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Abstract

This work shows the possibilities that observational analysis can offer to match analysis in Wheelchair Basketball, outlined in a study of the sequences that end in a shot, in the men's team considered to be the best in the world (USA), in the Tokyo Paralympic Games 2020. Data recording and coding the 527 sequences that end in a shot was carried out via the LINCE software, and inter-rater reliability guaranteed using Cohen's Kappa coefficient. Two diachronic behaviour analysis techniques – lag sequential analysis and T-pattern detection – were applied complementarily, thus allowing us to characterise effective and ineffective sequences. Effective behaviours are highlighted as being those which incorporate a final reception and shot by players with less functional limitation; or those in which the shot is made from the paint. Ineffective behaviours are those carried out by players with greater functional difficulty; or those which end in shots made from the offensive zone and external offensive zone.

INTRODUCTION

Wheelchair basketball (WB) is one of the main paralympic modalities for people with a physical impairment.[1,2] The International Wheelchair Basketball Federation (IWBF) establishes the official rules of the game which are similar to those of running basketball, with some adaptions – such as the use of a wheelchair – in order to facilitate participation by athletes with physical impairments.[3,4] In WB each player is classified by functional class (from 1.0 to 4.5), whereby the lower the functional class, the greater the athlete's motor limitation; the technical team should take the functional classification into account when choosing the initial five players, since it cannot exceed a total of 14 points.[5,6]

Wheelchair basketball is one of the adapted sports that has been the subject of examination by research in a range of areas, including physiology [7,8], training and sports performance [9,10], biomechanics [11,12], psychology [13,14], or sociology [15,16].

There are also match analyses being carried out on WB [17-21], some of which incorporate the players' functional class, as this work does [18]. Especially relevant to this work are match analyses of the USA squad's performance[22-24] carried out at the core of observational methodology, that will allow us to highlight similarities and differences in the game patterns of the USA team in the 2016 and 2020 Paralympic Games, in which the coach and eight of the twelve players were the same. What can be gleaned from the works mentioned throughout this paragraph are the similarities in performance between proximate functional classes, together with greater relevance in the game and in the scoreboard, of players with less functional limitation – also in women [25]–, although they show different kinematic shooting strategies [26].

The aim of this work is to show the possibilities that observational methodology can offer to match analysis in Wheelchair Basketball by carrying out a match analysis of the sequences that end in a shot, of the men's team considered to be the best in the world (USA), in the Tokyo Paralympic Games 2020, in which they were the champions.

METHOD

This research work was developed within the framework of observational methodology [27]. The observational design was idiographic, punctual with intra-sessional follow-up, and multidimensional [28]. It is idiographic in that it observes the winning team of the tournament. It is punctual because it studies the performance of the USA team in the Tokyo Paralympic Games 2020. At the same time, it is of intra-sessional follow-up since it records, frame by frame, the behaviours developed in each match that makes up the observation sample. Lastly, it is multidimensional since it studies the different behavioural dimensions that form the backbone of the observational instrument criteria; these can be grouped into: proxemics-type behaviours, which are related to the areas on the court where the actions take place; and gesture-type behaviours, which are identified with the different technical-tactical actions developed by the players in the offensive phase of the game.

Participants

This research work will study each and every sequence that ends in a shot, carried out by the USA men's Wheelchair Basketball team that won all seven matches in the last Tokyo Paralympic Games (2020) which took place between the 25th August and the 5th December of 2021. In accordance with the Results Book of Wheelchair Basketball Competitions (Paralympic Games, 2020), the "jersey number" (fixed) with which the players and their "functional class" were identified was: players 6 and 33 (1.0); player 7 (2.0); players 2 and 16 (2.5); player 5 (3.0); players 4, 9 and 11 (3.5); player 1 (4.0); and players 8 and 15 (4.5).

The recordings of the matches in which the winning team of the competition, USA, took part, were obtained from the International Paralympic Committee's open-source video channel (https://www.youtube.com/user/ParalympicSportTV). Table 1 below shows information relating to the observation sample. This research work has been approved by the Research Ethics Committee of the University of xxxx (document Nº 25238).

Tabla 1: Observation sample that forms the basis of the research.

