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Development of an observation tool for the Bottom-Turn manoeuvre in surfers.

Dissertação elaborada com vista à obtenção do Grau de Mestre em Treino de Alto Rendimento

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List of Abbreviations

BOS	- Base of Support
BS	- Back side
BT	- Bottom Turn
COD	- Change of Direction
COM	- Center of Mass
FPS	- Portuguese Surf Federation
FS	- Front side
ISA	- International Surfing Association
WSL	- World Surf League

Resumo

O surf é um desporto em desenvolvimento com um grande numero de praticantes e competidores. O *bottom-turn* é uma das primeiras manobras a ser ensinada, pois permite ao surfista virar para um dos lados da onda depois da descida. Contudo, há uma falta de literatura e de escalas referentes à análise desta técnica do surf. Portanto, o objetivo deste estudo é desenvolver uma escala de observação, para ser usada pelos treinadores, de forma a avaliar a técnica dos atletas durante a execução da manobra de *bottom-turn*.

De forma a atingir este objetivo, primeiro foi desenvolvido um modelo determinístico do movimento e foram determinadas as suas componentes criticas. Segundo, integramos o ponto de vista de sete treinadores nacionais de topo sobre o modelo e componentes criticas para chegar à versão final. Para tal foi realizada uma análise de conteúdo dedutiva das entrevistas sem restrições para o aparecimento de novos códigos.

Na versão final da escala de observação os itens orientação da cabeça, orientação do tronco e os ângulos de flexão-extensão dos joelhos foram melhor especificados. Para além disso foram acrescentados os itens ângulo da anca e inclinação do corpo.

Palavras-chave:

Analise Biomecânica; Análise de Conteúdo; Análise Qualitativa; Análise da Técnica; Biomecânica; Análise de vídeo; Desporto; Modelo Determinístico; Performance; Surf;.

Abstract

Surf is a sport in development with a large number of people practicing and competing. The bottom-turn is one of the first manoeuvres to be taught, as it allows the surfer to turn to one of the sides after descending the wave. However, there is a lack of literature and tools concerning the technique analysis of this manoeuvre in Surf. So, the aim of this study is to develop an observation tool, to be used by surf coaches, to assess the athletes' Bottom Turn technique.

In order to accomplish this goal, first a deterministic model of the movement was developed and the critical features of the movement were determined. Second, we integrated the views of seven top National coaches about the model and critical features to develop the final scale. A deductive analysis of the interviews with no constrains to the appearance of new codes was performed to arrive to the final scale version.

In the final version of the observation tool the items concerning the head and trunk orientation, as well as knee flexion-extension angles were further specified. Also, the items hip flexion/extension angles and body leaning were added.

Key Words:

Biomechanics; Biomechanics Analysis; Content analysis; Deterministic Model; Performance; Qualitative analysis; Sports; Surf; Technique Analysis; Video Analysis.

Introduction

Surfing is a sport characterized by riding waves with a board, which includes the following disciplines: Surf, Bodyboard, Stand Up Paddle, Longboard, Skimboard, Bodysurf, Kneeboard and Tow-In and Tow-Out. There are approximately 37 millions of recreational and competitive surfers worldwide (Moran & Webber, 2013). In 2016, over 15.000 athletes were registered in the Portuguese Surf Federation (FPS), as well as 100 clubs and 250 schools (FPS, 2019). FPS regulates every competition in Portugal and the guidelines for judging the competitions based on ISA (International Surfing Association) and WSL (World Surf League). Within the mentioned disciplines, the most practiced is Surf, with the highest number of competitors and competitions all year.

The judgment in surfing is based in guidelines. The factors affecting the score obtained by the surfer are the commitment, degree of difficulty, innovation, progression of the manoeuvres and combination of major manoeuvres. Furthermore, all manoeuvres should be performed with control, velocity, power and flow in the most critical part of the wave. Considering the mentioned criteria, the judges attribute a score ranging from 0.1 to 10 points (ISA, 2016; WSL, 2019) and the professional surfer tries to use his repertoire, in conformity with the external conditions to obtain the maximum score possible on each wave. The performance attained by the surfer is therefore dependent on the qualitative assessment of the judges and based on somewhat general parameters and, therefore, more prone to subjectivity, comparing with other sports.

The repertoire of a surfer is typically composed by three groups of manoeuvres: turns, tube rides and aerials (Lundgren et al., 2014). As may be observed in Table 1, turns are the most performed manoeuvre, followed by tubes rides and aerials, if we considered the sum of the events from the entire season.

Regardless of the manoeuvre type, almost all of them are performed at the half top of the wave including the air. Every surfer begins with a top-down sliding trajectory after the take-off. When arriving at the bottom the surfer needs to go up again, turning to the side of the wave that will break and, to do so, the surfer needs to perform a Bottom-Turn (BT) (Everline, 2007; Moreira & Peixoto, 2014). The BT is, therefore, fundamental to the ride of a surfer and one of the first

Table 1 – Motion Analysis

Study	Event(s)/Year	Turns	Tubes	Aerials
(Lundgren et al., 2014)	10 events, 2012 WCT	69%	22%	9%
(Forsyth et al., 2017)	All events, 2015 WCT	82%	13%	5%
(Peirão & Giovana, 2011)	Rio Pro, 2007 WCT	96,4%	0,4%	1,6%
	Rio Pro, 2010 WCT	83,5%	0%	8,3%
(Ferrier et al., 2014)	Rio Pro, 2014 WCT	88%		12%

manoeuvres to be taught. Without a good BT there is no good manoeuvre (Piter & Testemale, 2012), even if, sometimes, it looks too much aesthetics (Mulquin, 2014).

The goal of the BT task is to keep the speed of the descent or even to increase it, through a change of direction in the base of the wave, and to place the surfer in the best place to perform the following manoeuver. The trajectory should be similar to an "U" so that the surfer is able to reach the top of the wave in a good position to perform another manoeuvre (Piter & Testemale, 2012). If a surfer takes more time performing the BT (longer/deep curve, larger "U"), they will have a higher chance to achieve a higher score (Souza et al., 2012).

The BT can be performed for both sides – forehand and backhand (Furley et al., 2018; Moreira & Peixoto, 2014; Mulquin, 2014; Piter & Testemale, 2012), with only a few differences in the technique. Regardless of the side (frontside or backside), the BT should start with the board pointing to the bottom on the descent and the knees bended. When arriving to the bottom of the wave, the surfer must engage the rail closer to the clean water and lean towards the centre of the "U". During the entire BT, the surfer must apply pressure during all the length of the rail, until arriving to his target. While during the frontside BT, the surfer leans forward, applies the pressure in the toes and the rear arm reaches out in the direction of the water, during the backside BT, the surfer leans backwards, applies the pressure in the heels and the leading arm reaches out in the direction of the water (Mulquin, 2014; Piter & Testemale, 2012).

In order to improve the athlete's performance, surf coaches use a qualitative approach to observe and evaluate the BT technique. The qualitative analysis has four steps: description/preparation, observation, evaluation and intervention (Knudson, 2000). This type of analysis is based on scientific principles and the observation is done "live" or using video (Lees, 2002). Qualitative analysis has shown to be of use in both sports settings, allowing to qualitatively evaluate different techniques like vertical jump (Knudson, 1999), discus throwing (Hay & Yu, 1995), long jump (Hay, 1986), gymnastics (Takei, 1988), golf swing (Barnett et al., 2015), tennis (Knudson, 2007), and in clinical settings, allowing to analyse gait in different special populations (Lord et al., 1998; Martin et al., 2009; Read et al., 2003; Toro et al., 2007). Although more subjective than quantitative analysis, this type of analysis is also the most used in surf (Everline, 2007; Forsyth et al., 2018; Moreira & Peixoto, 2014; Mulquin, 2014; Piter & Testemale, 2012), since collecting quantitative data in the sea is very hard to do (Mendez-Villanueva et al., 2010). This is probably why there are not many studies focusing on quantitatively analyse the surf technique (Everline, 2007; Lundgren et al., 2013; Mendez-Villanueva et al., 2010; Moreira & Peixoto, 2014; Scarfe et al., 2009). A recent study has established the critical features for two types of aerials, (Forsyth et al., 2018). In the mentioned study, the critical features of the landing, related with the success of an aerial, were identified (Forsyth et al., 2018).

The determination of critical features of a movement, allows the coach to evaluate the performance and determining what is lacking in that athletes' performance (Hewit et al., 2012).

To standardize the observations and reduce evaluation error it is important to develop an observation tool based on the determined critical features. The determination of the critical features of a movement is the first step of qualitative analysis. There are different ways to determine the critical features of a task such as: observing good and bad performances to determine which are the factors distinguish between groups (Forsyth et al., 2018), or developing a deterministic model using biomechanical principles to determine the critical features (Hay & Reid, 1982). The development of a deterministic model starts with the establishment of the main objective(s) of the task, and then progresses by identifying and judging the relationship between the result and each factor that produces the result (Hay & Reid, 1982). Each level of the model has a direct biomechanical relationship with next highest level (Chow & Knudson, 2011). The terminal factors of a deterministic model can help define the key features of the performance (Chow & Knudson, 2011). The use of this kind of model to determine the critical features has been very common among gymnastics, swimming or track and field (Hay & Reid, 1982). However, the use of this model to a multi joint and multidirectional movement has been limited (Forsyth et al., 2018; Hewit et al., 2010). To the extent of our knowledge, only one study was able to assess key features of a multidirectional movement, Change of Direction (COD) (Hewit et al., 2012).

After defining the critical features and to confirm the quality of the findings, the target population (e.g., surf coaches) should be involved into the definition of the key features of the observation tool. This involvement would help verify if the features are relevant to the qualitative analysis (Prinsen et al., 2018), and to detect if there are any items that should be deleted, adapted or added (Binkley et al., 1999; Fen et al., 2013), making the theoretical model and the critical features easier to understand to those that will apply the tool. Although, this combination of procedures (i.e., combining the theoretical model information with the expert opinions) is a relatively more common in clinical tools (Lord et al., 1998; Martin et al., 2009; Toro et al., 2003), in sports performance this procedure is not commonly observed.

Therefore, the aim of this study was to develop an observation tool, to be used by surf coaches, to assess the athletes' BT technique. In order to accomplish this goal, first, a deterministic model of the movement was developed and the critical features of the movement were determined. Second, we integrated the views of top National coaches about the model and critical features to develop the final scale.

Methods

Study Design

Tool development (qualitative cross-sectional study design)

Sample

This study required two samples: a sample of experts (in biomechanics and surf coaching) and another of surf coaches.

The sample of experts included 2 participants who had a PhD degree and at least 15 years of experience in the respective area. The work group was invited to analyse and discuss the theoretical model and the critical features which derived from the model.

To be eligible for the study the surf coaches needed to be a certified level II coach by FPS and be currently coaching one athlete from the Portuguese national team. According to FPS nine coaches meet these criteria, and from these, eight accepted to participate (~89%). The participants were informed about the aims and study protocols. They agreed to participate and signed the informed consent. The Ethics Committee from Faculdade de Motricidade Humana – Universidade de Lisboa approved the study protocol (Parecer nº5/2020).

Procedures

Development of the Deterministic Model

Two researchers (MS and VMP) developed the initial deterministic model of the BT technique and table of critical features was developed following the process described by Hay (Hay & Reid, 1982). The development process started by establishing the main objective(s) of the task, and then proceeded by identifying and judging the relationship between the result and each factor that produced the result (Hay & Reid, 1982). Each level of the model was a direct biomechanical relationship with next highest level (Chow & Knudson, 2011). All factors were supported with the existing literature.

