DOI: 10.4025/jphyseduc.v27i1.2756

Original Article

ANÁLISE DA COMPLEXIDADE DAS TÉCNICAS DE *TE WAZA* DO JUDÔ PERTENCENTES AO *GOKYO*

ANALYSIS OF THE COMPLEXITY OF *TE WAZA* TECHNIQUES OF JUDO BELONGING TO G*OKYO*

Fernando Ikeda Tagusari[1], Fernando Garbeloto dos Santos[1] e Go Tani[1]

[1]Universidade São Paulo, São Paulo-SP, Brasil.

RESUMO

Assumindo que o *Gokyo* é um guia que orienta o processo de ensino das técnicas do Judô, é razoável deduzir que ele deve ser organizado seguindo uma ordem crescente quanto à complexidade das técnicas entre as séries. Baseado no conceito de complexidade da tarefa da área de aprendizagem motora, o presente estudo tem como objetivo analisar as técnicas de *Te waza* do *Gokyo* para verificar se elas estão organizadas na ordem crescente de complexidade. A complexidade foi conceituada como a quantidade de componentes e suas interações. A escolha dessas técnicas foi baseada na sua distribuição mais homogênea entre as séries do *Gokyo*. O resultado encontrado foi que 66% das técnicas de *Te waza* do *Gokyo* estão organizadas de acordo com a ordem crescente de complexidade definida pela aplicação dos critérios da área de aprendizagem motora.

Palavras-chave: Judô. Aprendizagem motora. Complexidade.

ABSTRACT

Assuming that the *Gokyo* is a guide for the teaching process of judo techniques it is reasonable to infer that it must be organized following a growing order in relation to the complexity of the techniques between the series. Based on the concept of task complexity drawn from motor learning literature the objective of this study was to analyze the *Te waza* techniques of *Gokyo* to verify if they are organized according to growing order of complexity. Complexity was defined as the number of components and their interactions. The choice of these techniques was based on a more homogeneous distribution among *Gokyo* series. The result found was that 66% of the techniques of *Te waza* are organized in accordance with the growing order of complexity defined by the application of criteria of the motor learning area.

Keywords: Judo. Motor learning. Complexity.

Introduction

The *Gokyo no waza* - five sets of throwing techniques - was established by Jigoro Kano and his students in 1895, aiming a more efficient teaching of Judo throwing techniques[1]. The current *Gokyo* consists of 40 techniques set out in 5 series of 8 throws in each. It is expected that, in the course of the progression through belts, from white to brown, the student will master these 40 techniques. In Brazil, many Judo teachers subdivide the Gokyo series by defining some techniques that they consider as a "prerequisite" for the next belt, thus elaborating a pedagogical sequence of techniques, from the simplest to the most complex. For example, for promotion to the gray belt one or two techniques of the 1st series are required; to the blue belt, in addition to the gray belt techniques other techniques from the 1st series are required, and so on, until the brown belt when the 40 techniques are known. Such conduct is sanctioned by the Regulamento de Graduação da Confederação Brasileira de Judô (CBJ)[2] [Rules of Graduation of the Brazilian Judo Confederation] introduced in 2011. Those rules define the the technical, theoretical and practice time requirements between promotions that Judo practitioners must meet for each graduation level.

Since the *Gokyo no waza* is widely used as a pedagogical sequence, it is expected that the techniques belonging to the first series will be less complex than the techniques of the subsequent series, a fact that would validate *Gokyo*'s use for progression throughout belts. In such context arises the question that motivates the present study, related to the basic principles of the Motor Learning field of study: are the *Te waza* techniques present in the *Gokyo* organized according to an increasing order regarding the techniques' complexity?

Therefore, the present work aims to analyze, based on the concept of task complexity in the Motor Learning field of study, the progression in the six *Te waza* techniques included in *Gokyo*. Specifically, identify in the techniques their components and interactions and evaluate the presence or absence of an ascending order of complexity among them.

Assuming there is an increasing order between *Gokyo* series it is expected the first series' techniques are simpler than the second ones and so forth. To find evidence to verify this assumption, the six sequential *Te waza* techniques were analyzed: *Seoi Nague* (1st series), *Tai Otoshi* (2nd series), *Kata Guruma* (3rd series), *Sukui Nague* (4th series), *Uki Otoshi* (4th series), and *Sumi Otoshi* (5th series). To evaluate complexity the number of components and their interactions - the greater the number of components and their interactions, the higher is the technique's complexity.