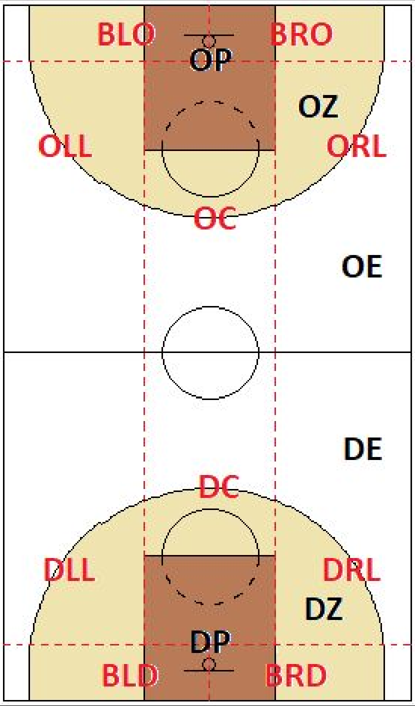
USA Rival	Sequences that end in a shot	From 2 points	From 3 points	USA Accumulated sequences
Great Britain (Group B)	71	64	7	1-71
Australia (Group B)	68	60	8	72-139
Germany (Group B)	59	57	2	140-198
Iran (Group B)	71	64	7	199-269
Algeria (Group B)	68	62	6	270-337
Turkey (Quarter finals)	63	54	6	338-400
Spain (Semifinal)	62	48	15	401-462
Japan (Final)	65	59	6	463-527

Observation Instrument

This work used the wheelchair basketball adaptation completed by Alsasua et al. [21] of the SOBL-2 designed by Fernández et al. [29] for running basketball. It is a combination of field format and exhaustive and mutually exclusive category systems [30].

Table 2. Observation instrument.

Dimension	Category (codes)
Laterality	Offensive Right Lateral (ORL); Bottom Right Offensive (BRO); Offensive Centre (OC); Offensive Left Lateral (OLL); Bottom Left Offensive (BLO); Defensive Right Lateral (DRL); Bottom Right Defensive (BRD); Defensive Centre (DC); Defensive Left Lateral (DLL); Bottom Left Defensive (BLD)
Area	Offensive exterior (OE); Offensive zone (OZ); Offensive paint (OP); Defensive exterior (DE); Defensive zone (DZ); Defensive paint (DP)
Game action	Ball recovered (BR); Defensive rebound (DR); Offensive rebound (OR); Penultimate pass (P1); Penultimate reception (R1); Last pass (P2); Last reception (R2); New possession (NP); Shot (SH)
Completion	Favourable: Score (SC), Received foul (RF) and Score and Foul (A1). Unfavourable: Miss (MS), Violation/foul in attack (VI) and Block (BL)
Game start	Ball in Play (BP); Offensive throw-in (OT); Offensive bottom throw-in (OBT); Initial jump (IJ); Defensive bottom throw-in (DFT); Defensive throw-in (DT); Free shot (FS)
Functional class	Class 1.0 (H10); Class 1.5 (H15); Class 2.0 (H20); Class 2.5 (H25); Class 3.0 (H30); Class 3.5 (H35); Class 4.0 (H40); Class 4.5 (H45)
Player	Player-number 1 (J1) ...



Recording and Coding

Data recording and coding of the 527 sequences that end in a shot (see Table 1), was done via the open-source software LINCE [http://lom.observesport.com/] [31]. These sequences are made up of the shot and up to five prevous actions – six rows of the record including the shot. In accordance with Bakeman's classical typology [32], the obtained data were type IV, concurrent and time-based. Similarly, in line with the new data typology produced by Bakeman and Quera [33] for the development of the GSEQ software, the data type is multi-event, in keeping with the fact that the observational design is multidimensional. The records obtained in the LINCE programme were automatically recoded by Lince for subsequent analysis in GSEQ5 and THEME.

Data Reliability

Two observers were given the task of recording the data that forms the base of this study – the first recorded the whole observation sample, while the second randomly re-observed more than 10% of the total sequences for each match. The observers received training in three phases, as proposed by Arana et al. [34], following on from Anguera [35]. Taking into account the classical reference values of Landis and Koch [36], the results corresponding to Cohen's Kappa [37] – calculated at the core of the LINCE software – which reflect the agreement of the records corresponding to each match (Great Britain - USA, 0.967; USA-Australia, 0.965; USA-Germany, 0.953; USA-Iran, 0.965; USA-Algeria, 0.947; USA-Turkey, 0.934; Spain-USA, 0.958; USA-Japan, 0.948) have an "almost perfect" agreement.

Data Analysis

This work used two of the most relevant and current diachronic analysis techniques, featured in each of the open-source software: lag-sequential analysis [32] and T-pattern detection [37].