The pilot version was then observed and analysed by the two experts, one in biomechanics and other in surf coaching. Each of them made comments that led to a new arrangement of the model and critical features. A consensus version was created and approved by both experts. Further, from these panel meetings, specific questions were drawn and included in the interview guide to be used during the interviews with surf coaches. These questions included: a) is the use of the rail a consequence of the inclination of the body? b) is the use of the hand, namely the hand touching the water during the turn, important to the performance of the BT? - (appendix I).

Data Collection

The individual interview was semi-structured starting with relatively open-ended questions and finishing with more closed questions (appendix I), in both with probing questions to assure more detailed answers. The aim was to allow the surf coaches to express their perspectives without being biased (Keogh et al., 2017) and allow a rich, in depth analysis of the model and observation tool (Patrick et al., 2011), then finishing with the more specific questions, to assure that responses to the doubts that arose from the development process and panel of experts were obtained.

The interviewer (MS) was trained before starting the interviews. This training included: (1) assisting to specific classes of qualitative methods and reading about how to conduct an interview (Berg & Lune, 2017; Hsieh & Shannon, 2005); (2) conducting interviews under supervision (and receiving feedback) to four coaches, who did not meet the inclusion criteria, and (3) performing a pilot interview with a surf coach who meet the inclusion criteria. This interview was not included in the analysis, but contribute, not only to the interviewer training, but also to improve the final interview script. (appendix I)

Moreover, a sample of seven surf coaches was invited to participate in individual interviews. The participants who accepted were pre-emailed with information about the study, the characterization questionnaire (e.g. age, sex, graduation, main professional occupation, experience as coach and as competitive surfer) (appendix II). The informed consent form was also emailed highlighting that their participation was voluntary, the collected information would be anonymised and that they could refrain from participating at any time without being penalized (appendix III).

Due to the COVID 19 pandemics, the individual interviews were done using the zoom platform (*Video Conferencing, Cloud Phone, Webinars, Chat, Virtual Events | Zoom*, 2020). The sessions were scheduled according the availability of the coaches and were performed during a 2 months' period. The sessions started by collecting the informed consent form signed and the characterization questionnaire filled. The interview was conducted following the interview guide (appendix I). The initial part of the interview was focused on the essential/critical features of the BT, the second part included the closed questions, derived from the theoretical model development phase and questions concerning the scale structure and their importance for the coaching process. On average, the interviews lasted 60 minutes and ranged between 51 minutes and 1 hour and 43 minutes. Simultaneously, the researcher (MS) organized the data transcribing all interviews word-by-word (*verbatim*) assuring anonymity using codes instead of any identifying data.

Data Analysis

Data analysis comprised 5 stages: 0) transcription;1) generating initial codes; 2) codification and identifying new categories; 3) reviewing and redefining categories and sub-categories; 4) assess saturation and ratification of interviews; 5) definition of the major themes to prepare for data presentation.

A second phase of the transcription was writing *memos* at the side of the text and pre-coding. A deductive content analysis was performed. Using the information acquired on the previous stage, the development of the deterministic model, and light read of the transcripts, a chart of codes and respective descriptions was created (Appendix IV). Data that did not fall within the research question, i.e., that was not related with the BT theoretical model or critical features assessment, was classified as "other". The interviews were then coded line-by-line as described in the following paragraph.

Three researchers (main researcher and a surf coach (MS), expert in biomechanics (VMP) and expert in qualitative analysis (AR)) independently read the transcripts from the first interview, defined meaningful units, and met to code the interview together. For the next three interviews, each researcher highlighted the meaningful units and coded each interview independently. The researchers met to compare the data and arrive to a consensus. The total disagreement decreased from 67,1% to 47,8% during this process (cf. Table 2). The last three interviews were initially coded by the main researcher (MS) followed by a meeting where the three researchers analysed the data together and arrived to a consensus.

Table 2 – agreement and disagreement between researchers

Subject	Disagreement		Agreement	
	Total (n)	Percentage (%)	Total (n)	Percentage (%)
BiomecSurf 3	100	67,1	49	32,9
BiomecSurf 4	99	53,8	85	46,2
BiomecSurf 5	66	47,8	72	52,2

During the codification process, the content emerged from the data led to new categories and sub-categories, as well as to the aggregation of other categories. A deductive analysis can comprise the creation of new categories, when the data collected does not fit the matrix but it is within the boundaries, giving space to an unconstrained matrix, where new categories and subcategories were created, based on the principles of inductive content analysis (Elo & Kyngäs, 2008). At the sixth interview, no new code emerged from the data, saturation was reached (appendix V).

Once the interview coding process was finished, the frequency of the codes was assed, to understand which were the more referred themes and confirm that we had enough information for the goals of the research. From these procedures it was concluded that it was not necessary to re-interview the surf coaches. All the information pronounced by each coach about each category and sub-category, was then grouped. After all information had been grouped, we clustered the individual perspective of each coach about each category and sub-category, giving place to a composite text telling the perspective of the surf coaches about the categories and subcategories. The emphasis gave by the coaches to each category and their experiences were taken into account while composing the text (Szedlak et al., 2021). During the composition of the text, the citations that help to fortify the surf coaches point of view were translated to English.

In a deductive analysis, the researcher has information about the themes before the categorisation of the study (Elo & Kyngäs, 2008). This information was taken into account to present the results focusing mainly in the following prior known themes: 1) deterministic model; 2) critical features (weight distribution, lower limbs and torso angles, upper limb, trajectory shape, head orientation, rail engagement, velocity, lean of the body and trunk rotation); 3) phases; 4) distribution of the critical features and connections; 5) differences between frontside and backside 5) scale levels; 6) usability and importance of the scale. While answering the previous topics, direct quotes or small paragraphs were extracted to better represent the perceptions about each theme (Szedlak et al., 2021).

Results and Discussion

Deterministic model and Critical Features

The first task aimed to develop a deterministic model and determine de critical features of the BT following the method established by Hay (Hay, 1985).

We started by stablishing the main goal of the task (performance criterion). Similar to what happens in gymnastics (Hay & Reid, 1982; Takei, 1988), in competitive surfing the main goal is to obtain the highest score possible. In gymnastics, the figures that the athletes produce will be observed by a group of judges and generate a score. Similarly, the figures that a surfer produces on the face of the wave will be observed by a group of judges who will attribute a score. These manoeuvres should be done with speed, power and flow, at the most critical part of the wave (WSL, 2019).

The BT task is a prerequisite for every surf manoeuvre (Mulquin, 2014), having has main goal placing the surfer at the critical part of the wave (Moreira & Peixoto, 2014) (trajectory precision) with postural control (the surfer should be able to maintain balance throughout the manoeuvre) and velocity (the surfer should arrive at the top of the wave with the highest velocity) (figure 1). We, therefore, consider those three as the major factors contributing for a good BT task and hence a higher score.

Two main factors were established to dictated a good trajectory precision were: the time spent in the BT and the shape of the trajectory. The shape of the curve should be deep, wide and delineate a "U" (Piter & Testemale, 2012). This will increase the BT duration and allow the surfer to reach a good position to go up and in the right tempo (Souza et al., 2012).

Similarly, in what is typical consider in other tasks involving a change of direction (90º and 180º) we considered that a good BT trajectory is dependent on head orientation, that should lead the turn allowing early visual scanning and knowledge of the situation (Hewit et al., 2010, 2012). Based in what we learn regarding the ski turn, in which the skier should lean into the turn to use the ski edges and turn over the pole (Lesnik & Zvan, 2007), the body leaning into the curve, was considered an important factor allowing use of the rail of the surfboard (the engagement of the rail should achieve approximately 2/3 of the surfboard); and the hand (backhand, in a frontside BT, and forehand in a backside BT) touches the water to serve as a pivot point. Regarding the last mentioned factors, two doubts arouse: (1) because the leaning of the body into the curve favours the use of the rail, could we use the use of the rail as parameter to evaluate this critical component? (2) the fact that the hand touches the water is a critical component or merely a consequence of body leaning and the use of the rail?

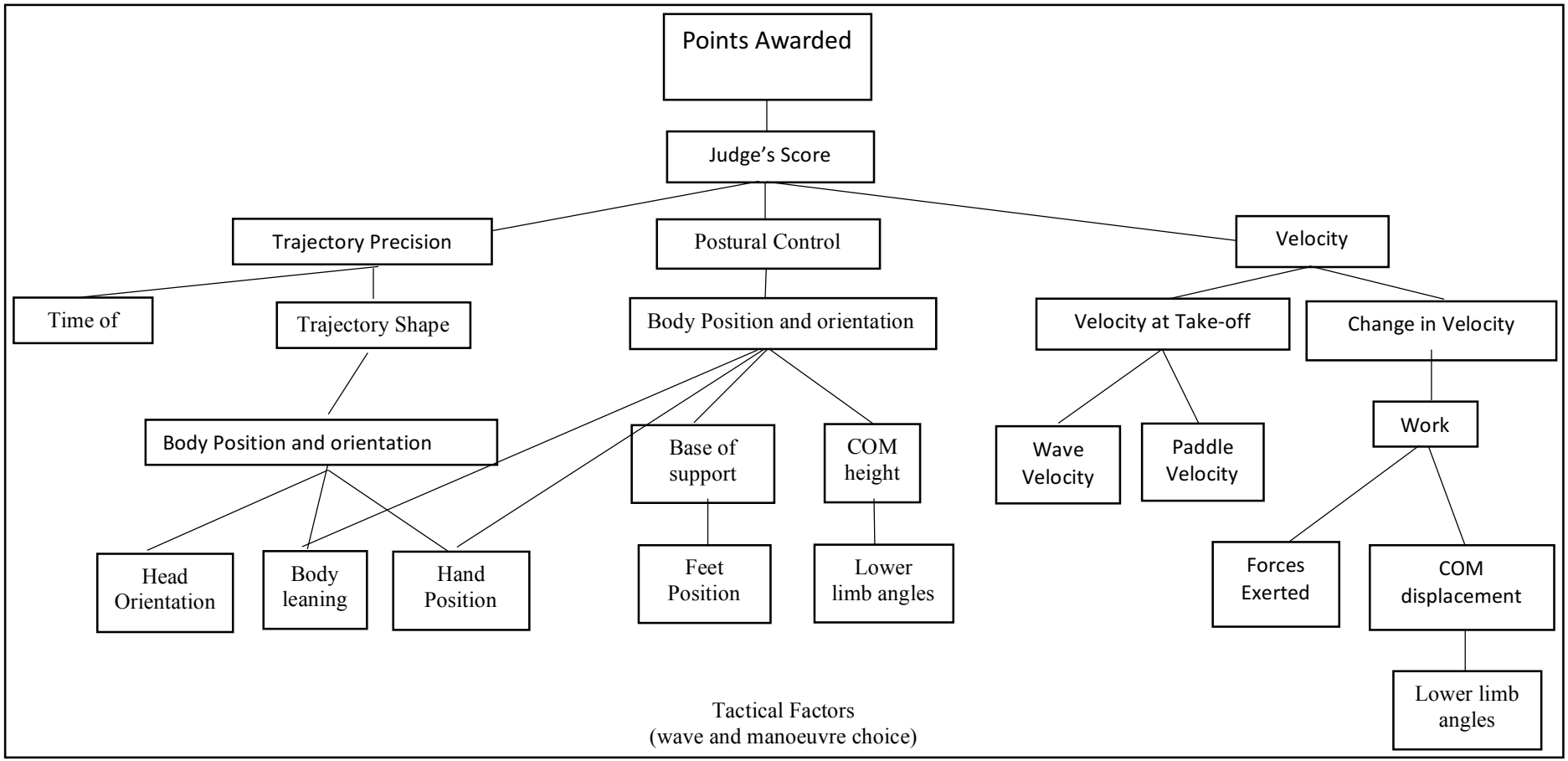

Figure 1 – Deterministic Model – pilot version

Postural control is the act of maintaining, achieving, or restoring a state of balance during any posture or activity (Pollock et al., 2000). This ability is dependent on both the sensory and motor systems of a person, i.e. how they perceive their body position and orientation throughout the visual, vestibular, and somatosensory systems, and which movement they generate upon this perception. During the turn, lean of the body allows to transfer the momentum achieved during the descend phase to desired direction (COD 180). Further, a wider stance, i.e. a larger base of support (BOS) and a lower center of mass (COM) height, achieved by bending the knees, will provide greater stability (Forsyth et al., 2018).

