Observational analysis of judo combat: from a high vertebration record to the selection of T-patterns by specific dimensions

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Abstract

Purpose: This communication presents an observational tool that allows recording, analyzing and interpreting technical-tactical performance in a judo match.

Method: Five bouts have been registered and analyzed -two semifinals, two bouts for the bronze medal and the final- of three female weight categories (-48kg, -63kg and +78kg) and three male categories (-60kg, -81kg and +100kg).

Results: The high vertebration of the observational tool designed implies that the records made are a faithful record of the behavior performed by the judokas in combat, and endow it with a high interest for its use not only by scientists, but also by coaches and competitors of this sport. But, on the other hand, the consequent variability of each event (row of the record or multievent in GSEQ terminology) that entails the complexity of the observation instrument indicates the convenience of reducing the number of dimensions to be incorporated in the detection of *T-patterns* with the THEME software so that regular behavior structures can be obtained.

Conclusions: In this work we present a concrete example of a targeted process of selecting *T-patterns* through the tool provided by THEME to incorporate dimensions to the search process that, in addition, is enriched with the subsequent application of qualitative and quantitative filters.

Keywords: metodología observacional; judo; análisis de combate; T-patterns.

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1. Introduction

Judo is a combat sport on which you can find abundant scientific literature, which collects information as disparate as that referring to the quantification of the effectiveness of the techniques used by judo, the energy demands of judo fighting, injuries most common of its practitioners or the temporal structure of the fighting. All the information provided by the different investigations is of great value to the specialist judo technician, who will have a better chance of success in his task if, in addition to his own experience, he bases his decisions as a coach on the scientific evidence provided by these studies.

At a technical and tactical level, it is not enough to analyze the judoka's behavior in isolation, the interaction that takes place between both opponents must be studied, since one's behavior is conditioned by the actions of his rival. For this reason, the objective of this research is to develop an observation system *ad hoc* that allows us to interpret the exchange of actions maintained by athletes during the judo match, in order to subsequently design training sessions with solid scientific support.

The present work aims to demonstrate the operation of the observational tool designed, based on a) the information contained in the records -data packages- and b) of the regular behavior structures (*T-patterns*) detected. In the analysis of the behavior records obtained by means of observation instruments constructed *ad hoc*, THEME generates an output of T-patterns, based on more or less restrictive search parameters, among which it is necessary to navigate selecting those that are more relevant to the study objectives. The profusion of *T-patterns* is usually a fact when handling large samplings even when including very restrictive search parameters (see Lapresa, Arana, Anguera, and Garzón, 2013); but the opposite can also be the case, mainly due to short samplings or a high vertebration of records, which makes it difficult to detect regular behavior structures. In this work we present a concrete example of a targeted process of selecting *T-patterns* in a high vertebrated register, through the tool provided by THEME to incorporate dimensions to the search process that, in addition, is enriched with the subsequent application of qualitative and quantitative filters.

2. Method

2.1. Observational design

According to Anguera et al. (2011) this study was punctual (records of a single competition but without doing an individualized follow-up of the judokas that competed in it), nomothetic (36 judokas) and multidimensional (taking into account different co-occurrence behaviors in the same registry, that corresponded to the different criteria that made up the observational instrument). The observation was active and non-participant (Anguera, 1990).

2.2. Participants

The sample of this investigation was made up of the judoka (n=36) who participated in the combats (n=30) corresponding to the semifinals (n=12), finals (n=6) and dispute for third to fifth place (n=12) of the six Olympic modalities of the Rio 2016 Olympic Games (less than 48 kg, less than 63 kg and more than 78 kg in the women's category, and less than 60 kg, less than 81 kg and more than 100 kg in male category). In this study, the ethics criteria described

in the Declaration of Helsinki, reviewed in Fortaleza (Brazil) in 2013 (World Medical Association, 2013) were respected, and the project in which it was found integrated was approved (0099S/2912/2010 2607/LA) by the clinical research ethics committee of the sports administration of Catalonia (2005).