The lag-sequential analysis [38] was carried out with the open-source software, GSEQ [https://www.mangold-international.com/en/products/software/gseq.html] [33]. This software enables the calculation of adjusted residuals between criteria – or given – behaviours and conditioned – or target – behaviours, and the subsequent interpretation of the statistically significant differences between the conditioned (from the observed frequencies) and unconditioned probabilities (from expected frequencies), in the successive observed lags. GSEQ is mainly used in research with multi-event sequential data [40], as is the case with this work.

Firstly, we determined whether or not there was a relationship between the “laterality”, “area”, “functional class” and “game action” dimensions or criteria, and the criterium “completion consequence”. A local analysis was then carried out – the calculation of the residuals adjusted to the corresponding cell – always on the condition that, via Pearson’s χ^2 test, the frequencies in the contingency table were not distributed at random.

According to Bakeman and Quera [41], the adjusted residual is positive if the observed or conditioned frequency is greater than chance, and negative if it is lower than chance. According to Bakeman and Gottman [42]: transitions greater or equal to 1.96 ($p<0.05$), represent a higher probability of occurrence than that expected by chance (activation relationship between the behaviour criterion and conditioned behaviour); and the transitions less than or equal to -1.96 ($p<0.05$), represent a lower probability of occurrence than expected by chance (inhibition relationship between the behaviour criterion and conditioned behaviour).

The calculation of the adjusted residuals was carried out taking into account: a) the logic of the observation instrument; and b) that according to Lapresa et al. [43], from lag -5 (and +5) the sequential patterns of behavior seem to weaken and become diluted. In this way, we analysed both the lag 0 or co-occurrence – the row of the record corresponding to a shot on the basket –, and the retrospective perspective (the five behaviours that occur before the behaviour criterion – five rows of the previous record).

T-pattern detection was also used via the open-source THEME software (v.6 Edu) [www.patternvision.com] [39,44,46], that enables the detection of regular patterns of behaviour hidden in the record. Although the main contribution of THEME is the detection of temporal patterns, this software also offers the possibility of detecting sequential structures under the order parameter, from the assignment of a constant duration to each unit of behaviour. This provides some highly relevant possibilities for the analysis of sequentiality, by allowing us to deduce if the behaviours are consecutive or if there are gaps in the T-pattern (interspersed behaviours) between the detected multi-events [43,45].

The selected search parameters were those listed below (see reference manual: *PatternVision Ltd* and *Noldus Information Technology bv*, 2004) [46]: a) the *T-patterns fast* type was used, whereby the lower time limit of the critical interval is set at a value equal to 0, so that the components of the critical interval tend to occur relatively quickly in succession; b) a minimum number of occurrences equal to or greater than 5 was set; c) significance level of 0.005, i.e. the percentage of accepting a critical interval due to chance is 0.5%.

Once the T-pattern selection search had been carried out, as qualitative filters [47] we applied the selection of T-patterns that: a) incorporate the multi-event "completion" – corresponding to the shot; b) the average of the internal intervals between their multi-events is equal to 1, thus guaranteeing that the multi-events reflected in the T-pattern corresponded to consecutive behaviours in the record.

RESULTS

Firstly, we will present the lag-sequential analysis results, followed by the T-patterns detected with the stated search parameters and qualitative filters [47], which have allowed us to characterise effective and ineffective type sequences.

Tables 3, 4 and 5 below show the significant adjusted residuals (activation or inhibition relationships) of those dimension intersections – in the considered lags – in which a relationship of significant statistical association was established ($p < .05$) via Pearson's χ^2 statistic. The left column shows the criteria or given behaviours (corresponding to the criterium "completion consequence"), and in the top row the conditioned or *target* behaviours (corresponding to the criteria "laterality", "area" and "functional class"). In the corresponding cells, firstly the lag is shown (L0= record row corresponding to completion; L-1= lag -1, corresponds to the row prior to the completion; L-2, two rows before, etc.); and then, in brackets, the value of the adjusted residual corresponding to that lag. As an example, in table 3 it can be seen how the given behaviour "score" (SC) has an activation relationship with one last pass – the behaviour that in general supposes lag -2 – taken from the offensive centre (OC), and a relationship of inhibition with the categories bottom left offensive (BLO) and offensive right lateral (ORL).

Table 3. Lag-sequential analysis between the given categories of the dimension "shot consequence" –Score and Foul (A1); Score (SC); Miss (MS); Received foul (RF); Block (BL)– and the target behaviours corresponding to the dimension "laterality" –Defensive Centre (DC); Defensive Left Lateral (DLL); Defensive Right Lateral (DRL); Bottom Right Defensive (BRD); Offensive Centre (OC); Bottom Left Offensive (BLO); Bottom Right Offensive (BRO); Offensive Right Lateral (ORL)–.