Method

Techniques selection

The present *Gokyo* is composed of 40 techniques (Table 1). The selection of *Te waza* techniques considers these techniques are distributed more evenly throughout the series, therefore allowing a better appraisal of the sequential progression regarding complexity. The *Te waza* techniques are: *Seoi Nague, Tai Otoshi, Kata Guruma, Sukui Nague, Uki Otoshi,* and *Sumi Otoshi*.

Table 1. The Gokyo techniques

Dai Ikyo	Dai Nikyo	Dai Sankyou	Dai Yonkyo	Dai Gokyo
De Ashi Harai	Ko Soto Gari	Koto Soto Gake	Sumi Gaeshi	O Soto Guruma
Hiza Guruma	Ko Uchi Gari	Tsuri Goshi	Tani Otoshi	Uki Waza
Sassae Tsuri Komi Ashi	Koshi Guruma	Yoko Otoshi	Hane Maki Komi	Yoko Wakare
Uki Goshi	Tsuri Komi Goshi	Ashi Guruma	Sukui Nague	Yoko Guruma
O Soto Gari	Okuri Ashi Harai	Hane Goshi	Utsuri Goshi	Ushiro Goshi
O Goshi	Tai Otoshi	Harai Tsuri Komi Ashi	O Guruma	Ura Nague
O Uchi Gari	Harai Goshi	Tomoe Nague	Soto Maki Komi	Sumi Otoshi
Seoi Nague	Uchi Mata	Kata Guruma	Uki Otoshi	Yoko Gake

Source: [3](adapted)

The execution of a Judo technique involves the perception of the environmental demands by analyzing the stimuli coming from several sensory sources, especially kinesthetic ones, the choice of the proper technique and the execution of the movement itself in a coordinated, harmonic and sequenced way. Most of Judo techniques can be classified as serial skills, since it implies the accomplishment of a sequence of movements (components) that seek the unbalance, the preparation of the throw, and the projection itself; specifically, the *kuzushi*, the *tsukuri,* and the *kake*. Apart from the number of components, the interaction between them defines the techniques' complexity level.

Techniques' description

For the technique description, the *Tori* - the one who throws - employs the right hand hold, throwing the *Uke* - the one who's thrown - with the technique performed on the right side. As seen, the Judo throwing techniques comprises three distinct stages: *Kuzushi* - the art of "breaking" the opponent's balance and forcing him into a vulnerable position; *Tsukuri* - the correct body positioning of the one who will perform the technique in relation to the opponent, after inducing the opponent's imbalance; *Kake* - the execution of the technique itself.

Judo techniques can be considered as a system in which the characterization of each technique is made by the combination of the several components performed in each phase of the throw. Every movement involves interaction between the *Tori* and the *Uke*, that is, the synchronism between action and reaction; in the *kuzushi* phase aiming the imbalance, in the *tsukuri* phase the ideal positioning, and finally in the *kake* phase the throwing action. The unbalancing is accomplished by the displacement of the center of gravity of the *Uke*, that can be performed in eight different positions - *happo no kuzushi*[1,3-5].

From the point of view of the classification of motor skills, Judo throwing techniques consist of discrete motor skills placed in a sequence, that is, serial skills. Thus, each discrete motor skill that composes the whole - the throw - has been assumed as a component that interact with each other.

To better describe the components of each *Te waza* technique, an analysis has been carried out for each throw, in which the components were identified in each of its phases. These are the movements performed by the *Tori*, in each phase. In a few techniques, in order for them to "conform" with the *Seiryoku zenyo* theory, i.e., principle of maximal efficiency with minimal energy expenditure, a few movements are performed to "instigate" a reaction from the *Uke* and this *momentum* is employed to enable the following components, "saving" energy. All Judo techniques follow this principle. A few components occur simultaneously, requiring different movements to reach a common objective.

For the identification of the throws' components, both temporal and spatial aspects were considered. The temporal aspect refers to the *kuzushi*, *tsukuri*, and *kake* phases, which always occur in this order, with unequal time lengths and ending with the *Uke*'s throw. The spatial aspect corresponds to the actions of the arms, trunk, legs, etc., expressly, the control of the body's degrees of freedom.