The velocity of a surfer COM at the top of the wave, after making a BT, is influenced by the velocity at take-off and change in velocity during the BT. The velocity at the take-off is influenced by the wave velocity and paddle velocity needed to catch the wave. The change in velocity is on the work done in the COM (W=F.d) and thus in the rotational work done by the lower limb joints. In order to do so, during the descend phase, the surfer should bend his knees achieving an angle of between 90 and 110 degrees, and should extend the knees during the ascend phase. This will allow a better transmission of forces through the joints (Richards, 2008). Moreover, a good catch of the rail is needed in order not to lose velocity. This is similar to skiing, where a carved turn can be done at 13,9m/s and a skidded turn at 10,4m/s, while the first have a very good catch of the edge of the sky the other loses it and as consequence lose speed (Klous et al., 2012). In snowboarding and skiing the forces increase during the turn (Gilgien & Chardonnens, 2013), especially at the 25% of the movement and between 50-75%, the last boost of force is higher, being these forces related to the engagement of the rail and to speed improvement, while making a carved turn (Klous et al., 2012). Due to the resemblance with surf, we can expect to observe the same role of forces throughout the BT manoeuvre. However, we were in doubt if the distribution of the forces between feet and from the heels to the toes during the BT was also an important to accomplish a good technique.

All the mentioned technical factors are dependent on tactical choices, such as the wave and manoeuvre choice. Those choices will depend on the repertoire of the surfer, his/her experience and the way to approach the wave. Although these factors are important, the deterministic model approach was developed to analyse the technique of the movement (Hay & Reid, 1982), and therefore the tactical factors are not included within the model.

To have a better understanding how the critical features are distributed throughout the manoeuvre, we have divided them in the following phases: preparation phase, descending phase, ascending phase and follow-through (cf. table 3).

Table 3 – Critical features table– pilot version

Phase	Key Features	Over All
Preparation	- Head oriented to the bottom of the wave	- Time of Bottom-Turn - Design of the curve (U/V/W)
Descending	- Changing the head orientation to the pocket of the wave. - Engaging the rail (0- 2/3) - Hand reaching the water - Knee flexion (90º and 110º)	
Ascending	- Head oriented to the pocket of the wave - Hand leaving the water - Knee extension (150º and 170º) - Disengaging of the rail Length of rail (2/3-0)	
Follow Through	- Distance of the surfboard to the pocket - Changing the head orientation towards the next goal - Knee flexion (90º and 110º)	

During the expert meeting, we started by discussing the model and critical features in a more general way and then asked the specific aforementioned doubts.

The expert in surf coaching suggested primarily that the trajectory shape should be changed to the top of the pyramid (figure 2), because is the criterion that is judged (where the judges mainly look), as the BT itself is not punctuated, but is central to perform all the top turns.

The same expert further suggested to remove the time of the BT, as this variable that will change accordingly with the type and size of the wave, and to include trunk rotation as an important to movement, (figure 2). The same happens in movements like change of direction, where the arms driving action, follow the head orientation and give more momentum to the turn (Hewit et al., 2010, 2012).

This meeting also led to the inclusion of trunk angles (flexion/extension) because of its influence in the COM height, on the branch of postural control. In ground change of direction, the athlete also performs a deep squat and transfers weight into the desired direction, leaning into it (Hewit et al., 2010, 2012). The importance of hand position (namely the hand touching the water) was kept as a doubt to pose to surf coaches. The velocity branch also suffered some changes. First, the initial velocity was replaced by gliding velocity and the factors that influence this velocity were further specified as the wave height, wave slop (breaking intensity) and wave velocity (peel angle). The wave velocity also considered to influence the change of velocity,

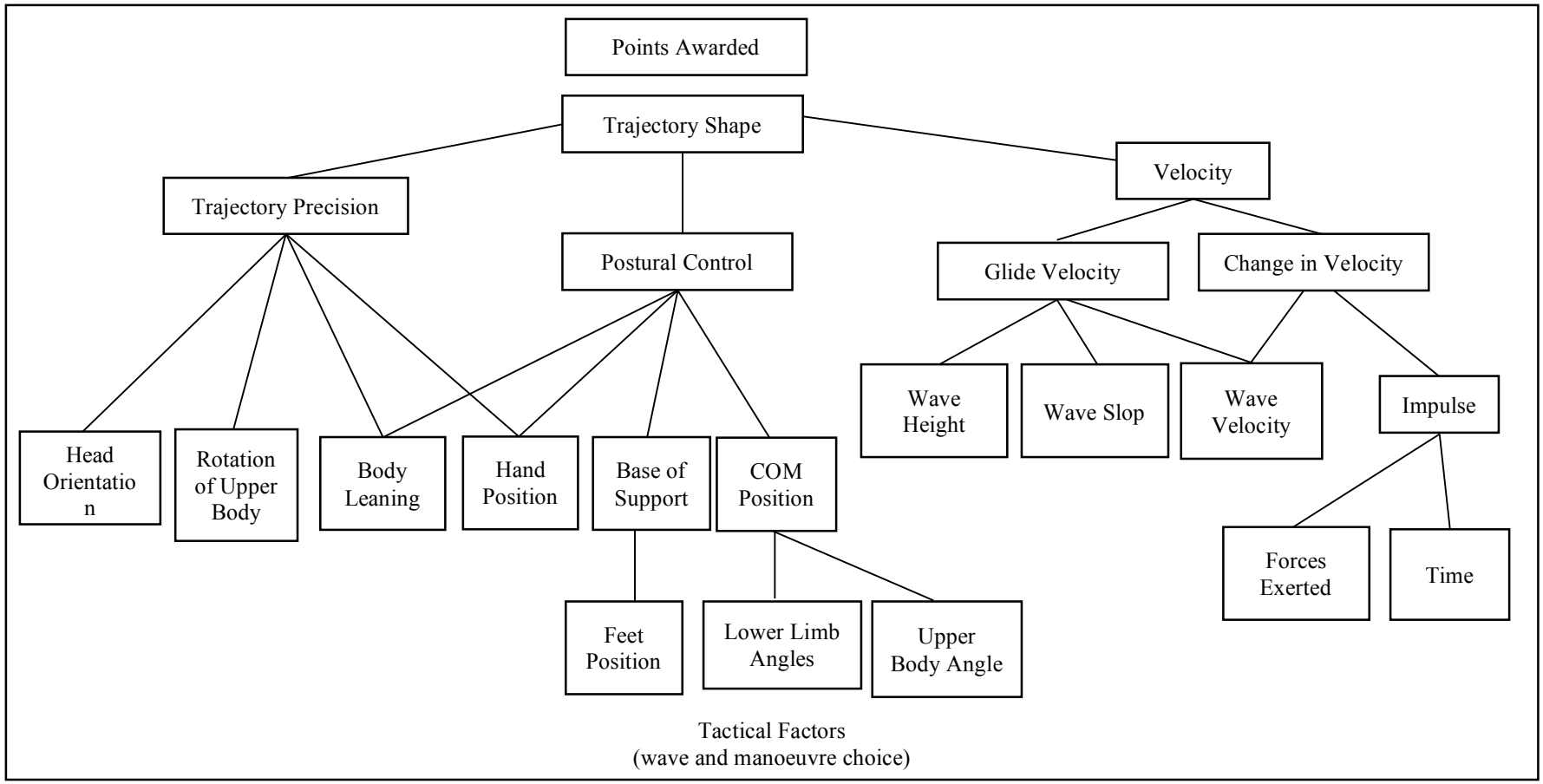

Figure 2 – Deterministic Model – consensus version

because during the wave riding the surfer can choose to improve speed or just control it, depending on the velocity that he acquired during the descent. Free skiers during the downhill to the "kick", before arriving to the place to jump they can feel if the velocity they have is too much or just enough, making decisions accordingly with his visual perception (Nyberg, 2015)

Finally, the expert in biomechanics also suggested to use impulse, forces exerted over the time, instead of work, force exerted over the displacement of COM, so that the time spend in the BT (previously related with trajectory precision) would be the time that the surfer will use to apply force over the surfboard.

Regarding the critical features tables, both experts recommend a division in 3 movement phases instead of 4 (cf. table 4), which is in accordance with the temporal phasing observation model suggested in qualitative analysis to organize the critical features (Gangstead, 1984; Lees, 2008). Previous analysis of the aerial manoeuvre also divided the movement into 3 phases (Forsyth et al., 2018).

In this new version, the timing of the knee flexion moved from the fundamental to the preparatory phase, similarly to what can be found in the change of direction task (Hewit et al., 2010, 2012). After lowering the COM, leaning into the desired direction following the rotation made by the head and followed by the upper body (Hewit et al., 2010, 2012). Further, the extension of the lower limbs marked the beginning of the final phase, the surfer disengages the rail and then leaves the hand from the water, directing the board to the task goal, like the "first-foot takeoff" into a change of direction (Hewit et al., 2010).

After resuming all the information discussed during the meeting, the deterministic model and the table of critical features were rebuilt and the interview guide developed based on the questions that arouse during this process.

Table 4 – Critical features table – consensus version

Phase	**Critical Features**	**Over all**
Preparation Phase	- Head oriented to the bottom of the wave. - Knee flexion (90º and 110º).	- Time of Bottom-Turn. - Design of the curve (U/V/W).
Action Phase	- Changing the head orientation to the pocket. - Engaging the rail (0- 2/3). - Hand reaching the water. - Rotation of the upper body towards the wave.	
Follow Through	- Knee extension (150º and 170º). - Disengaging of the rail Length of rail (2/3-0). - Hand leaving the water. - Distance of the surfboard to the pocket.	

Surf Coaches Perception

After developing the deterministic model and establishing the critical features, we needed to be sure that both the model and critical features were relevant, comprehensive and exhaustive to those that will use it (Prinsen et al., 2018). In order to achieve this goal, we interviewed a group of top National Coaches to integrate their views and learn about their acceptance regarding the model and critical features established.

The target sample (cf. table 5) had on average 43 years old (SD = 7,5 years), an average coaching experience of 13 years (SD = 5,6 years) and all of them were male (table 5). Five of them (~70%) had been athletes competing during 25 years, on average. Three of them (~40%) had studies in sports science or surfing science (i.e. post-graduation in surfing). Only one (~15%) had been an athlete and had studies in sports science. The greatest result attained as a coach was a world junior champ and a world under 16 champ title, achieved by the surf coaches with no studies (~30%), but with greater results when they were athletes. Other great results were achieved, as having an Olympic athlete and European and Vice-World Champ (team), these results were achieved by the surf coaches with sports studies (~30%).