	DC	DLL	DRL	BRD	OC	BLO	BRO	ORL
A1		L-2 (2.13)	L-2 (2.95)	L-1 (4.24)	L-2 (-2.31)			
SC					L-2 (2.21)	L-2 (-2.23)		L-2 (-2.35)
MS	L-2 (-2.46)	L-1 (2.2)				L-2 (2.56)	L-1 (-3)	L-2 (2.55)
RF			L-1 (1.97)				L-1 (2.19)	
BL						L-1 (3.75)		

Table 4. Lag-sequential analysis between the given categories of the dimension “shot consequence” and the target behaviours corresponding to the dimension “area”.

	Defensive exterior	Offensive exterior	Defensive paint	Offensive paint	Offensive zone
Score and Foul	L-2 (3.26)			L-1 (2.32); L0 (3.26)	L-1 (-2.69); L0 (-2.6)
Score		L-1 (-3.22); L0 (-2.91)		L0 (2.42)	
Miss	L-2 (-2.03)	L-2 (2.55); L-1 (4.38); L0 (4.01)	L-2 (-2.69)	L-1 (-3.87); L0 (-5.69)	L0 (3.11)
Received foul			L-2 (2.36)	L-1 (4.07); L0 (5.11)	L-1 (-2.9); L0 (-3.99)
Block				L-1 (2.58)	

Table 5. Lag-sequential analysis between the given categories of the dimension “shot consequence” and the target behaviours corresponding to the dimension “functional class”.

	Class 1.0	Class 3.5	Class 4.0	Class 4.5
Score and Foul		L0 (2.47)		
Score				L-1 (2.81); L0 (2.93)
Miss				L-1 (-2.65); L0 (-2.54)
Received foul			L-1 (2.82); L0 (2.98)	
Block	L-1 (3.8); L0 (3.8)			

Tables 6 and 7 show the T-patterns detected in accordance with the aforementioned search parameters that include the completion multi-event which includes the shot. Table 6 shows those effective sequences that end in a converted shot; while Table 7 shows ineffective sequences – those which end in a failed shot. To aid better understanding of the information contained in the multi-events of the detected T-patterns, effective (Figure 1) and ineffective (Figure 2) type sequences have been characterised.

Table 6. Detected T-patterns that reflect effective sequences, including: the number of occurrences, the sequences in which they take place, the zone and side where the shot is taken from, and the "functional class" of the player who makes is.

T-pattern	Occurrences	Sequences
(blo,op,r2,h25 blo,op,sh,sc,h25)	7	174-197-281-289-334-422-511
(bro,op,r2,h45 bro,op,sh,sc,h45)	7	84-198-250-341-347-364-517
(orl,oz,r2,h25 orl,oz,sh,sc,h25)	7	20-105-165-179-180-366-417
(blo,oz,r2,h25 blo,oz,sh,sc,h25)	6	66-80-310-331-395-410
(bro,op,r2,h35 bro,op,sh,sc,h35)	6	79-110-119-316-407-455
(oll,oz,r2,h25 oll,oz,sh,sc,h25)	6	156-169-283-288-314-392
(orl,oz,r2,h35 orl,oz,sh,sc,h35)	6	50-200-201-284-381-497
(blo,op,r2,h25 blo,op,sh,rf,h25)	5	13-219-433-490-515
(blo,op,r2,h45 blo,op,sh,sc,h45)	5	102-155-178-355-435
(bro,op,r2,h25 bro,op,sh,sc,h25)	5	56-333-396-447-454
(bro,oz,r2,h35 bro,oz,sh,sc,h35)	5	29-31-375-443-504
(bro,oz,r2,h45 bro,oz,sh,sc,h45)	5	21-82-181-196-353

Table 7. Detected T-patterns that reflect ineffective sequences, including: the number of occurrences, the sequences in which they take place, the zone and side where the shot is taken from, and the "functional class" of the player who makes is.