With reference to the *Seoi Nague*, in the kuzushi phase, two components were identified: the first is a movement to prompt the movement of the *Uke*, and the second is composed of two interconnected components that occur simultaneously, aiming at the actual unbalance of the *Uke*. In the *tsukuri* phase two components are identified: both are composed of two interconnected components - the first represents the beginning of the positioning and the second the stability and the complete positioning of the *Tori* relative to the *Uke*. In the *kake* phase five components are identified: one encompassing two components, with the objective of "displacing" the *Uke* to the *Tori'*s back, and another consisting of three components for the projection itself.

In the *Tai Otoshi*, the particularity is the fact that the three components are constituted by the interconnection of two components each, and the phases of the throw are not well defined.

As for *Kata Guruma*, in the *kuzushi* phase, the first component is composed of two interconnected components, aiming to prepare for the *Uke*'s imbalance, which reacts to the movement; the second component is singular. The *tsukuri* phase incorporates three components, the latter being the preparation for the *kake* phase. The *kake* phase consists of four components, with the last one encompassing three interconnected components. As

regards the *Sukui Nague*, the *kuzushi* phase is composed of a single component; whereas the *tsukuri* phase amounts to two, the latter being the integration of two components, aiming the arms' positioning; in the *kake* phase a single component is recognized.

Regarding the *Uki Otoshi*, in the *kuzushi* phase the first movement is necessary to cause a reaction in the *Uke*, thus prompting its disequilibrium; in the *tsukuri* there's a technique particularity which makes the projection effective only if the *Tori* starts the movements of the *kake* phase at the same time the *Uke* starts supporting his weight on his right foot. The *kake* phase is composed of three interconnected and simultaneous movements. Finally, concerning the *Sumi Otoshi*, in the *kuzushi* phase the first movement intends to elicit the *Uke*'s reaction; in the *tsukuri* phase, the objective is the body positioning, and the body projection begins - in this phase two moments are recognized, the first involving the stabilization of the *Tori*, and the other the "pushing" of the *Uke* to the backward right direction. In the *kake* phase, the *Uke*'s support is pushed to his right foot and the projection action is continued.

Technique analysis

We sought to identify, in *Te waza* techniques, their components and interactions, classifying them according to an increasing complexity order. The distinction between Judo techniques is the involvement of the components of the projection action, that is, the synchrony between body segments recruited aiming the opponent's displacement.

The components were conceptualized as necessary movements for the accomplishment of the throw, from the *kuzushi* to the *kake*, in which each action plays an essential role for the execution of the technique. As such, for the technique's understanding (i.e., to understand the whole) it's necessary to identify the function of each part and the relation between them to achieve a certain objective. One component can be said to be more complex than another from Billing's[6] proposition: the greater the number of operative muscle groups and the joint control refinement, the higher is the complexity. Some movements aim to elicit an action/reaction from the opponent and the next component can only be triggered if the movement of the opponent satisfies the expected reaction; such evaluation is done based on information from sensory receptors, in other words, through the use of feedback. Without this evaluation, the throw may continue, but it will certainly result in failure.

It is worth mentioning that for the analysis of the *Te waza* techniques the patterns established by Judo's founder, Jigoro Kano, expressed in *Kata*[1,3,4,5] form were used. The character of the duality of the technique mentioned by Gomes[7], in which both practitioners try to take down one another at the same time, will be considered as if the *Uke* is not trying to overcome the *Tori*, only reacting to his lead. The throws will be considered in this way in order to seek similarity with technique demonstration situations - often considered a standard for evaluation in belt promotion - showing each phase of the throw in a clear way, and therefore allowing the identification of the technique's components.

Results and discussion

For each technique component many body segments, joints, and muscle groups are employed, and consequently countless movement degrees of freedom are available. In a way, one off the greatest challenges for the practitioner is controlling the degrees of freedom to allow the skill's execution[8]. Choshi[9] describes the several articular degrees of freedom involved in the execution of a simple gesture (e.g. 7 articular d.o.f. in an arm action). For this movement to be actually performed, it is necessary to restrict the other movements that the limb could do. Schmidt e Wrisberg[10] suggest that, for the degrees of freedom control in rapid movements, the sensory information modifies a set of pre-structured motor commands at the

executive level, and that defines the essential details of a skilled action - characterized as a motor program - which, with practice, becomes more and more elaborate, controlling ever-longer series of components[11].