Table 5 – Sample Characterization

n=7	**M±sd**	**Min-Max**
Age (y)	43 (±7.5)	28-52
Surf coaching experience (y)	13 (±5.6)	7-20
Career as surf athlete (y)	25 (±12)	0-43
	n (%)	
Sex (male)	7 (100)	
Education		
Primary education	0 (0)	
Basic education	1 (14.3)	
High school	1 (14.3)	
University	5 (71.4)	
Degree (BsC or Post-graduated) in Sport Sciences	3 (42.9)	
Career as surf athlete	5 (71.4)	
Training athlete(s) who won one European or international competitions	4 (57.1)	

Deterministic Model

In this research, the deterministic model is the "foundation" for the determination of the BT critical features. We were particularly interested in knowing if our systematization of the BT task (criterion performance and factors that produce the result) in the theoretical model had comprehensiveness (i.e. no key aspects of the construct were missing), was relevant and easy to understand. All coaches agreed with the deterministic model, but some of them (n=3 ~43%) expressed some doubts, generally concerning the links of the model.

All surf coaches considered the BT as a fundamental maneuver, as supported by the following quotations: the BT is, e.g. "**the most important maneuver in surf**, in my opinion. Is a maneuver that precedes all big maneuvers (…)" (S4SCORE1); "**The BT is the most important in surf**, without BT there's nothing" (S3SCORE1); "the importance of the BT is exactly **(…) the surf doesn't survive without it**" (S1SCORE3). They mentioned that even if isn't directly punctuated, the BT will have a crucial role in the score attributed to the top turn, so "…**a good BT, well performed, with quality will allow to potentiate the maneuver**" (S2SCORE2); "at the end, **the BT optimize and does that the punctuation gave by the judge's is not incorrect**, because at the back, a maneuver without BT is a maneuver that is not punctuated in the same way" (S1SCORE1). These statements support that, although the BT task is not punctuated by the judge, the "points awarded" can be considered as the BT performance criterion (task goal), because the BT technique influences the conditions that the surfer has to perform the top turn, hence to obtained a higher score.

The surf coaches with graduate and postgraduate studies, either in Sports Sciences or Surfing (n=3 ~43%) were the ones with less interventions in this topic, showing their agreement with the model "From what I read of the document, I read it last night and I'm now here reading a little more. This **seems to me to be quite complete** here" (S3MD1). It was expected that this group of surf coaches would have more facility to analyze and understand this type of model, as this is a frequent academic discussion topic. This may be why they only expressed that they agreed with it and had no need for expressing more doubts. The specific comments that this group did about the deterministic model showed also that they had more capability to analyze and express what they thought will be the important factors to the BT technique.

One of these coaches specifically expressed is agreement with the velocity branch, "… BT is a preparation maneuver for a maneuver at the top of the wave. Then here speed, height, incline are all factors that happen and need to be taken into account, too. **This speed part is, it's pretty good**" (S7MD_CC3), while other, with a degree in sport science and with more experience in training high level athletes, expressed that the branch of velocity have a special role in the BT technique "I think that all this, **you could even have connections here to connect, from speed to everything else, because with more speed you will be able to do better certain aspects** that you have here more on the left side, or you will have an easier time reaching them" (S4MD_CC1). These statements (n=2 ~29%) show specifically that they give a special importance to velocity as a determinant factor for the BT technique.

One of the surf coach with graduation in sports science showed specifically emphasize his agreement with the branch of precision "…yes, because here the rest, **the trajectory shape is linked with the trajectory precision, the trajectory precision is linked with the head orientation, rotation, leaning** (…)" (S7MD2), but he would think that the "body leaning" will produce the next factor "hand position", "…**this chain of movement: leaning of the body,**

position of the hand could be also included in body leaning." (S7MD1), although later during the interview he will defend that the "hand position" will serve to many things.

From the four surf coaches without studies related to surf or sport science, three of them (~43%) showed the more extensive intervention over the deterministic model, while one of the surf coaches with international titles was short in his point of view about the deterministic model, only expressing that he agreed with the model. Their interventions expressed general accordance with the model and one general doubt concerning the lack of connections between the model branches.

In particular, two of the first three (~29%) expressed the need for connecting the final factors from "trajectory precision" and "postural control", to the two-major factor: "I think that **postural control and trajectory precision are connected** (…)" (S1MD5). They seemed to assume that these factors will be influencing both branches, that the features from postural control will influence the "trajectory precision": "… the level here of what we're seeing, it's exactly **this whole line there (critical features) they all end up influencing the trajectory precision like the postural control**, if we think about it. You rotate your torso you are changing your posture, I think everything ends up influencing postural control and everything influences the accuracy of the trajectory" (S2MD4).

The other surf coach, expressed that the impulse shouldn't be so far away from the precision, because the change of velocity created with the impulse will allow the surfer to have greater precision over the BT, saying that this impulse will allow the surfer to tighten the curve: "… here the trajectory precision that is on the left side. It could also be linked to the impulse and the change of speed, **because when you change the trajectory... get the angle tighter, you need an impulse a little different to get a tighter angle. So I think that these are also a little linked, from the precision of the trajectory with the impulse and with the change of speed**, that is, they are all connected." (S6MD2). This intervention highlights the connection that exists between the impulse and the trajectory shape, as the others factors. This states that the external factors of the wave, will influence the intensity with each the surfer has to perform the features of the BT.

Critical Features

In this section, the critical features of the BT were organized according to the emphasis given by the surf coaches during the interviews, i.e. from the most to the least referred codes (cf. table 6), allowing us to analyze them assuming a certain degree of relevance for them. The weight distribution (DFRAIL, DFRAIL_VEL and DFRAIL_IC), which concerned the use of rail and weights placements over the surfboard, was the most cited followed by the lower limbs (MIT) and torso flexion/extension angles during the BT. In the third place was the upper limb movement

(PMS), followed by the trajectory shape (DT), head orientation (OC), rail engagement (amount of rail engaged) (DFRAIL), velocity (VEL), lean of the body (IC) and trunk rotation (RT).

Table 6 – Codes and Frequency

Themes	Frequency
Weight Distribution	132
Lower Limbs	95
Upper Limbs	87
Trajectory Shape	71
Head Orientation	50
Rail Engagement	49
Velocity	44
Lean of the Body	40
Trunk Rotation	39

Weight Distribution (DFRAIL, DFRIAL_VEL and DFRAIL_IC)

All surf coaches agreed that weight distribution is crucial to the performance of a good BT, e.g.: "Hey! For me **the main thing is** bending and **weight distribution**" (S5MIT1). Also, they stated that is this weight shift during the BT that will allow for rail engagement: "**In the descent phase, when we are in the first 1/3 of the wave, we have to put our weight ahead to accelerate**, (…) **the front weight, the front weight is transferred when we are in the middle of the wave, to the heels or to the toes**. (…). **When we arrive at the bottom of the wave, we have to be full rail**, (…) **up to the foot of the front at least the rail has to be in the water and then we start to transfer the weight more to the tip of the back foot or more to the back heel, so we can tighten the line and hit the lip**. (…) **if we keep the weight evenly distributed on both heels or both toes, we're going to go straight forward,** we're going to have a much more horizontal line or we're even going to fault (…)" (S3DFRAIL2). In general, they described the weight shifts during the BT as follows: during the preparatory (descent) phase the weight is over the front foot with chest over the front foot and zero engagement of the rail; during the action (fundamental) phase has to start change progressively the weights to the back foot, with the combination of the flexion of the body and lean into the curve, to apply pressure over the internal rail and engage the rail; and during the follow-through (ascent) phase it has to be over the rear foot and release the pressure of the rail with a progressive extension of the lower limbs and trunk with rotation of the torso.

The surf coaches with graduation in sports science and other surf coach (n=4 ~57%) made the connection between the weight distribution and the increase of speed during the descent (preparatory) phase: "**In the descent phase, when we are in the upper 1/3 of the wave, we have to put our weight forward to accelerate**, otherwise we drop on a wheelie, we will brake, that is, we put our weight ahead! (…)" (S3DFRAIL_VEL4). Also, one of the surf coaches mentioned

that the weight and chest over the front foot will allow the surfer to have more balance, and "(…) **That's why on the descent it goes from 0-2/3, considering the 0 of the rail, you have the weight in the widest area, in the wide point of the board, which is the widest and longest and most stable area, therefore more stable**. Is this position that will make you put more weight where there is more area, for more area of the surfboard to be in contact with the water and in return to acquire maximum speed, that at the end it is what you want acquiring when you are starting the descent (…)" (S1DFRAIL_VEL2).

Two surf coaches (~29%), one with graduation in sports science and one with international title, also relate the use of the rail with a higher velocity achieved by the surfer on top of the wave, "(…) **always assuming that quality BT has to be done on the rail**, it can never be done with the bottom of the board, we will never be able **to reach the top of the wave with speed**" (S4DFRAIL2).

Lower Limbs and Torso angles (MIT)

One of the four surf coaches of athletes who won one international title started the interview by expressing that this feature is one of the two key features to the performance of a good BT, "… **for me the main thing is bending** and weight distribution." (S5MIT1). The other surf coaches (n=4) claimed that the flexion during the BT is fundamental to the performance of a good BT, while the remaining (n=2) qualified the flexion to be very important for the BT technique "(…) I think they are important things because what you are going to see is the position you are in... you come and you are in that position, after that you leave for the maneuver, so **I think it is one of the fundamental things, as important as bending the knees**" (S2MIT10).

Almost all surf coaches (n=6 ~86%) described a good flexion extension pattern as a flexion during the action (fundamental) phase and an extension during the follow through, e.g. "… **the beginning of the BT is with the weight behind the back leg, as he does it, it flexes, flexing... more and more compressing, as you want to widen or not the curve and then right after the decompression**, go there will be a little weight transition there, which is the output of the weight behind, which is the output of the BT for the ascent, for the maneuver (…)" (S5MIT4); "(…) **is more important to be aligned on the descent, which then on the ascent is not so aligned, because the body has to go from compression to decompression**, with a rotation of the trunk and then it gets a little more misaligned, it only aligns itself afterwards the maneuver at the top of the wave" (S7MIT8).

Furthermore, almost all surf coaches (n=6 ~86%) described that the surfer should adopt a flexion of the knee equal or lower than 90º, e.g. "a Kelly Slater, a Mick Fanning, I think they are very good references, you understand, you will see and **they reach much lower angles, much tighter than the 90º**" (S2MIT9) and "**I always ask to be at the angle of sitting in the chair,**

from that angle down, I never ask them to go up much higher than that, you see. And this expansion is given after BT" (S5MIT13).

One of the surf coach with graduation in sports science, stated that the extension of the lower limbs should not be so big, being the knee angle less than 150º "… [At] the moment of the BT I am ± 90º, (... thinking) **170º is almost the leg fully stretched... it is almost the leg fully stretched and the front leg is always more stretched than the back one, but the back leg has to go much less than 150 degrees**. I'll even tell you that **the back leg doesn't have a big variation, from the 90º**, you stretch a little, but you can't stretch too much either, if not later, if you're too stretched up there then you'll have less balance when you do the maneuver at the top of the wave." (S4MIT11), also differentiated the angles between the back leg and front leg, defending that the back leg should not extend, continuing at 90º. This line of thinking was also verified in one of the surf coaches with international title and other two surf coaches (n=4 ~57%). Moreover, the surf coach graduated in sports science and the surf coach with one international title stated that the extension during the follow-thought (ascent) phase has to be progressive, "… here the angle of the trunk is what we talk about, it is important on the descent that the trunk is here on top of the front leg, so that we can descend with speed and then also important that the angle of the trunk, **with the legs that does not open completely in the moment of BT exit to the top of the wave. It has to be a gradual opening and it has to be an opening that never comes to a full opening**" (S4MIT10), also four more coaches were in accordance with this perception of the extension (n=6 ~86%).