T-pattern	Occurrences	Sequences
(bro,oz,r2,h25 bro,oz,sh,ms,h25)	9	14-157-173-191-240-254-266-317-370
(orl,oe,r2,h35 orl,oe,sh,ms,h35)	9	6-70-83-189-202-300-372-415-496
(orl,oz,r2,h35 orl,oz,sh,ms,h35)	9	10-32-39-48-148-411-500-502-516
(blo,op,r2,h25 blo,op,sh,ms,h25)	8	68-85-86-210-239-253-361-438
(oll,oz,r2,h25 oll,oz,sh,ms,h25)	8	159-162-214-242-356-369-394-448
(oc,oz,r2,h25 oc,oz,sh,ms,h25)	7	113-123-223-308-380-405-501
(blo,op,r2,h45 blo,op,sh,ms,h45)	6	72-91-97-145-357-402
(blo,oz,r2,h25 blo,oz,sh,ms,h25)	6	60-117-175-193-264-373
(bro,op,r2,h25 bro,op,sh,ms,h25)	5	215-216-330-383-425
(bro,op,r2,h45 bro,op,sh,ms,h45)	5	183-271-276-464-521
(oc,oe,r2,h25 oc,oe,sh,ms,h25)	6	22-413-426-430-453-459
(oc,oe,r2,h35 oc,oe,sh,ms,h35)	6	100-221-263-358-449-482
(oc,oz,r2,h20 oc,oz,sh,ms,h20)	6	35-40-41-146-336-344
(orl,oe,r2,h25 orl,oe,sh,ms,h25)	6	38-63-116-247-295-420
(oll,oe,r2,h25 oll,oe,sh,ms,h25)	6	236-320-351-397-408-423
(oc,op,r2,h35 oc,op,sh,ms,h35)	5	11-24-118-374-486
(oc,oz,r2,h35 oc,oz,sh,ms,h35)	5	74-218-365-398-431

DISCUSSION

Observational methodology [27], from being justifiably considered mixed method in itself [30], has developed its own quantitizing pathway from the option "connect" [49] that enables alternation of the QUAL-QUAN-QUAL stages [50], and which is being widely applied in different fields, including sport.

This article aims to show the possibilities that observational methodology offers to match analysis in Wheelchair Basketball, thanks to its ability to record behaviours spread out over time that enable us to detect the existence of regular behavioural structures hidden in the record. [27]

The methodological aim was fulfilled through a match analysis of the sequences that end in a shot in the team considered to be the best in the world (USA), in the Tokyo Paralympic Games 2020.

Lag-sequential analysis results

Effective and ineffective behaviours were detected in the statistically significant results obtained from the analysis of adjusted residuals in the lag 0 or co-occurrence. In terms of the dimension "area", sequences characterised as effective were those in which the shot was made from the paint (OP-SC: L0=2.42; OP-RF: L0=5.11; OP-A1: L0=3.26; OP-MS: L0=-5.69). The paint is the most effective place for completing shot sequences, both in wheelchair basketball [24,25] and in running basketball [17,29,53]. On the other hand, sequences characterised as ineffective were those in which the shot was taken from the offensive zone, due both to their association with shot failure, and the inhibition relationship when faced with the possibility of fouls in favour, with or without an additional shot (OZ-MS: L0=3.11; OZ-A1: L0=-2.6; OZ-RF: L0=-3.99). This result had already been detected [22] in the USA team that dominated the Paralympic Games in Rio de Janeiro, 2016. Other studies propose the offensive zone as ineffective and infrequent both in running basketball [17,29,53] and wheelchair basketball, although it is more used in wheelchair basketball, especially by players with greater functional difficulties; the offensive zone is the most used for shots by players in functional classes 1.0 and 2.5 [25]. The exterior offensive zone is also ineffective due to its association with shot error or hinderance to scoring (OE-MS: L0=4.01; OE-SC: L0=-2.91). This relationship between shots from the exterior offensive zone and error was also detected in the USA team's participation in the Paralympic Games of 2016 [24]. Players with greater functionality present a higher offensive threat through their tendency to occupy zones close to the paint, whilst players with less functionality fulfil other roles, such as blocking and screening[20].

When taking into consideration the functional class of the player who makes the shot, it has been proved that when the shot is made by a player with less functional limitation, there is an association with an effective shot, both in players from functional class 4.5 (H45-SC: L0=2.93; H45-MS: L0=-2.54), and class 4.0 (H40-RF, L0=2.98) and class 3.5 (H35-A1: L0=2.47). These results are in line with those obtained in previous Paralympic Games [18,22,51]. When a shot is made by a player with greater functional difficulties (H10) an association was detected with receiving a block (H10-BL: L0=3.8). This difficulty of achieving effective shots by players with greater functional difficulty has already been demonstrated [22,52].