In the technique performance the three phases always occur in the same order. In *kuzushi* the action or reaction from the *Uke* is essential, whose movement is received by sensory receptors generating the feedback employed in movement control, expressly, in closed-loop control. In *tsukuri*, the *Tori* positions itself to trigger the movements for the projection execution in a more efficient way - *kake.* The *kake* is performed in a fast and powerful way, without feedback use, that is, in open-loop control. Hence, Judo techniques demand both closed and open-loop movement control.

In *Seoi Nague* the following components were found: (a) in *kuzushi* phase: stepping forward with the right foot and perform the pushing action (1); as the *Uke* resists the movement, drawing back the right foot (2); and, at the same time, "pulling" the *Uke* with both arms causing the imbalance (3); (b) in *tsukuri*: setting the positioning, performing a counter-clockwise turn (*hidari ushiro no sabaki*) (4); and putting the right foot in front of the *Uke* (5); stabilizing the finished positioning flexing both knees (6); and placing the left foot (7); (c) in *kake* phase: pulling the *Uke*'s right arm (8); flexing the right elbow (9); thrusting the right elbow under the *Uke*'s armpit (10); and placing the *Uke* on his back (11); carrying out the projection, extending knees (12); and flexing hips (13); pulling the *Uke* down with both hands (14); and rotating the torso to the right (15).

In *Tai Otoshi*, the following components were identified: (a) in the *kuzushi* phase: stepping back with the right foot (1); and, at the same time, "pulling" the *Uke* up causing the imbalance (2); (b) in the *tsukuri* phase: "turning" back with the left foot (*hidari ushiro no sabaki*) (3); and placing the right foot, "outstepping" the Uke's right foot laterally (4); (c) in the *kake* phase: "pulling" the *Uke* forwards and downwards (5); and, at the same time, "pushing" in the movement's direction with the right arm, finishing the throwing action (6).

In *Kata Guruma* the following components were identified: (a) in the *kuzushi* phase: stepping back with the left foot (*hidari ushiro no sabaki*) (1); and, at the same time, leading the *Uke* with both hands (2); from the *Uke* resistance to moving, "pulling" his right arm (3); (b) in *tsukuri* phase: flexing knees (4); placing the right leg between the *Uke*'s legs (6); (c) in the *kake* phase: carrying the opponent over the shoulders (7); pulling the *Uke*'s left arm (8); stabilizing the posture (9); pulling down with the left arm (10); and, at the same time, pushing the *Uke* up with the right arm (11); turning the *Uke*'s body over his neck (12).

In *Sukui Nague* the following components were identified: (a) in *kuzushi* phase: performing the backward left unbalancing (*hidari ushiro no kuzushi*) (1); (b) in *tsukuri*: stepping with the right foot behind the *Uke* (2); for the positioning, wrapping around the *Uke*'s hip with the right arm (from the frontside) and holding the back of the right leg (3); at the same time, placing the left arm in the back of *Uke*'s left leg (4); (c) in *kake* phase: raising the opponent with the (right side of) hip (5).

In *Uki Otoshi* the following components were identified: (a) in *kuzushi* phase: stepping wide back with the right foot (1); *Uke* reacts with a step forward with the left foot, evoking the forward left imbalancing (*hidari mae no kuzushi*); (b) in *tsukuri* phase: the *Uke* starts placing his weight in his left foot; backing off the left foot (2); (c) in *kake* phase: three components are necessary for the opponent's projection and are triggered when the *Uke*'s weight distribution is finished: turning the torso leftwards (3); pushing the *Uke* up with the arms (4); and then, pulling downwards (5).

In *Sumi Otoshi* the following components were identified: (a) in *kuzushi* phase: stepping back with the right foot (1); *Uke* reacts stepping forward with the left foot. (b) in *tsukuri* phase: two actions that enable the throw were identified. The first aims to stabilize the

support, dropping down hips and lightly flexing knees (2); stepping diagonally forward with the left foot (3); the second action aims to push the opponent in a backward right direction, by means of two actions: pushing the opponent with the right arm (4); and, at the same time, pulling with the left arm (5); in *kake* phase: the *Uke* is pushed diagonally in the backward right direction, while the right arm keeps pushing (6); and pulling with the left arm (7).