2.2. Observation and recording instruments

To obtain all the information regarding the techniques and tactics used by judokas during the judo matches to be analyzed, an observation instrument was designed *ad hoc*, which was called JUDOBS, which is a combination of field format and systems of categories, made up of 52 criteria and 555 categories. The analysis possibilities provided by the designed observation instrument and its adaptations used in this study are diverse. Table 1 presents the adaptation that was made of JUDOBS to analyze the behavior patterns of the Olympic champions, but an adaptation was also made to determine the existing T-patterns in the exchange of actions between judoka, not focusing on a specific judoka but the one who performs the first action in each of the recorded events. In this way, it is possible to analyze if any pattern of behavior exists when a specific judo technique is performed in certain circumstances, regardless of who is the judoka who performs it. The data was recorded and encoded using the software Lince, version 1.2.1 (Gabín et al., 2012).

2.3. Data quality

The panel of experts involved in the validation of JUDOBS was made up of a total of 28 judo coaches. The statistic used to validate this instrument was the calculation of the percentage of positive matches, which was 0.809 as there were 8258 matches out of a total of 10206 possible matches/discrepancies. To obtain the confidence intervals we assume the binomial model taking into account 8258 successes over 10206 possible options, applying the binom.test function of R to obtain 95% confidence intervals starting from the number of successes (coincidences) on the total number of trials (possible matches/discrepancies). The resulting values returned a 95% confidence interval (CI), between 0.801 and 0.817, for the proportion of positive matches of a 0.809 probability.

To assess intraobserver reliability, one observer analyzed 5 combats twice, with values obtained criterion by criterion by Fleiss's Kappa (1971) of between 0.911 to 1 (with an average of 0.988 in all Kappa values). The Iota coefficient (Janson & Olsson, 2001) of the set of agreements of both observers in all criteria was 0.977. Interobserver reliability was determined by calculating the agreement between the records of three observers who analyzed these same combats, with values obtained criterion by criterion by Alpha Krippendorff (2018) of between 0.664 to 1 (with an average of 0.941 in all values Alpha). The Iota coefficient (Janson & Olsson, 2001) of the set of agreements of both observers in all criteria was 0.932.

Table 1. Adaptation of JUDOBS that contains the criteria and categories that were activated for the detection of regular behavior structures of the six champions of the Rio 2016 Olympic Games.