We will now go on to address the results relating to retrospective lags. Analysis of the dimension "laterality" has enabled us to characterise the use of the reception prior to the shot, from the bottom right offensive, as an effective situation in terms of making a basket (BRO-MS: L1=-3; BRO-RF: L1=2.19). A pass made prior to the shot from the offensive centre was also characterised as an effective sequence (OC-SC: L2=2.21). Making the last reception in the bottom left offensive was characterised as an ineffective situation due to the possibility of receiving a block (BLO-BL, L1=3.75), as were making the last pass from the bottom left offensive (BLO-SC: L2=-2.23; BLO-MS: L2=2.57) and the offensive centre (OC-A1, L2=-2.31). All these results, linked to the retrospective analysis of the dimension "laterality", coincide with those obtained in the Paralympic Games in Río de Janeiro, 2016 [22]. However, making the last pass from the offensive right lateral was also characterised as ineffective behaviour (ORL-SC: L2=-2.35; ORL-MS: L2=2.55), which is a new result with regard to previous Paralympic Games.

The results that correspond to the defensive area coincide with those obtained in previous Paralympic Games [22]. It has been demonstrated that a reception prior to the shot in the defensive bottom right is more likely to result in a foul and additional shot (BRD-A1: L1=4.24), and in the defensive right lateral the received foul (DRL-RF: L1=1.97). Last passes made from the right lateral (DRL-A1: L2=2.95), left lateral (DLL-A1: L2=2.13) and the defensive centre (DC-MS: L2=-2.46) are also productive. The use of the defensive left lateral for the last reception (DLL-MS: L2=2.13) is characterised as an ineffective situation, whilst in previous Paralympic Games the defensive right laterals and bottom left defensive gave rise to ineffective situations [22]. This therefore reflects the importance of the defensive area in actions prior to the shot in wheelchair basketball, which substantiates that counter-attack and fast play is a characteristic of the wheelchair game [21].

Regarding the retrospective analysis of the dimension "area", and its relationship with the last reception (lag -1), it has been observed that the paint is an effective place to repress a shot failure, and favours the achievement of a foul plus additional shot (OP-RF: L1=4.07; OP-A1: L0=3.32; OP-MS: L1=-3.87). However, it also carries risks, as shown by the association with receiving a block (OP-BL: L1=2.58). Situations in which the reception prior to the shot is carried out from the offensive zone have also been characterised as ineffective (OZ-RF: L1=3.11; OP-A1: L0=-2.6; OP-RF: L0=-3.99). All these situations linked to the retrospective analysis of the dimension "area" had already been detected in the Paralympic Games de Rio de Janeiro [22]. As a distinguishing aspect, receptions prior to the shot (OE-MS: L1=4.38; OP-SC: L1=-3.22) and making the last pass (OE-MS: L2=2.55) in the offensive exterior zone were characterised as ineffective situations in the technical-tactical performance of the USA team in the Tokyo Paralympic Games.

A proxemics analysis of the defensive zone, dimension "area", and in line with what happened in previous Paralympic Games [22], the defensive exterior zone has been characterised as an effective place for making the last pass prior to the shot (ED-A1: L2=3.26; ED-MS: L2=-2.03). However, unlike the results obtained in the previous Paralympic Games [23], in which it had been characterised as ineffective behaviour, it has been proved that the defensive paint, as a place for making the last pass prior to the shot, leads to a favourable consequence in the shot (DP-RF: L2=2.36; DP-MS: L2=-2.69).

In terms of the players' functional class, it has been shown that there is an association relationship with an effective shot when the last reception is carried out by players with less functional limitation (H45-SC: L1=2.81; H45-MS: L1=-2.65); in previous Paralympic Games the association relationship of these USA players was with a foul plus additional shot [22]. An activation relationship was also detected of a last reception carried out by players from functional class 4.0 with "received foul" (H40-RF: L1=2.82). This effective presence of players from functional classes 4.0 and 4.5 is in line with the results of Skučas et al. [51] and Pérez Tejero and Pinilla [18] where they showed that these players, grouped in the same category, receive the most fouls, make the most shots and with more accuracy.

With regard to players with greater functional limitation, an association relationship has been demonstrated of the last reception carried out by players from functional class 1.0 with a blocked shot (H10-BL: L1=3.8). In previous Paralympic Games,[22] obtained an association relationship with failed shot, and one of inhibition with a successful basket shot. These results are in line with those of Grashchenkova et al. [52] and Pérez Tejero et al. [21] which present these players as those who make the least shots and with least accuracy.