Two of the surf coaches with graduation in sports science and one surf coach with international title (~43%) stated that the angle of the hip during the BT should never be larger than 90º (considering 180 degrees as the alignment between the thighs and the trunk), "(…) **if I create this straight line from the leg to the torso, my weight is behind me and it is very important for the athlete to maintain an angle, most of the times less than 90º, between the front leg and the chest and torso** (…)"(S3MIT4) and "(…) **it is important on the descent that the trunk is here on top of the front leg**, so that we can descend with speed and then also **important that the angle of the trunk, with the legs that are not fully open at the moment of BT exit to the top of the wave**. It has to be a gradual opening and it has to be an opening that never comes to a full opening" (S4MIT10).

Furthermore, one of the surf coach with graduation in sports science made the connection between being flexed and having more control "(Q) What do you think doing lowered will help you do most? (A) You will be able to reach the top of the wave with more speed and you will be able to perform a maneuver with much better quality. When I say with more quality, I mean with more speed, with more power, **with more control**. (…)" (S4MIT14). The other surf coach with studies in sports science, also mentioned: "…**when you put your hand in the water, it compresses, it's more stable, it has a lower COM**, (…), **bend your legs** and sit down, he doesn't

even put his hand in the water…" (S3MIT9), which reinforces the connection into the deterministic model between lower limbs angles and postural control.

Almost all the surf coaches (n=6 ~ 86%) made the connection between the flexion that a good BT requires and the place where the surfer will apply more pressure on the surfboard (weight distribution). Two of them, one with world title and one with graduation in sports science, stated that the flexion over the front foot should be still during the most part of the BT, making the surfer applying more pressure in the forefoot. The other four surf coaches, stated that the surfer, during the follow-through phase, should extend progressively, without creating a full extension of the hip and, by consequence, applying more pressure over the rear foot and disengaging the rail.

Finally, one of the surf coach with international title and one of the surf coach graduation in sports science, emphasized the connection between the time that the surfer as to remain flexed during the BT, the progressive extension during the ascendant phase with the size and type of wave (external factors) "**I want to see the athlete doing this progressive compression, you see, on the descent. Not completely, so that you know how to dose this compression well and I want to see the athlete very compressed down here in the BT**…" (S5MIT5) and "…**It will always have to be... here I am, do a gradual opening without ever fully stretching**…" (S4MIT11).

Upper Limb (PMS)

All surf coaches described the position of the upper limbs mostly through the description of the placement of the hands, "… when I talk about the hand, I talk a lot about FS, the back hand approaching the water and approaching the front leg, which is to transfer the weight more to the front leg and get more pressure on the rail from inside the moment of ascent; and BS, I like that hand and then **when I talk about the hand, I'm also associating the whole arm, hand, elbow, shoulder** and directing it towards the top of the wave" (S4BSFS_PMS1).

None of the surf coaches stated that the use of the hand during the BT is fundamental, but all of them agreed that the hand position during the BT is important to achieve other fundamental features "**this approach of the hand of the water is full of information, because in the end it is what it will do for you to get your COM to move**. If you take out the hand approach to the water, from your explanation board and you talk to a surfer and you don't talk to him about touching the water with his hand, that one... BT will be very deficient. The keyword that unlocks a series of events is exactly that, touching the water with your hand." (S7PMS11).

During the preparatory (descent) phase the upper limb position did not seem to have a great relevance, as only two surf coaches (one with international title and one graduated in sports science) (~29%) specifically described that the upper limbs should be one each side, towards having more pressure over the front foot and have more balance, "… **at the moment when we are going down the wave**, put the weight on the front leg, either... the legs bent, the trunk also

bent, the chest close to the front leg, **one arm on each side** and reach the base as soon as possible. as soon as possible" (S4PMS1).

All surf coaches described that the approach of the hand to the water during the action (fundamental) phase will allow the surfer to achieve a more flexed position, lean into the curve and put more pressure on the internal rail: "(…) **you bring your hand close to the water, to compress and displace the COM, but the objective is the COM. COM will do what? It will make you use the rail** (…)" (S3PMS18). The surf coaches with graduation in sports and other surf coach (n=4 ~57%) specifically stated that this hand approach is only a "reminder" to the surfer of what he really has to do, because what he achieves with approaching the hand to the water are the key features: "… you can say bring your hand closer to the water and the kid goes with his hand in the water, but he goes on top of the board. It's no use. You have to tell him, that putting your hand in the water is for this is going to happen, **it's an easier way for them to remember, that it's for that to happen, do you understand? the hand in the water does two things, which is to displace the COM and force them to compress. Force them to lower**, you see, because if not, the kid can do it... he can move the COM like that, being stretched out, but it will fall. What happens, when he puts the hand in the water, helps him to compress, to be more stable and to lower the COM, do you understand? so, putting your hand in the water is something that has an objective, but it is not the fundamental thing (…)" (S3PMS17). Two of them (~29%) still emphasized that should be the elbow approaching the water to obligate the surfer to adopt a more flexed and leaned position, "(…) **the inclination of the body has a lot, it has a lot to do with the technique I mentioned... with the legs bent**, with the trunk on top of the front leg**, trying to take the hand and even the elbow, at a more advanced level, to be as close to the water as possible**" (S4PMS6).

Almost all surf coaches (n=6 ~86%) defended that during the follow-through (ascent) phase the surfer has to raise the leading arm towards the place where he wants to perform the maneuver (Lip). In order to do so, they described that the hand should move away from the water, creating a rotation of the trunk "(…) **when you say raise your arm**, look with your head, rotate your torso, orient to the pocket place, or not what... **you are basically promoting the rotation of the torso,** trunk flexion, extension, knee flexion" (S1PMS6).

Almost all surf coaches (n=6 ~86%) made the connection between the movement of the leading arm after approaching the water, rising towards the top of the wave and the precision to project the surfboard to the right place to attack (LIP), "… in BS the hand that touches the water is on your back. So at the moment it touches instead of being low, **it has to go up, which is for the board to be able to project upwards later**" (S7BSFS_PMS8.1); and, "… a good BT, on the descent, start compressing immediately with the back knee slightly inward with the weight slightly forward, then we can still get the front hand, **the leading arm... This must also be**

slightly stretched forward and slightly point to where we want to go and the gaze itself has to be clearly directed to where we want to go, where we want to hit is not" (S6PMS1).

Furthermore, the surf coaches with graduation in sports science and other surf coach (n=4 ~ 57%) made the relation with the hand approaching the water and the flexion of the body and weight transition. This movement is responsible for starting the extension of the lower limbs and the transition of the weights from the front foot to the back foot, as creates the rotation of the torso: "… there's a mistake here that all kids make, which is... **when we tell them to send the back arm, the back arm, they don't create a rotation**, they create a lateral flexion, that is, and what is that? **will happen, they stretch their front leg and stand on the bottom of the board with their weight behind**" (S3PMS4).

Finally, we conclude that according with the surf coaches the hand position is not crucial to the performance of the BT, but help the surfer remember to perform the flexion and lean of the body, being frequently used as a feedback during practice. The coaches also seem to highlight the relevance to have the hand pointed to the lip will help the surfer to achieve the most critical part of the wave, improving precision.

Trajectory Shape (DT)

Almost all surf coaches (n=6 ~86%), argue that the BT should be always adapted to wave/section that the surfer has ahead of him, adjusting the time that they spend on the BT and the shape of the trajectory accordingly, e.g. "I think it is very important to have this issue that we talk about the duration and design of the BT, it is not more or less evaluated according to whether it lasts more or less, whether in "U", in "V" or in "W". **No trajectory is more valuable than the other, it is directly related to wave reading and wave speed, I think this is very important**." (S1DT5) and "…Hey, **a "V" BT already, it's because something there didn't go well and you've already lost speed, you've adapted... do you understand? not to say it's poorly made, but, but it's not the textbook, BT**" (S2DT9). This shows that the line drawn with the BT has to be in accordance with several external factors and that there is no trajectory more valuable than other, it will depend on the surfers' adaptation to external factors. One of the coaches went further defending that the time of BT should be also adapted to the type of maneuver that will follow "… **then depending on the type of maneuver and the type of section ahead**. If it is a vertical section, the compression time has to be longer, so that the surfer has a more vertical exit, if the maneuver to be performed is more horizontal, then the compression time at the base, let's say in BT, will be shorter, so that this rail is not in contact with the water for so long" (S7DT1).

On the other side, almost all surf coaches (n=6 ~86%) also defended that a BT with quality should have a trajectory shape similar to an "U", independently of the wave/section, the surfer should read the wave towards make it possible: "**Quality surf is always in a "U"**. Therefore, the BT will provide you with a good BT, it will always make a "U" trajectory. (…) it doesn't need to

be so at the base and we surf more like that (forward), but to do a BT of quality is in "U". Even if you're not going to make a top turn later, get up there and put the rail and come back again, but it's in a "U". Because it is close to the lip that is the maximum wave energy, the maximum wave potential" (S4DT6); or, in other way to reassure the importance of trajectory, and referring to the performances at a Junior European stage, "… I saw many surfers, who don't have... the quality of their maneuvers is nothing phenomenal and out of the ordinary in relation to the Portuguese... **but there is one thing that was different for me, they come to the bottom, they go to the top of the wave, they come to the bottom, they come back to the top of the wave and they surf in this register**. And ours are very geared towards speed, preparation and boom, one maneuver, turn, grab the wall again, swim again in the wave" (S1DT1). "**Basically, what are you doing in BT? You are doing two things: one, you are doing a waiting time for the wall to stand up to attack**, (…); **the second, the second objective of the BT is for you to enter the wall of the wave with the board as vertical as possible**, right, because you don't do a BT, you attack the lip with the board at 40/60º, with the BT you attack the lip with the board closer to 90º". (S1DT1) This show us that the surfer has to have in good consideration the external factors representing the wave formation, because the BT shape has to be in accordance with the wave/section and the surfer should always try to full fill the wave with vertical going ups and downs. However, is expected if doesn't achieve the correct timing the surfer may make an adaptation to the BT shape to achieve the top of the wave.

Furthermore, almost all surf coaches (n=6 ~86%) agreed that the BT should be performed at the flat part of the bottom of the wave, "… it has to do, it will always have to do with what the wave asks for, do you understand? But, **what we ask of our athletes is that the BT is given right at the bottom of the wave** (…)" (S2DT1); and, "… **the ideal place is always at the base of the wave and at the most advanced level, beyond the base of the wave**, even if you manage to move a little beyond the base of the wave" (S2DT1).

Two of the surf coaches (~29%), with graduation in sports science, stated that the line drawn with the BT will help the surf coach to evaluate if the BT was well performed: "… **you analyze a BT through the line, the trajectory in the wave** and for the trajectory in the wave to be correct, this then has to have several success criteria at technical levels, varying the FS from the BS" (S3DT1). This reinforces the idea that the line drawn during the BT is a general performance criterion. Further, two surf coaches (~29%), with international titles, defended that this vertical approach of the descent to the bottom of the wave will allow the surfer to gain more speed and that a vertical approach going out helps the surfer to hit the critical zone, e.g. "… a BT has to be, **you have to descend vertically to the base of the wave, which is to win, try to gain maximum speed**, is not it, and then using your body a bit to press on the base and look closely at the area where you want to attack. **So you're looking up and attacking in the critical zone**" (S2DT2). This emphasizes the relation between the trajectory shape and the task goal.

Finally, the surf coaches with graduation in sports science and one with international title (n=4 ~57%), defended that position of the COM (here meaning: body leaning into the curve) during the curve and the rotation of the head and shoulders will influence the trajectory shape of the BT: "(…) I can move the COM, but if it doesn't follow with the rotation, it's not, **I'm not doing anything, I'll be projected, then I'll be projected forward. So, a displacement of the COM accompanied by the rotation of the shoulders, either for FS or BS, for me this is the most important thing**. Because if I'm turning my shoulders to the correct spot on the wave, it's all done, then I just have to think about the maneuver (…)" (S3DT2). This reinforces too the connections established in the deterministic model proposed between the trunk rotation, body leaning and the trajectory precision.