Criteria	Codes and categories
Scoreboard situation	EMPATE: matched score; GANANDOC: champion ahead on the scoreboard; GANANDOO: opponent is ahead on the scoreboard
Duration	HAJ: hajime; MAT: matte
Combat time	TI: first minute; TII: second minute; TIII: third minute; TIV: fourth minute; TV: fifth minute; GS: golden score
Stand or floor action	TW: tachi waza; NW: ne waza
Tatami placement of who initiates the 1st action	CCT / OCT: champion / opponent on the center of the tatami; CLTE / OLTE: champion / opponent on the line and not facing it; CLTC / OLTC: champion / opponent on the line and facing it
Scoring	NC / NO: nothing for the champion / opponent; YC / YO: yuko for the champion / opponent; WC / WO: waza ari for the champion / opponent; IC / IO: ippon for champion / opponent
Kumi kata of the champion previous to the 1st action	KCIMDS / KCIMIS: one hand_right / left on flap; KCIMDM / KCIMIM: one hand left / right on sleeve; KCSK: no kumi kata; KCIIMC: classic_sleeve and flap; KCIIMA: two-handed_high; KCIIM: on two sleeves; KCIIS: on two flaps; KCCS: flap cross; KCCA: high cross; KCCMDU: crossed uke right sleeve; KCCMIU: crossed uke left sleeve; KCCIIM: one hand waist and the other on sleeve; KCCIM: one hand waist; KCAIM: high on one hand
Kumi kata of the opponent previous to the 1st action	Same as above but with the opponent's kumi kata (KOIMDS; KOIMIS; KOIMDM; KOIMIM; KOIIMC; KOIIMA; KOIIM; KOIIS; KOCS; KOCA; KOCMDU; KOCMIU; KOSK; KOCIIM; KOCIM; KOAIM)
Action 1	IPSNC / IPSNO: ippon seoi nage from the champion / oponnent; ISNC / ISNO: seoi nage from the champion / oponnent; ISOC / ISOO: seoi otoshi from the champion / oponnent; ISNRC / ISNRO: seoi nage reverse from the champion / oponnent; IKGC / IKGO: kata guruma from the champion / oponnent; ITOC / ITOO: tai otoshi from the champion / oponnent; IUMSC / IUMSO: uchi mata sukashi from the champion / oponnent; IOGC / IOGO: o goshi from the champion / oponnent; IKOGC / IKOGO: koshi guruma from the champion / oponnent; IHRGC / IHRGO: harai goshi from the champion / oponnent; IUGC / IUGO: ushiro goshi from the champion / oponnent; ISTGC / ISTGO: sode tsurikomi goshi from the champion / oponnent; IDABC / IDABO: de ashi barai from the champion / oponnent; IHIGC / IHIGO: hiza guruma from the champion / oponnent; IOSGC / IOSGO: o soto gari from the champion / oponnent; IOUGC / IOUGO: o uchi gari from the champion / oponnent; IUMC / IUMO: uchi mata from the champion / oponnent; ISTAC / ISTAO: sasae tsurikomi ashi from the champion / oponnent; IKUGC / IKUGO: ko uchi gari from the champion / oponnent; IOSGAC / IOSGAO: o soto gaeshi from the champion / oponnent; IOUGAEC / IOUGAEO: o uchi gaeshi from the champion / oponnent; ITNC / ITNO: tomo nage from the champion / oponnent; ISGC / ISGO: sumi gaeshi from the champion / oponnent; IUNC / IUNO: ura nage from the champion / oponnent; ISMC / ISMO: soto makikomi from the champion / oponnent; IYGC / IYGO: yoko guruma from the champion / oponnent; IKUMC / IKUMO: ko uchi makikomi from the champion / oponnent; IKEGC / IKEGO: kesa gatame from the champion / oponnent; IKSGC / IKSGO: kami shiho gatame from the champion / oponnent; IYSGC / IYSGO: yoko shiho gatame from the champion / oponnent; ITSGC / ITSGO: tate shiho gatame from the champion / oponnent; INJJC / INJJO: nami juji jime from the champion / oponnent; IHJC / IHJO: hadaka jime from the champion / oponnent; IOEJC / IOEJO: okuri eri jime from the champion / oponnent; IKJC / IKHO: kataha jime from the champion / oponnent; IKTJC / IKTJO: kata te jime from the champion / oponnent; ISJC / ISJO: sankaku jime from the champion / oponnent; IGJJC / IGJJO: gyaku juji jime from the champion / oponnent; IKJGC / IKJGO: kata juji gatame from the champion / oponnent; IUGRC / IUGRO: ude garami from the champion / oponnent; IJGC / IJGO: juji gatame from the champion / oponnent; IUGAC / IUGAO: ude gatame from the champion / oponnent; IHGC / IHGO: hiza
Actions 2 to 4	The categories of action 1 are repeated but for actions 2 to 4 (replacing the initial "I" of each criterion "II", "III" or "IV")
Winner of the combat	GC / GO: Combat won by champion / opponent

2.4. Data analysis with Theme

The detection of regular behavior structures (*T-patterns*) has been resorted to using the *software* THEME (version 6.Edu) (Magnusson, 1996, 2000). The selected search parameters, which guarantee that the detected T-pattern is not a product of chance, have been the following (for more information see the reference manual; PatternVision Ltd & Noldus Information Technology bv, 2004): a) a frequency of occurrence equal to or greater than 2 has been set; b) a significance level of 0.005 has been used, which means that the percentage of accepting a critical interval due to chance is 0.5%; c) Redundancy reduction has been set so that the *T-pattern* is not incorporated into the output of Theme if more than 90% of the occurrences of a new *T-pattern* start and end coinciding with the critical interval relationships of patterns already detected; d) *fast requirement* has been deactivated at all levels, selecting the critical interval mode *Free*. Taking into account the works of Lapresa, Arana et al., (2013) and Lapresa, Anguera et al., (2013), the detection of T-patterns has been realizaed under the order parameter, assigning a constant duration to each unit of behavior -row of the registry-, which allows to deduce if the behaviors reflected in the T-pattern are consecutive or if there are intercalated behaviors between the detected multi-events.