To analyze the complexity the components were tallied and organized as shown in Table 2. The number of components represents the necessary number of movements needed to reach a technique's goal. The number of components in interaction is the consolidation of two or more components - usually from different limbs - aiming the same objective in the technique's execution. The number of opponent action/reaction components shows how many times in a given phase the *Uke* reacts to the *Tori*'s action, and this action is necessary for prompting the following actions. The techniques in Table 2 were disposed according to their order in *Gokyo*.

Table 2. Number of components in Gokyo's Te waza techniques in series order.

	Kuzushi				Tsukuri				Kake				Total			
Technique	**A**	**B**	**C**	**B/A %**	**A**	**B**	**C**	**B/A %**	**A**	**B**	**C**	**B/A %**	**A**	**B**	**C**	**B/A%**
Seoi Nague	3	2	1	67%	4	4	0	100%	8	5	0	63%	15	11	1	73%
Tai Otoshi	2	2	0	100%	2	2	0	100%	2	2	0	100%	6	6	0	100%
Kata Guruma	3	2	1	67%	3	0	0	0%	6	3	0	50%	12	5	1	41%
Sukui Nague	1	0	0	0%	3	2	0	67%	1	0	0	0%	5	2	0	40%
Uki Otoshi	1	0	1	0%	1	0	1	0%	3	3	0	100%	5	3	2	60%
Sumi Otoshi	1	0	1	0%	4	4	0	100%	2	2	1	100%	7	6	2	86%

Legend: A = total number of components; B = number of integrated components; C = number of opponent action/reaction moments; B/A= relationship between A/B components and interaction.

Source: The authors

The *Seoi Nague* is the throw with the greatest quantity of components - fifteen - and its *kake* phase amounts for most of them. Many body segments participate for the projection execution, such as hips, knees, elbows, wrists and shoulders, involving many muscle groups, thus increasing demands for control and coordination between segments. This shows that despite being considered as *Te waza*, the *Seoi Nague* shows a hybrid character, in which many body segments are engaged in a common action. For the imbalance to ensue, the *Uke* reaction while being "pushed" by the *Tori* is necessary, producing force opposing the pushing action. This "resistance" energy is exploited for the projection.

The *Tai Otoshi* is the technique with the greater proportion of interaction between components - in its six identified components there is pair interaction in all the technique's phases - expressing the technique's dynamic character. There is no contact with the opponent except for the hands, and to potentialize the projection action, the energy stored with the combine segments action, such as the *Tori* rotation, is transferred to the arms which will perform the throwing action.

The *Kata Guruma* is the technique with the greatest number of components after *Seoi Nague* - twelve. However, there are less components in interactions since in the *tsukuri* phase the positioning isn't as dynamic as the *Seoi Nague*. The *Tori* action requires the placing the *Uke*'s body over the shoulders, for then throwing him. The projection involves the concerted action of three components.

The *Sukui Nague* is the technique with fewer components, with a single interaction between components in *tsukuri* phase, wherein the arms are placed, for the throw to finally occur.

The *Uki Otoshi* and the *Sumi Otoshi* are techniques with similar features. Both, according to Daigo[1], are called *Kuuki Nague*, which can be literally translated as wind projection. This denomination refers to the techniques' traits, which demand minimum physical contact to perform the projection, exploiting the momentum, i.e. being intrinsically dependent on the opponent's reaction. The *Uki Otoshi* comprises five components, among which three are integrated. In turn the *Sumi Otoshi* is composed of seven components of which six interact; four out of those six are related to the beginning of the projection. The difference of both techniques to the other *Te waza* is in the knowledge of the *Uke*'s position and the "resistance" reaction to the movement of "pulling" him. The projection action is elicited through this resistance.

Concerning the data presented in Table 3 the following features were considered to order the techniques with reference to complexity: the presence of *Uke*'s action/reaction - when there is an *Uke*'s action/reaction that information must be processed to decide to carry on the technique or not, representing *Uke*'s "ideal" response; total number of components - the greater the amount of components, the larger the extent of information to be processed; the higher the interaction, the higher must be the coordinative control between elements (Table 3).

