Event configurations performed by athlete number 8.

Athlete #9

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	4		0.40	
			2CL2,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	2	11	0.20	1.00
			2CL3,2CL5,2SL2,2SL4,2H1,2T2,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	10	8	1.00	1.00
		TE	3CL5,3SL6	4		0.40	
			3CL5,3SL8	4	4	0.40	1.00
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	13	37	-	-

Figure A9 - Event configurations performed by athlete number 9.

Athlete #10

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL7	6	3	0.60	1.00
			1CL6,1SL6	4		0.40	
	2	SLE	2CL3,2CL5;2SL2,2SL4,2H1,2T3,2La2,2Ra1	8	9	0.80	1.00
			2CL3,2CL4;2SL2,2SL4,2H1,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	8	5	0.80	1.00
			2CL8,2CL11,2SL7,2SL8	2		0.20	
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	6	9	0.60	1.00
			3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	4		0.40	
		TE	3CL5,3SL8	8	3	0.80	1.00
			3CL5,3SL7	2		0.20	
			Total of event patterns and alphanumeric codes observed:	12	38	-	-

Figure A10 - Event configurations performed by athlete number 10.

Athlete #11

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La1,1Ra1	10	8	1.00	1.00
		KL	1CL6,1SL6	10	2	1.00	1.00
	2	SLE	2CL3,2CL5;2SL2,2SL4,2H2,2T2,2La2,2Ra1	4		0.40	
			2CL3,2CL5;2SL2,2SL4,2H1,2T2,2La2,2Ra1	2	11	0.20	1.00
			2CL3,2CL4;2SL2,2SL4,2H1,2T2,2La2,2Ra1	2		0.20	
			2CL3,2CL4;2SL2,2SL4,2H2,2T2,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H2,3T2,3La2,3Ra1	4		0.40	
			3CL2,3CL3,3SL1,3SL3,3H2,3T3,3La2,3Ra1	4	10	0.40	1.00
			3CL2,3CL3,3SL1,3SL3,3H1,3T2,3La2,3Ra1	2		0.20	
		TE	3CL5,3SL6	6		0.60	
			3CL5,3SL8	2	4	0.20	1.00
			3CL6,3SL6	2		0.20	
			Total of event patterns and alphanumeric codes observed:	13	39	-	-

Figure A11 - Event configurations performed by athlete number 11.

Athlete #12

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La1,1Ra2	4		0.40	
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra2	2	11	0.20	1.00
			1CL2;1CL5,1SL1,1SL3,1H2,1T1,1La2,1Ra2	2		0.20	
			1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra2	2		0.20	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL4;2SL2,2SL4,2H1,2T3,2La2,2Ra1	6		0.60	
			2CL3,2CL4;2SL2,2SL3,2H1,2T3,2La2,2Ra1	2	10	0.20	1.00
			2CL3,2CL4;2SL2,2SL4,2H1,2T2,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	4		0.40	
			3CL2,3CL4,3SL1,3SL3,3H2,3T3,3La2,3Ra1	2	11	0.20	1.00
			3CL1,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL6	8	3	0.80	1.00
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	16	42	-	-

Figure A12 - Event configurations performed by athlete number 12.

Athlete #13

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La2,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL7	6	3	0.60	1.00
			1CL6,1SL6	4		0.40	
	2	SLE	2CL1,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	6	10	0.60	1.00
			2CL1,2CL4,2SL1,2SL4,2H1,2La2,2Ra1	2		0.20	
			2CL3,2CL4,2SL2,2SL4,2H1,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL4,3SL1,3SL3,3H1,3T3,3La2,3Ra1	8	9	0.80	1.00
			3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	2		0.20	
		TE	3CL6,3SL8	10	2	1.00	1.00
			Total of event patterns and alphanumeric codes observed:	11	37	-	-

Figure A13 - Event configurations performed by athlete number 13.

Athlete #14

Skill	Phases	Obs.Moment	Event Configurations	NEC	NAC	SI	TSI
Dollyo-chagi	1	TOF	1CL2;1CL5,1SL1,1SL4,1H1,1T1,1La1,1Ra1	6	9	0.60	1.00
			1CL2;1CL5,1SL1,1SL3,1H1,1T1,1La2,1Ra1	4		0.40	
		KL	1CL6,1SL6	8	3	0.80	1.00
			1CL7,1SL6	2		0.20	
	2	SLE	2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	4	11	0.40	1.00
			2CL2,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T2,2La2,2Ra2	2		0.20	
			2CL3,2CL5,2SL2,2SL4,2H1,2T3,2La2,2Ra1	2		0.20	
		CM	2CL8,2CL11,2SL6,2SL8	10	4	1.00	1.00
	3	SLF	3CL2,3CL3,3SL1,3SL3,3H1,3T3,3La2,3Ra1	10	8	1.00	1.00
		TE	3CL5,3SL6	4	4	0.40	1.00
			3CL5,3SL8	4		0.40	
			3CL6,3SL8	2		0.20	
			Total of event patterns and alphanumeric codes observed:	13	39	-	-

Figure A14 - Event configurations performed by athlete number 14.