3. Results

As an example of the operation of the observation system built, Figure 1 presents: a) the data package corresponding to the record of the combat of the semifinals of the less than 48 kg female category, disputed by the judokas Pareto (Argentina) and Kondo (Japan) and b) one of the T-patterns detected that, including the performance of technical-tactical actions, reflects regular behavior patterns of the judoka Pareto and, only, from data package that corresponds to a single combat.

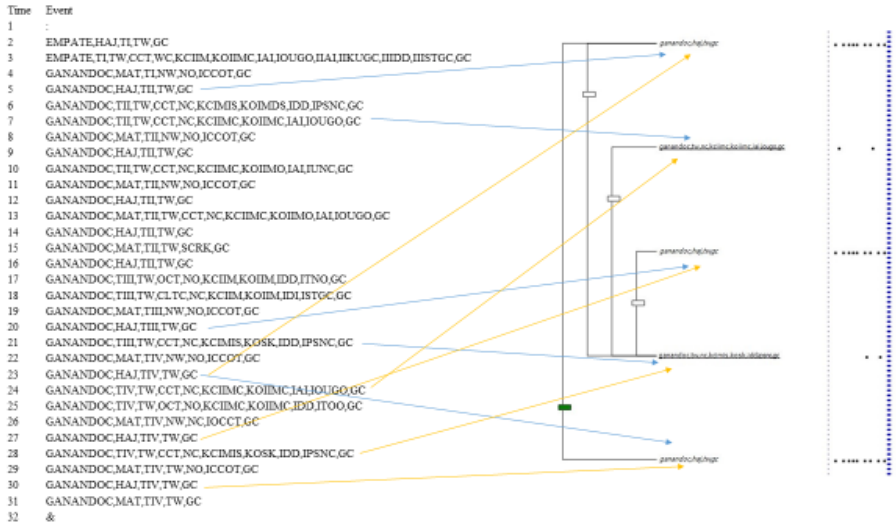

Figure 1. Data pack corresponding to the Pareto vs Kondo semifinal match of the female category of less than 48 kg of the Rio 2016 Olympic Games and dendogram of the selected T-pattern to demonstrate the operativity of the observation instrument. The arrows highlight the events that make up the T-pattern in each of the two occurrences.

Specifically, the *T-pattern* ((ganandoc, haj, tw, gc (ganandoc, tw, nc, kciimc, koiimc, iai, iougo, gc (ganandoc, haj, tw, gc ganandoc, tw, nc, kcimis, kosk , idd, ipsnc, gc))) ganandoc, haj, tw, gc), is made up of five events -Theme terminology; multi-events in GSEQ terminology- that are repeated twice. The first occurrence is made up of rows 5-7-20-21-23 from the registry; and the second occurrence of rows 23-24-27-28-30. The information contained in the T-pattern shows us that during these sequences of actions, in which the one who was the Olympic Champion (Pareto) was always winning on the scoreboard. The following behavior pattern was repeated significantly during combat in the interaction between both judokas: classic sleeve grip and flap of both judokas, Kondo makes attacks by O Uchi Gari on the right, without obtaining a result, while Pareto makes attacks by Ippon Seoi Nage on the right, also without scoring. From the reading of this pattern of behavior it can be interpreted that the Japanese judoka tries to make attacks backwards, probably due to the defensive posture of her winning rival. And the Argentine judoka takes advantage of this circumstance to make attacks forward thanks to Kondo's risky attitude, in the attempt to overcome the scoreboard. The usefulness of these results is high, as it shows the offensive profile of the Japanese judoka at times when she must risk to overcome a result, at the same

time that we know what Pareto does to contain that situation without being sanctioned by passivity and how the attitude and direction of the rival attacks are used.

3.1. T-patterns

At this point, and in the same way that the researchers who use THEME for their corresponding works, we are faced with the need to select the T-patterns to present from the total of the T-patterns detected in the search of all thirty combats (five per category studied: 48F, 1-5; 63F, 6-10; 78F, 11-15; 60M, 16-20; 81M, 21-25; 100M, 26-30).