Table 3. Number of components in Gokyo's Te waza techniques ordered according to complexity criteria - from higher to lower.

Technique	Kuzushi				Tsukuri				Kake				Total			
	A	B	C	B/A %	A	B	C	B/A %	A	B	C	B/A %	A	B	C	B/A%
Sumi Otoshi	1	0	1	0%	4	4	0	100%	2	2	1	100%	7	6	2	86%
Uki Otoshi	1	0	1	0%	1	0	1	0%	3	3	0	100%	5	3	2	60%
Seoi Nague	3	2	1	67%	4	4	0	100%	8	5	0	63%	15	11	1	73%
Kata Guruma	3	2	1	67%	3	0	0	0%	6	3	0	50%	12	5	1	41%
Tai Otoshi	2	2	0	100%	2	2	0	100%	2	2	0	100%	6	6	0	100%
Sukui Nague	1	0	0	0%	3	2	0	67%	1	0	0	0%	5	2	0	40%

Legend: A = total number of components; B = number of integrated components; C = number of opponent action/reaction moments; B/A= relationship between A/B components and interaction
Source: The authors

In accordance with the application of the established criteria to order the *Te waza* techniques concerning complexity, the outcomes are different to the order found in the *Gokyo*, from simpler to the more complex.

Comparing the order established in *Gokyo*, we point out two techniques among the six that changed places between each table order: the *Seoi Nague* and the *Sukui Nague*. Therefore, 33% of the *Te waza* techniques of *Gokyo* are not ordered according to complexity. Pedagogical implications of these results imply *Tai Otoshi*, *Kata Guruma*, *Uki Otoshi*, and *Sumi Otoshi* techniques can be taught according to the order of appearance in the series. However, it is suggested to invert the moment of teaching *Seoi Nague* and *Sukui Nague* techniques between each other.

Final considerations

According to the findings of the present study, 66% of *Gokyo*'s *Te waza* techniques are organized in an increasing complexity order. As these results refer only to the *Te waza* techniques, we emphasize the need to expand these kind of study for the other techniques to reorganize the *Gokyo* as a whole, rearranging techniques from simplest to the most complex.

References

1. Daigo T. Kodokan Judo - Throwing Techniques. Tokyo : Kodansha International; 2005.
2. Confederação Brasileira de Judô. Regulamento para exame de graduação. Rio de Janeiro; 2011.
3. Kano, J. Kodokan Judo. Tokyo : Kodansha International, 1994.
4. Mifune K. The canon of Judo - Classic Teaching on Principles and Techniques. Tokyo: Kodansha International; 2004.
5. Shinohara M. Manual de Judô Vila Sônia. São Paulo: produção independente; 1982.
6. Billing J. An Overview of Task Complexity. Motor Skills 1980;1(4):18-23.
7. Gomes FRF. Aprendizagem do Kuzushi (Desequilíbrio) nos golpes de Judô o osoto gari e tai otoshi. s.l. : [Tese de Mestrado em Educação Física], Escola de Educação Física e Esporte da Universidade São Paulo, Programa de pós graduação em Educação Física, 2007.
8. Schmidt RA, Lee TD. Motor Control and Learning - A behovioral emphasis. Champaing: Human Kinetics; 2005.
9. Choshi K. Aprendizagem Motora como um problema mal-definido. Rev Paul Educ Fís 2000;3:16-23.
10. Schmidt RA, Wrisberg, CA. Aprendizagem e Performance Motora - Uma abordagem da aprendizagem baseada no problema. Porto Alegre: Artmed Editora; 2001.
11. Tani G. Processo Adapativos: Uma concepção de Aprendizagem Motora Além da Estabilização. Comportamento Motor Aprendizagem e Desenvolviemnto. Rio de Janeiro : Guanabara Koogan; 2005. p. 60-67.

Received on Aug, 07, 2015.
Reviewed on Oct, 20, 2016.
Accepted on, Oct 26, 2016.

Corresponding address: Fernando Ikeda Tagusari – Laboratório de Comportamento Motor – LACOM. Av. Professor Mello Moraes, 65 - Cidade Universitária, São Paulo - SP, 05508-030, e-mail fernando.tagusari@usp.br