Head Orientation (OC)

All surf coaches highlighted that is fundamental that the surfer looks to the place where he wants to perform the maneuver: "First is the place where we do it, the place where we do BT. Then, it is the technique that we do the BT. I don't think we will ever be able to do a good BT if we do not have good technique and that has a lot to do with it, **another fundamental aspect is the place where we look, it is also super decisive,** and after what I also told you before, when we go up, we stretch too much" (S4OC3).

Almost all surf coaches (n=6 ~86%) described a good orientation of the head during the BT as follows: during the preparatory (descent) phase the surfer should be looking to the bottom of the wave, during the action (fundamental) phase has to change his gaze from the bottom to the place that wants to attack (Lip) and during the follow-through (ascent) phase the surfer should keep the orientation to the place that wants to attack (Lip), as one of them said: "I come on the wave and I'm preparing the maneuver, so **I go to the base and I'm looking at the base** (…)" (S2OC5); and, "**In the same way as you direct your head, you change your gaze from the base to the pocket of the wave**, you are rotating your torso towards the pocket of the wave (…)" (S1OC10); reinforced by another one thought that, "**Yes, the head here is still oriented towards the lip, so is still focused on the place where you have to... (…) You're starting to climb... so actually here's the final phase**... it's already, it's already when you're already climbing, do you understand? And here this ascent phase is the beginning of the ascent" (S3OC3).

Four coaches (two surf coaches with international titles and two others surf coaches with graduation in sports science) (~57%) specified that the surfer must be looking to the Lip, specifically after the lean into the curve of the surfer and engagement of the rail. About this, one of the four stated: "**The incline will put a little pressure on your toes**, isn't it, that is, even lift your heels a little. The front arm behind the front leg and the back arm starting to want to touch the water, because at the same time (…) you instinctively give them a certain confidence in their balance. **Then there's the look**." (S5OC3).

Furthermore, all surf coaches stated that the head orientation is fundamental to accomplish trajectory precision. “That is, **I cannot ask an athlete to verticalize a maneuver if the head does not go through the pocket, that is, if we do not look at the area where we want to put the maneuver**. So this is essential” (S3OC4); but, “it depends on the orientation of the head, on the rotation of the trunk... In this case that precision... let's say it's optimized, isn't it... **it's optimized by these components, by these details. Head orientation, it's from the base, it's looking at where the trajectory goes**” (S1OC1). This emphasizes the relation between the head orientation and trajectory precision in the deterministic model proposed in this work.

Rail Engagement (DFRAIL)

During the interviews the surf coaches were specifically asked about the engage of the rail and most of them (n=5 ~71%) had problems to understand the features concerning the engage of 2/3 of the rail. But after a little explanation of what was supposed to be, all surf coaches agreed with the feature of use of 2/3 of the longitudinal part of the rail during the BT, saying that is crucial to the performance of the BT: “(S2) – Rail usage, **what is this 0-2/3?** (MS) – think about it, imagine that it is when he comes from 0, that is, with the bottom part all settled, the bottom of the board all settled in the water and he suddenly, to do that BT right at the base, he will pass from 0 to 2/3 of the longitudinal use of the board. That is, here is a measure that can be observed. (S2) – **OK perfect. Exactly, very good**.” (S2DFRAIL5). They also stated that the flexion of the body, leaning into the curve and the applied pressure are the factors leading to the engagement the rail., “…but I think the most important thing is, without a doubt, to do it well at the base of the wave… and to use well your body and your board, they must be a whole, as if it were a band playing, do you understand? If the body, if you don't squat… and if you don't apply pressure it will never be a good BT. Ahhh, **if the rail of the board doesn't go into the water, you'll never be able to do a good BT**” (S2DFRAIL1).

Finally, two surf coaches (with graduation in sports science) (~29%) made the connection between the amount of inclination the surfer has, the amount of pressure applied on the rail and the amount of surfboard that will be out the water. One of them, stated: “Okay and this, let's say, deep down this depth, one thing is the length, 2/3 is right, okay, it can be a horizontal BT, or it can be a much more vertical BT, **the 2/3 will always be in the water, theoretically we click this box**, **now if we want to see if the COM has been moved... how was your question? As I understand it, if it was more or less displaced. What will dictate that at the bottom is not the 2/3 of the length, in my opinion it will be the depth, what stays in and what stays out of the water**. (…) **It could be an indicator**. **Obviously it's just for my coach's appreciation, because if I explain to an athlete that he has to leave 3 fins out of the water**... poor guy, he won't notice, he won't” (S7DFRAIL9). This shows that the surf coach could verify if the surfer really leaned

into the curve and applied pressure on the rail by the surfboard inclination and how many fins are out of the water.

Velocity (VEL)

Two aspects of the surfer "velocity" that were always referred during the interviews were the general movement speed and any kind of change of velocity during the movement.

In general, all surf coaches stated that the BT is a tool that will help the surfer to manage the velocity achieved from the descent, through a change of direction and keep or increase it until arrive at the top: "So **you have to ensure that there is a velocity of the slide and that there is no loss of speed when there is a change**, when you make a change, from the drop part when you make it to BT, you make a change of trajectory and if you do not do it well, you will also lose speed (…)"(S1VEL1).

All surf coaches described that during the BT technique the surfer has to exert force on the surfboard (impulse) that is accompanied by the motion of flexion-extension pattern of the body, e.g. "… there are BTs where you decompress more slowly and there are BTs where you have to decompress faster, **but we have to press and then take pressure off, because that's what will make the board project for the lip**. Okay and this part of pressing is very important". (S3VEL7). Two surf coaches, with graduation in sports (~29%), stated that the surfer has to adapt the impulse to his needs of velocity, taking into account the amount of velocity from the previous maneuver. As one said: "…here it doesn't compress as much... then there are these variables that have to do with speed, **the speed with which it comes from here is what helps not to have to compress and depend so much on the movement of your body to maintain speed**, that's exactly why he's more stretched" (S7VEL6).

Further, the surf coaches with graduation in sports science (n=3 ~43%) emphasized the importance that the velocity of the BT will have on the top turns, "… speed, all this, all this is important, but even without speed it is possible to make quality BT, of course with more... **in general, the more speed you have, especially when the descent of the wave, the more you'll be able to get away from the wave at the moment of the BT and it will give you the possibility to do totally different maneuvers at the top of the wave**. Since there are times when we don't need to do a BT so far from the base, because the maneuver doesn't require that either" (S4VEL8). This shows that the velocity of the BT will influence the range of maneuvers that the surfer would be able to perform into the top of the wave, that influence the final score.

Lean of the Body (IC)

All surf coaches considered the lean of the body very important for the BT technique, "**for me the most important thing is to move the COM out... out of the rail, because this is what will make you have speed and this is what will make you have projection**. Of course, I

can't talk about a displacement of the CM... I can do a displacement of the CM, but if I don't follow it with the rotation" (S3IC2). Almost all surf coaches (n=6 ~86%), stated that the lean into the curve works together with flexion of the body, to allow the surfer to engage better the rail of the board. "(Q) Do you think an athlete can make use of the rail (0-2/3), in the longitudinal part, without leaning the body into the curve? (S4) Getting it done, but then it falls apart. You always get it (laughs). Because the leaning of the body, when you get into the leaning part of the body, this has to do with the technique. If the... is the BT technique. **In the BT technique, the body has to be inclined, it has to be inclined, because you have to have your legs bent, you have to have your torso bent and then if you are using the rail**..." (S4IC2). This combination of movements was named by four surf coaches (~57%) as the compression that the surfer has to do during the action (fundamental) phase of the BT.

Also, three surf coaches (~43%) referred the lean of the body through the displacement of the COM, e.g. "**putting the hand will result in an inclination of the body, it will result in a displacement of the COM**, this is all connected, that is... we sometimes think... hey! why is he not arriving up there? We have to go back to the beginning of BT to understand that it is something, hey… the displacement of the COM for me is fundamental" (S3COM3). When these surf coaches cited the displacement of the COM, they seem to want to describe the lean of the body into the curve. The others surf coaches (~57%) stated that the lean of the body would imply the displacement of the COM.

Trunk Rotation (RT)

One of the surf coaches (with graduation in sports science) specifically considered the trunk rotation a fundamental feature of the BT: "I focused much more on the technical part, because I think that an athlete also only achieves high performance when he has the technique and in that sense, that is, **the issue of COM displacement, shoulder rotation, gaze, for me are fundamental**" (S3RT10). The others surf coaches (n=6 ~86%) described trunk rotation as an important feature to the performance of the BT.

All surf coaches mentioned the position of the shoulders through the position of the upper limbs as the feedback to give to their athletes, although they considered the movement goal was the rotation of the trunk, e.g. "So, for not having any repetition, that is, like you say "look and lift your arm", "twist your torso", ok… **but when you look and lift your arm, you are promoting the rotation of the torso and that is what is the critical feature, which is the trunk rotation**" (S1RT5). The surf coaches with graduation in sports science and one surf coach with an international title (n=4 ~57%) stated that the surfer should use the arms to help the surfer to achieve wider rotation of the torso: "**This arm (front) has to rotate to the place where I want to perform the maneuver, accompanied by this arm (back), because they can rotate this one (front), the left one in case it is regular, but if they don't rotate the outer arm, what will**

happen? They won't have the same range of rotation. So, this arm has to rotate (back), both arms must point towards the lip and then send the pizza to the floor again, in the rotation phase" (S3RT3).

The surf coaches with graduation in sports science (n=3 ~43%) defined that during the preparatory (descent) phase the surfer most have the torso orientated to the base of the wave, "… when I explain to my kids, I have two different methodologies here for FS and BS, but the initial step is the same, both on one side and on the other, **the position of the shoulders should be turned as much as possible towards the base of the wave at the initial moment of the drop**, that is, the shoulders and the gaze are directed, that is, the gaze is always ahead, the gaze and the shoulders are always in front of the legs" (S3RT1). Then, two of the surf coaches with graduation in sports science and one surf coach with an international title (n=3 ~43%) defined that in the follow-through (ascent) phase the surfer most rotate his shoulders/chest towards the Lip. One stated, "A fundamental thing is to follow, as I had already said, **with the rotation of the shoulders, shoulders and head to the place where we want to perform the maneuver,** this is fundamental" (S3RT5). This let us know that the shoulders rotation should always follows the head orientation and that this emphasizes the capability of the surfer to hit the Lip. This point of view was also described by almost all surf coaches (n=6 ~71%), saying that the shoulders rotates towards the gaze. This emphasizes the connection between the rotation of the upper body and the trajectory precision.

Phases (FASES)

In this research, the goal is to develop an observation tool that will be divided into phases to allow a more systematic observation. Before the interview, the surf coaches received the consensus version of deterministic model and the pilot version of the critical features (i.e. the movement was divided in 4 phases). During the interview, the consensus version of the critical features' table was shown (movement divided in 3 phases) and they were asked about their perspectives about the different division of the movement into phases (appendix I).

During the interviews, while describing the movement of the BT, all surf coaches divided the BT in three phases or mentioned that they felt that one phase was missing at the bottom of the wave in the version with the 4 phases. As one stated, "… **before the ascent, you still have a phase**, which is the phase... because on the descent, you still have a phase that is the base of the wave and you don't mention the base of the wave here" (S2FASES3). Therefore, when the consensus table of critical features (i.e. with the BT divided in three phases) was shown, they all expressed agreement with that new version, "(…) I like this model more... **I would consider the preparatory phase the descent, the fundamental phase the phase in which we are at the base**

of the wave and the final phase the phase of the 3rd/3rd going up. I think this model is better" (S3FASES9).