Of the T-patterns detected in the analysis of the 30 combats, specifically, in the exchange of actions between judokas -when the focus is on who takes the initiative and performs the first action, which we will call "p" (and its rival will be "q")- including in the search all the variable criteria of the observation instrument, the T-pattern detected with the greatest scope is presented: ((pdqz, tie, haj, ti, tw, gp pdqz, tie, haj, ti, tw, gp)((pdqz, tie, haj, tii, tw, gp pdqz, tie, haj, tii, tw, gp) ((pdqz, tie, haj, tiii, tw, gp pdqz, tie, haj, tiii, tw, gp) (pdqz, tie, haj, tiv, tw, gp pdqz, tie, haj, tiv, tw, gp)))), with occurrence in combat 18 (category 60M) and 21 (category 81M), and with an average of the internal intervals between its multi-events constitutive of: 3,50-3,50-2-2,50-2,50-2,50-2. Although we could also consider interesting the T-pattern that occurs in a greater number of combats such as (pdqz, tie, haj, ti, tw, gq pzqd, tie, haj, tii, tw, gp), with occurrences in combats 5-9-20-23-25-29; and with an average of its internal intervals of 6-5-7-2-3-5.

Now, if we look at the information that these *T-patterns* contain, we will see that in all the multi-events the row of the record corresponding to the action of the combat by the referee is reflected. So, as may be usual, in this case the most frequent multi-events are those that are reflected in the *T-patterns*. But, on the other hand, the consequent variability of each event (row of the record or multievent in GSEQ terminology) that entails the complexity of the observation instrument indicates the convenience of reducing the number of dimensions to be incorporated in the detection of *T-patterns* with the THEME software so that regular behavior structures can be obtained.

At this point and from the activation tool dimension presented by THEME, we proceed to detect regular behavior structures activating the punctuation, kumikata prior to the 1st action of both judoka, type of techniques performed within the exchange of actions, and duration dimensions. As the categories that make up this last dimension, *hajime* –activation of the combat by the referee-, and *mate* -interruption of the combat by the referee- are inherent to the structure of the registry, we decided to select for presentation those *T-patterns* that provide more information than that contained in said rows of the record.

Furthermore, we may be interested in: a) *T-patterns* that are detected in the same category (weight / masc-fem), such as the *T-pattern* (((mat, nq haj)(mat, nq haj))((mat, np haj) np, kpimis, kqsk, ipsnp)), which occurs in combats 2 and 5, category 48F, with the average of the internal intervals 1-2-1-8-1-1; b) or T-patterns that are detected in various categories, such as the *T-pattern* ((haj (mat ha j)) mat, np, kpiim, kqiim, istgp), which takes place in fights 1, 5 and 26 (40F and 100M), with a mean of internal intervals=6; c) or, perhaps, regular structures of conduct that are repeated intra-combat, such as *T-pattern* (mat, np, kpcs, kqsk, iosgp mat, np, kpcs, kqsk, iosgp), which takes place in the combat 22 (category 81M) with an average of internal intervals=4 (that is, with three rows of the register interspersed).

But it could also be interesting to study the technical-tactical performance of the competitors without considering their effectiveness; for this, we would deactivate the Point criterion from the search; and respecting the three decisions made in the previous paragraph, we find: a) *T-patterns* that are detected in the same category (weight / male-fem), such as *T-pattern* (mat, kpiima, kqiimc, iougp (kpiim, kqiim, istgp (mat haj))) that occurs in combats 1 and 2, category 48F, with the average of the internal intervals 6-1-1; b) *T-patterns* that are detected in various categories, such as *T-pattern* (kpiim, kqiimc, idabp kpiim, kqiimc, istgp), which takes place in combats 4-17 (40F and 60M), with an average of internal intervals of 2-1-1.67. c) *T-patterns* that occur intra-combat (kpiimc, kqiimc, idabp, iiump mat, kpiimc, kqiimc, idabp, iiump), which occurs twice in combat 8 (category 63F) with an average of intervals internal =3 (that is, with two rows of the record interspersed).