T-patterns detected

We will now go on to discuss the information contained in the regular behavioural structures detected with the THEME software, which have enabled the characterisation of effective (figure 1) and ineffective (figure 2) sequences.

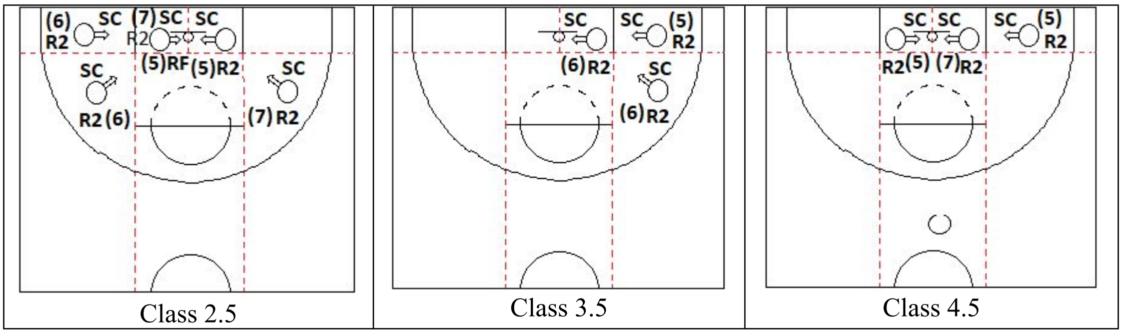


Figure 1. Graphical representation of the effective sequences categorised according to the "functional class" of the player who makes the shot (in brackets the number of occurrences of the sequence).

Regarding effective sequences that end in a shot, it is worth highlighting the great variety of sequences involving players with less functional limitation. This greater relevance within the game – characterised in the form of greater quantity of shots made and greater effectiveness obtained in the shots – of players with less functional limitation in the USA team, is in line with the results of Vanlandewijck et al. (2003)[25], Skučas et al. (2009)[51], Pérez-Tejero and Pinilla (2015)[18], Grashchenkova et al. (2018)[52], Pérez Tejero et al. (2021)[21].

It is interesting to note that functional class 2.5, which in previous Paralympic Games [23] only reflected converted shots from the bottom left, in the Paralympic Games of 2020 also represents effective sequences with a shot from the offensive zone – a lesser used zone mainly related with shot failure in wheelchair basketball [25]. There is also an increase in class 4.5 of sequences in the offensive right zone and bottom left which expands the effective zones from previous Paralympic Games [23]. What stands out in all these is, above all, the use of the bottom and paint that correspond with shots close to the basket, the most effective in studies of wheelchair basketball [25,51,52]. On the other hand, in class 3.5 we can see the relevance of converted shots made from the offensive right lateral – which in previous Paralympic Games were completed with shots from the offensive bottom right [23].