One surf coach with graduation in sports science (~14%) suggest to use a draw, where we can show the division of the wave in three equal parts and attribute one part to each phase: "I would define that maybe with a drawing it is even easier, the descent is the previous 1/3, dividing the wave in 3/3. **The 1st and 2nd third is the descent phase, the second phase is in the 3/3 of both the descent and the ascent and the last BT phase is in the upper 2nd/3 and 3/3 in the ascent phase**" (S3FASES5). Furthermore, all surf coaches agreed that the fundamental phase would happen at the bottom of the wave.

In the following subcategories, the coaches' perception of the timing of each critical feature during each of the 3 phases will be explored.

Preparation Phase

The first phase of the BT task is the preparatory (descent) phase, where the surfer goes to the bottom of the wave, "… a BT has to be, **you have to descend vertically to the base of the wave**, which is to win, try to gain maximum speed" (S2DT2).

All surf coaches stated that the head orientation leads the rotation of the of the body and that the movement of the other segments will follow, "because here is the rotation of the trunk towards the wave but the look is towards the pocket… If **the sequence of movements is first I look and then I rotate the trunk**, **it is not. Normally the torso rotates in the direction of the gaze**, try to see some connection here" (S7OC2).

Being the head orientation the body segment that leads the movement and helps the surfer to interpret the descent of the wave, almost all surf coaches (n=6 ~86%) stated that firstly, the surfer must have the gaze orientated to the bottom of the wave: "(…) As for the preparatory phase, I think it is a little poor, you could develop **the preparatory phase more, because there are many more factors than just a head oriented to the base of the wave** and the flexion of the knees, namely, the positioning of the trunk and arms. I also added here the positioning of the weights even after the take-off and the axis of the shoulders" (S7FASES_P9). Also the surf coaches with graduation in sports science (n=3 ~43%) stated that the shoulders should be orientated to the same place, "**on the descent we talk about the trunk rotation towards the base**, isn't it, because we are talking here… trunk rotation towards the wave. hum… I would say that on the descent the trunk is facing/directed towards the beach" (S7FASES_P2), seeing that the shoulders follow the head orientation.

Moreover, all surf coaches stated that during the descent the surfer must lean the torso over the front knee and flex the lower limbs. "After taking the take-off, **when we are going down the wave, put the weight on the front leg, either... the legs bent, the torso also bent, the chest close to the front leg,** an arm of each side and reach the base as early as possible" (S4FASES_P1).

The movement of flexion of the hip and knees will happen after the head and chest orientation to the bottom of the wave, because those segments lead the movement. As one mentioned: "… when I explain to my kids, I have two different methodologies here for FS and BS, but the initial step is the same, both on one side and on the other**, the position of the shoulders should be turned as much as possible towards the bottom of the wave at the initial moment of the drop, that is, the shoulders and the gaze are directed, that is, the gaze is always ahead, the gaze and the shoulders are always ahead of the legs**" (S4FASES_P1).

Fundamental Phase

The fundamental phase is when the surfer is at the bottom of the wave, or just like the one of coaches would describe it, is during the 3/3 of the wave: "**it's when we're at the bottom of the wave, it's when we're in the last third of the wave, both going down and up**" (S3FASES8).

Almost all surf coaches (n=6 ~86%) stated that when the surfer is arriving the base of the wave he has to start to change his head orientation to the place where he wants to attack (Lip). One stated that, "when we are in the drop at the top of the wave, in the top 1/3 of the wave to be dropped, our head and shoulders are turned towards the base, **as we approach the base, our shoulders and our head start to look to the place where we are going to start, where we want to place the maneuver,** that is, the spot we have determined for the maneuver" (S3FASES_FU1). This reinforces the idea that the head is the first segment to move.

All surf coaches stated that following the change in the head orientation, the surfer has to flex the lower limbs (even more) to lean into the curve and to engage the rail. One mentioned that, "I want to see the athlete doing this progressive compression, you see, on the descent, not completely. So that you know how to dose this compression well and **I want to see the athlete very compressed down here in the BT, completely leaning forward, even holding the board with the rail, with the back arm preferably touching almost the water**, for him to feel the level more or less he can go and the little front arm behind the leg. It does not mean that it is well glued to the leg, but that it is behind the leg, for me it is already important" (S5FASES_FU2); and another one reinforced that, "Until the descent begins and then the fundamental phase begins. Which is that curve at the base and then back up, **which is the main phase, it has to do first with... the positioning of the knees. Sorry, the look, the positioning of the knees, the hand in the water and then direct the board to the place where the maneuver will be performed** (…)" (S7FASES_FU5). Almost all surf coaches (n=5 ~71%) related the lower limb flexion and lean into the curve with the approach of the hand to the water: "…the AI here is even a special case, because he would normally go down the wave a little stretched out, **but at the moment of compression down there, he would bend, he would almost put his elbow in the water**" (S4FASES_FU8).

Moreover, almost all surf coaches (n=5 ~71%) stated that after bending the body (lower limb and trunk flexion), leaning into the curve and engaging the rail, the surfer should change his gaze directed to the place where he wants to attack (Lip). “There are also many cases in which the athlete is not compressing the rail from the inside, that is, he is not taking full advantage of the speed he can gain in the moment before the ascent and **in that moment before ascending, to the top of the wave, the athlete legs bent, torso on top, torso bent over the front knee... the head has to be directed to the place where we want to perform the maneuver, preferably at a higher level, we have to point for the lip**, that is, for a trajectory as vertical as possible.” (S4FASES_FU3).

Two surf coaches, with graduation in sports science (~29%), stated that the hand leaving the water will dictate the end of the action (fundamental) phase and be responsible for the weight transition to the back of the feet , “she keeps it, look at the displacement of the COM, the shoulders are out of the board, do you understand? weight is on tiptoes, but slightly more on tiptoe of back foot... **now full rail (completely on base), keep looking, keep looking, arm comes out behind, do you understand? Continues to look and here it extends the torso, that is, when it leaves the 2nd/3 of the wave to go up**, it moves away to perform the maneuver” (S3FASES_FU11).

Follow-Through Phase

The follow-through was defined as the ascending phase of the BT task. Where the surf coaches identified as the moment when “goes up” or “starts to climb”. The beginning of this phase is identified by one of the coaches as the timing when the surfer leaves the base of the wave 3/3 and enters the 2/3.

Almost all surf coaches (n=5 ~71%) affirmed that the extension of the lower limbs dictates the beginning of the follow-through (ascent) phase, “**the body has to stretch and at the same time it stretches is when you get out of the BT**”. (S2FASES_FI1). Three of the surf coaches, two with graduation in sports science and one with world title (~43%), emphasized that this extension should be progressive: “(…) and then is also **important that the angle of the trunk, with the legs that does not open completely at the moment of the exit of the BT to the top of the wave. It has to be a gradual opening and it has to be an opening that never comes to a full opening**” (S3FASES_FI5). All surf coaches stated that this extension of the lower limbs and torso will allow the surfer to disengage the rail and shifts weights more to the back of the feet, “… it goes up and you move a little more to the back, to the leg, to the back leg, isn't it. You're there a little bit pressing on the front leg, all bent over and **then when you want to go up there, you change the COM backwards and that will have an influence on your trajectory** (…) **This change of that, that weight, so you leave that crouching position to, you understand, to go to the area where you want, which is when you pass the weight back and**

you lighten the weight of the board and take the board up, I don't know I say... I think it ends up being a bit interconnected here" (S2FASES_CC_FI2).

Almost all surf coaches (n=5 ~71%) said that during the progressive extension the surfer should rotate the torso towards the place to perform the maneuver (Lip), projecting the leading arm and disengaging the rail, "that **later on the climb is not so aligned, because the body has to go from compression to decompression, with a rotation of the trunk** and then it becomes a little more misaligned, it is only aligned again after the maneuver at the top of the wave" (S7FASES_FI2); and "then comes the angle of the knees between 150 and 170º, removed from the rail from the water... this has to be before**. This removal of the rail from the water has to be entered with the head, with the look and with the rotation of the torso**... this movement is all allied..." (S7FASES_FI2); and reinforced for another one stated that: "**on the climb you have to aim for the area where you want to perform the maneuver, so is for the lip** (…)" (S2FASES_FI3).

Differences between Frontside and Backside

During the interview the surf coaches were specifically asked if they thought that the critical features could be used for both sides. All of them described that the majority of the critical features of the BT technique are similar for FS and BS, as stated from one of them: "there are many BT criteria for both FS and BS, **although the vast majority are all the same** (…)" (S4BSFS1). However, some differences were described by the surf coaches: points of pressure; hand approaching the water; hand leaving the water; and lean of the body.

Three surf coaches (with graduation in sports science and an international title) said that the points of pressure would be different (toes or heels): "(…) Here it is supported and **I'm going to do more in this part (anterior third), when it's FS I do this, when it's BS I'm using this part more (posterior third of the foot)** (…)" (S4BSFS_CC2).

All surf coaches defined which is the hand that approach the water, depending on the side. They said that at FS should be the rear arm. "[W]hen I talk about the hand, **I talk a lot about FS, the back hand approaching the water** (…)" (S4BSFS_PMS1), and at BS should be leading arm: "a regular surfer, but **now with BS on a left, there are those who like to put their left hand** in the water (...) instead of taking their left hand, which **is our guiding arm or leading arm** (…)" (S4PMS8).

Almost all surf coaches (n=6 ~86%) described that during a FS BT after approaching the hand to the water, the rear arm should make an abduction, going towards the back of the surfboard and creating a rotation of the trunk. The surf coach with one world title was more specific saying that the arm should rotate until reach straight line with the shoulders. As one stated: "the arm doesn't come back here, **so the arm has to be here (follow the line of the shoulders) it has to**

be here on this side... but I don't like it touching the water." (S2PMS4). During the BS they described that the arm should raise towards the place to attack (LIP), to allow the surfer to have a better rotation, "(…) the surfer ends up instead of, instead of taking the left hand, which is our "guiding arm" or "leading arm" towards the top of the wave, **instead of projecting the arm towards the top it will end up happening that the arm ends up coming behind the back and we end up being blocked**, especially in the lumbar area and we can't make a correct trajectory (…)" (S4PMS8).

Two surf coaches, one with graduation in sports science and one with an international title (~29%), stated that the scale should be more precise when describing the lean of the body into the curve, "passing the initial velocity that needs to be generated. Hey, the displacement of the COM, **in the BS is to put... the tail outside the rail and in the FS it is to place the shoulders outside the rail**, is not and the shoulders of FS... We in the BS we rotate the shoulders to the (wave) and in FS we have to create a twist" (S3BSFS_CC2), they described which segment of the body should be place out of the surfboard, depending on the side.

Scale Levels

During the interview we asked the surf coaches what they thought were the best scale to evaluate the critical features (yes/no, 1-3; 1-5). Almost all surf coaches (n=5 ~71%) said that they preferred a numerical scale, e.g. "I like it a lot and work a lot with the 1 to 3 scale. 3 performed well, 2 weak or average and 1 weak. Now.... **assign this score to each of the BT phases... only in video analysis with the athletes, which can also be done in 1, 2 and 3**" (S7NC1); reinforcing that, "It doesn't do it, it does it but it doesn't do it well, but it does it and it does it... I think so. **Now you can be rigorous, which is the one from 1 to 5, which also works, which is 1 doesn't really work and 5 is very good, and being 2, 3 and 4 is on this scale of 1, 2 and 3 But you can always do this with a 3+ and a 1-**" (S1NC2). Four surf coaches, with international titles and graduation in sports science (~57%), defended that within the numerical scale the scale 1 to 5 is the best option or most used by them.