4. Conclusions

The operativity of the observation system is supported by the data package presented as an example of the registry (that of one of the semifinals of the female category of 48 kg), and the informative power of the *T-patterns* detected that show regular structures in the behavior displayed in a single match by the judoka who ended up becoming the Olympic champion in the category of less than 48 kg. The record that configures each data package allows us to represent what happens in the course of a judo match, based on the structure that underpins the observation instrument. This representation facilitates the understanding of the behavior developed by judoka in combat. In addition, the detection of regular behavior structures (T-patterns) has been used through the software Theme (version 6.Edu) (Magnusson, 1996, 2000) within the data package corresponding to the semifinal match of less than 48 kg played by Pareto and Kondo. The presented *T-pattern* provides detailed information (synchronous and diachronic), on regular guidelines in the technical-tactical performance of the Olympic champion and her interaction with the rival, and in the course of a single combat.

The consequent variability of each event that entails the complexity of the observation instrument indicates the convenience of reducing the number of dimensions to be incorporated in the detection of *T-patterns* with the THEME software so that regular behavior structures can be obtained. In this work a concrete example of a targeted process of selecting *T-patterns* through the tool provided by THEME has been presented to incorporate dimensions to the search process that, in addition, has been enriched with the subsequent application of qualitative and quantitative filters.

References

American Psychological Association (2002). Ethical principles of psychologists and code of conduct. Metodología *American Psychologist*, 57(12), 1060-1073. https://doi.org/10.1037/0003-066X.57.12.1060

Anguera, M.T. (1990). observacional. En J.Arnau, M.T. Anguera y J. Gómez, (Eds.), *Metodología de la investigación en ciencias del comportamiento* (pp. 125-238). Murcia, España: Universidad de Murcia.

Anguera, M.T., Blanco-Villaseñor, A., Hernández-Mendo, A., & Losada, J.L. (2011). Diseños observacionales: ajuste y aplicacion en psicología del deporte. *Cuadernos de Psicología del Deporte, 11*(2), 63-76.

Bakeman, R. (1978). Untangling streams of behavior: sequential analysis of observation data. En G.P. Sackett (Ed.) *Observing Behaviour, Vol. II: Data Collection and Analysis Methods* (pp. 63-78). Baltimore: University Park Press.

Fleiss, J.L. (1971). Measuring nominal scale agreement among many raters. *Psychological Bulletin, 76*, 378-382.

Gabin, B., Camerino, O., Anguera, M.T., y Castañer, M. (2012). Lince: multiplatform sport analysis software. *Procedia-Social and Behavioral Sciences*, 46, 4692-4694. https://doi.org/10.1016/j.sbspro.2012.06.320

Janson, H., & Olsson, U. (2001). A measure of agreement for interval or nominal multivariate observations. *Educational and Psychological Measurement, 61*(2), 277-289.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Beverly Hills, Sage publications.

Lapresa, D., Anguera, M.T., Alsasua, R., Arana, J. y Garzón, B. (2013). Comparative analysis of T-patterns using real time data and simulated data by assignment of conventional durations: the construction of efficacy in children's basketball. *International Journal of Performance Analysis in Sport*, 13(2), 321-339. https://doi.org/10.1080/24748668.2013.11868651

Lapresa, D., Arana, J., Anguera, M.T. y Garzón, B. (2013). Comparative analysis of the sequentiality using SDIS-GSEQ and THEME: a concrete example in soccer. *Journal of Sports Sciences*, 31(15), 1687-1695. https://doi.org/10.1080/02640414.2013.796061

Magnusson, M.S. (1996). Hidden real-time patterns in intra- and inter-individual behavior. *European Journal of Psychological Assessment*, 12(2), 112-123. https://doi.org/10.1027/1015-5759.12.2.112

Magnusson, M.S. (2000). Discovering hidden time patterns in behavior. *T-patterns and their detection. Behavior Research Methods, Instruments y Computers*, 32(1), 93-110. https://doi.org/10.3758/BF03200792

PatternVision Ltd & Noldus Information Technology bv (2004). *Theme, powerful tool for detection and analysis of hidden patterns in behaviour*. Reference manual, version 5.0. Wageningen: Noldus Information Technology bv.

World Medical Association. (2013). *World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects.* Jama, 310 (20), 2191. Doi: 10.1001/jama.2013.281053