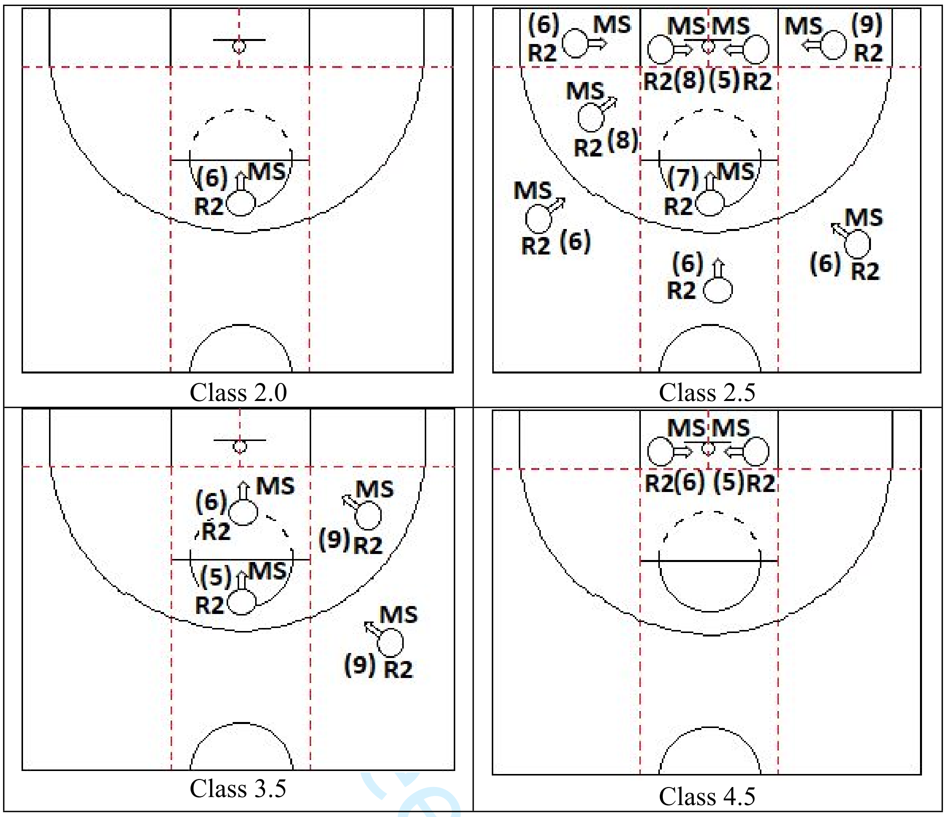


Figure 2. Graphical representation of the effective sequences categorised according to the "functional class" of the player who makes the shot (in brackets the number of occurrences of the sequence).

Ineffective sequences, characterised from the information contained in the detected T-patterns, reflect shots made by players from functional class 2.0, 2.5, 3.5 and 4.5; whilst in previous Paralympic Games no regular behavioural structures were detected corresponding to ineffective sequences involving players from functional class 2.0 [23].

The main difference in the performance of the USA team in the Paralympics of 2016 and 2020 is related to the variety of ineffective shot positions shown by class 2.5, much higher than that shown by the USA team in previous Paralympic Games [23]. Ineffective sequences have been characterised in the junction between both bottoms of the court and the paint, despite being effective zones for taking a shot [25,51,52].

In class 3.5, regular behavioural structures were detected of failed shots from the right lateral – offensive exterior and offensive zone –, whilst in previous Paralympic Games ineffective sequences with a shot were only detected from the offensive zone [23]. It is also worth highlighting the characterisation of the central corridor as an ineffective place to make a shot – in the junction with the offensive paint, offensive zone and offensive exterior. However in the Rio Paralympic Games, failed shot sequences were characterised by players from functional class 3.5. from the centre, in the junction with the offensive exterior, and from the left lateral and bottom left [23]. Lastly, in class 4.5 ineffective sequences were characterised that were formed by shots made from the junction between both bottoms and the paint, despite these being considered effective shot zones [25,51,52]; in the Paralympic Games of 2016 completed sequences were only detected, by players in this functional class, with a shot from the junction between the bottom left and the paint [23].

Conclusion

The match analysis of the men's team considered the best in the world (USA), in the seven matches of the Tokyo Paralympic Games 2020 is a specifice example of the possibilities that observational methodology offers to match analysis in Wheelchair Basketball. The records obtained by the observtaion instrument include the specific player perrforming the action. Whilst it is very relevant for technicians and coaches to set apart the specific player in their match analyses, we considered the grouping of players depending on their functional class to be a greater contribution to the knowledge of wheelchair basketball.

The results obtained via the two diachronic analysis techniques (lag-sequential analysis and T-pattern detection), has allowed us to characterise effective and ineffective type sequences, enabling technicians and coaches to analyse different features of one reality. Lag-sequential analysis has allowed us to detect, as effective behaviours: those in which the shot (lag 0) is made from the paint; the reception prior to the shot (lag -1) takes place in the paint, the bottom right offensive, the bottom right offensive and the right lateral defensive; the pass prior to the shot (lag -2) is made from the offensive centre and, highly significantly, in the defensive area (right lateral, left lateral, centre, paint and exterior zone) that are related to sequences of counter-attack and fast play. In terms of functional class, it is worth highlighting the effectiveness shown in sequences that incorporate a final reception and shot by players with less functional limitation. Ineffective behaviours are reflected as: those in which the shot is made from the intermediate offensive zone and the exterior offensive zone; the reception prior to the shot takes place in the offensive bottom left, the defensive left lateral, the paint – which was also characterised as an effective area –, the offensive zone and the exterior offensive zone; the pass prior to the shot is made from the offensive bottom left, the offensive centre, the offensive right lateral and the exterior offensive zone. Regarding functional class, it is worth mentioning that when a shot was made by a player with greater functional difficulties, an association relationship with receiving a block was detected. The informative potential of the detected T-patterns has led to the characterisation of effective and ineffective sequences. In terms of effective sequences, what stands out is the great variety of sequences carried out by players with less functional limitation. As far as ineffective sequences go, they correspond to shots made by players from functional classes 2.0, 2.5, 3.5 and 4.5.

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