Two surf coaches, with international title (~29%), argued that the number of levels of the scale should change accordingly with the level of the athletes: "Of course, if you really want to be assertive, I think giving a scale is better. If you really want to be assertive. But I think, you can say... I can't answer you this way. I would say it like this... **for an athlete already very advanced I would put a scale, because he knows how to compartmentalize the things he has to do along the wave. For a beginner athlete, no, it was yes/no, nothing more. Didn't go into details**" (S6NC1).

Usability and Importance of the Scale to the Training process

At the end of the interviews the surf coaches were asked about the usability and importance of having an observation tool for the training process. All surf coaches stated that if they had a tool like that they will be using it in daily training sessions or that they are using something similar: "**Yea. I use it**... when, for example, at this point in my career, I don't have athletes learning maneuvers, it's not. I already have experienced athletes, who sometimes observe the execution of the technique, which as a consequence of not being able to complete a maneuver is a poorly done BT. OK? But it's another maturity... I think this would apply much better and would be much more useful in the formation layers" (S7UE1); And, "(Q) [d]o you think this was an observation tool that you would use in your trainings? (A) **Yes. Yes, absolutely. Yes. I, I, I, make a sketch like this on the student sheet when I'm giving training**" (S5UE1).

All of them (~57%) also pinpoint out about the importance of having a tool like this in surfing and said that would be an added value for surf training. As one stated, "**I think this is an important work that can be done for the benefit of the coaches' community** due to the low number of written documents that there is, in relation to surfing, a more technical content, but I think, I think what has happened is that these documents" (S3IT2).

The surf coaches with graduation in sports science (n=3 ~43%) specified that this observation tool will have a better application in formation layers and less experienced surf coaches. Would be a tool that can guide them defining the goals to improvement "(…) [B]ut I believe that or **with less experienced coaches, or with coaches who don't master the subject so well, or with maybe lower level athletes, that this could be a good tool for the coach together with his athletes to define goals**" (S4IT1).

Conclusion

The aim of this study is to develop an observation tool, to be used by surf coaches, to assess the athletes' Bottom Turn technique. In order to accomplish this goal, first a deterministic model of the movement was developed and the critical features of the movement were determined. Second, the views of top National coaches about the model and critical features were considered to develop the final scale.

The group of surf coaches with graduation in sports stood out by their capability for expressing their opinion about the deterministic model, and clearly expressed their agreement with the model. When asked directly, the surf coaches without any sports science formal education, revealed to have some difficulty to understand the deterministic model. However, during the interviews their quotes about the movement and critical features were also in accordance with the model. This shows that they are not used to analyze that type of models, but they know what does each feature and what it influences. The only factor which was not directly considered in the deterministic model was the Weight (Force) distribution between and within limbs. All coaches described systemically that the surfer should have different weight positions, accordingly with the BT phase and that this will be influenced by the lean of the body and the angles of the trunk and lower limb (flexion/extension). Thus, weight distribution was not added to the deterministic model. During the interviews the surf coaches mentioned always the upper body as trunk, due to that, we changed upper body angles for trunk angles (figure 3).

The critical features and respective timing were the most argued themes during the interviews which led to, a more complete, and different version of the observation tool, (table 7).

The surf coaches indicated that the weight distribution will influence the engagement of the rail and this will influence the velocity achieved by the surfer at the end of the BT. The weight shift is accomplished by the positioning of the upper body (leaning into the curve) and angles of the lower limbs and trunk. This led to creation or reconstruction of critical features like, the "Trunk over the front foot - orientated to the bottom (FS – leading arm over outer rail, rear arm over inner rail; BS – leading arm over inner rail, rear arm over outer rail)", the "The body leans into the curve (hand of the inner rail reaches the water)." and "progressive knee and hip extension".

The surf coaches specified that the lower limbs and torso angles should be equal or lower than 90º during the flexion, the extension of the lower limbs should be progressive and the hip angle should never be higher than 90º. The flexion-extension pattern of the body, as well as the weight distribution, will dictate the ability to produce force and impulse and, as consequence, the velocity gained by the surfer. While flexing the lower limb joints, the surfer must have the weight over the front foot and during the extension the surfer should transfer the weight to the back foot.

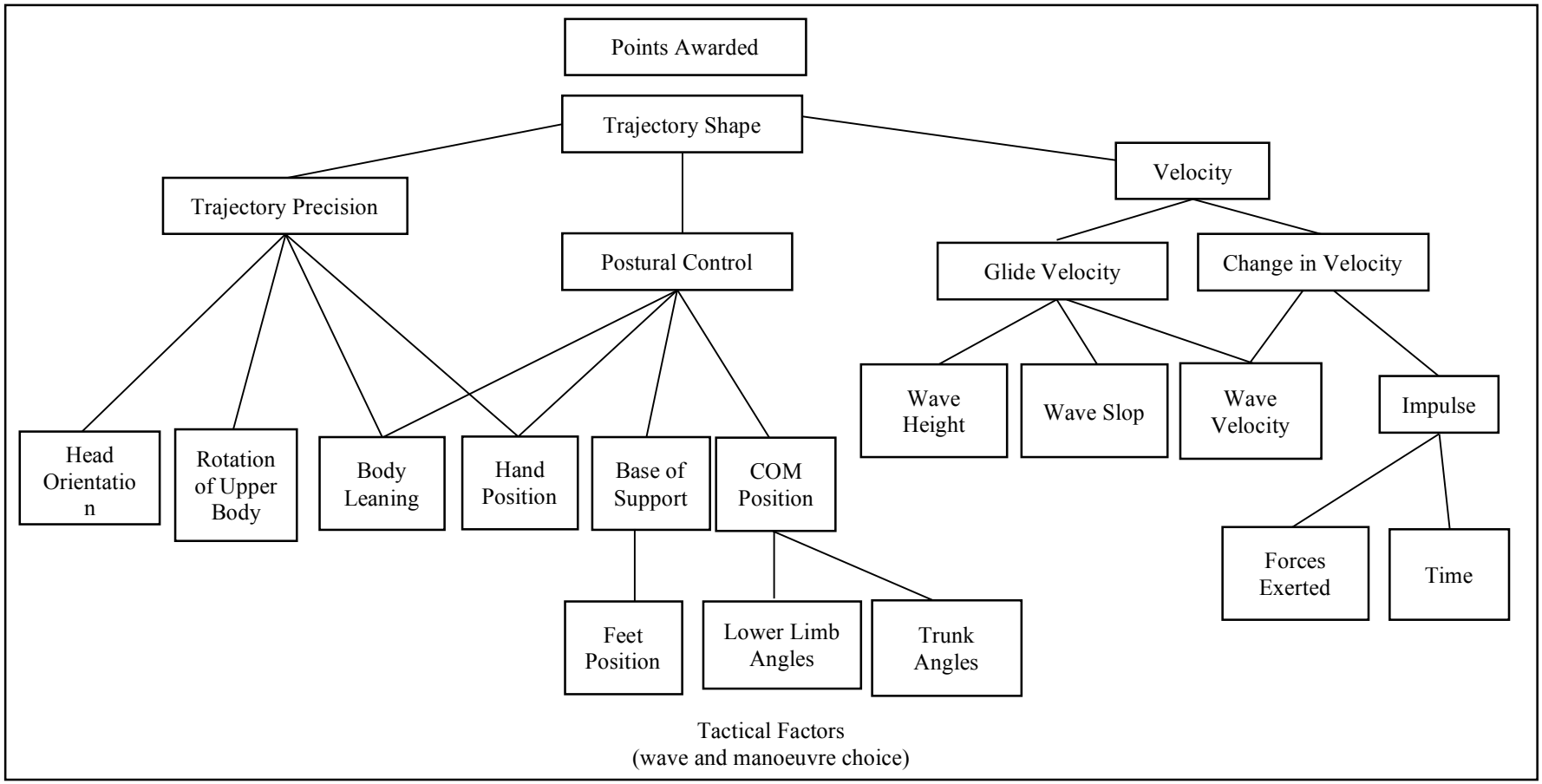

Figure 3 – Deterministic Model – final version

Table 7 – Observation Tool – final version

Phase	Picture	Critical Features	Evaluation Scale				
			Poor	Fair	Good	Very Good	Excellent
Preparation Phase	 	The head oriented to the bottom of the wave	1	2	3	4	5
		Trunk over the front foot - orientated to the bottom (FS – leading arm over outer rail, rear arm over inner rail; BS – leading arm over inner rail, rear arm over outer rail)	1	2	3	4	5
		Knee flexion between 90º and 110º	1	2	3	4	5
Action Phase	 	The orientation of the head changes to the Lip.	1	2	3	4	5
		Knee flexion angle ≤90º	1	2	3	4	5
		Hip flexion angle ≤90º	1	2	3	4	5
		The body leans into the curve (hand of the inner rail reaches the water).	1	2	3	4	5

		Length of the rail the rail = 2/3	1	2	3	4	5
		Head oriented to the Lip	1	2	3	4	5
		- Hand of the inner rail starts to leave the water and the trunk starts to rotate. (FS – abducts; BS - raises)	1	2	3	4	5
Follow Through	 	Progressive knee extension	1	2	3	4	5
		Progressive hip extension	1	2	3	4	5
		Knee extension angle ≤150º	1	2	3	4	5
		Hip extension angle ≈90º	1	2	3	4	5
		Length of the rail =0	1	2	3	4	5
		Trunk faces the Lip	1	2	3	4	5
		Leading arm (from the outer rail) points to the Lip	1	2	3	4	5
Over-all	Reaches the bottom of the wave (base)		1	2	3	4	5
	The best trajectory shape (U, V or W), considering the external factors		1	2	3	4	5

BS – Backside; FS – Frontside

This lead to the replacement of the critical features that in the consensus version only specified the knee flexion angle by the following critical features: in the action phase was “knee flexion angle ≤90º”, “hip flexion angle ≤90º”; and in the follow through was “progressive knee extension”, “progressive hip extension”, “knee extension angle ≤150º” and “hip extension angle ≈90º”. In the preparatory phase the feature was reconstructed “knee flexion between 90º and 110º”.

Although the hand touching the water was considered not to be crucial to the performance of the BT, the majority of the surf coaches stated that the “approach of the upper limb to the water” helps the surfer to achieve several critical features of the BT, as: flexion of the body, lean of the body and apply pressure. Also, when the surfer decides to go up, the coaches agreed that it is fundamental that he/she starts the climb by moving away the upper limb from the water and the trunk rotation towards the crucial part of the wave (Lip). The trunk rotation will have a wider range and be more efficient if the upper limbs work together. This lead to adding some critical features: in the preparation phase was “Trunk over the front foot - orientated to the bottom (FS – leading arm over outer rail, rear arm over inner rail; BS – leading arm over inner rail, rear arm over outer rail)”; in the action phase was the “The body leans into the curve (hand of the inner rail reaches the water).”; and in the follow through was “trunk faces the Lip” and “Leading arm (from the outer rail) points to the Lip”. While developing the new scale item a more detailed description was used, with the goal of clarifying the critical features.

According with the interviewed surf coaches, a good BT should always be in accordance with the external factors, to arrive at the top of the wave at right tempo, even if sometimes the surfer would have to adjust his trajectory. However, the surfer that performs a “U” BT would show better adaption to the external factor, showing more expertise. Furthermore, the surfer should never miss the bottom of the wave during the performance of the BT. This lead us to adapt the general features to “reaches the bottom of the wave (base)” and “the best trajectory shape (U, V or W), considering the external factors”.

The head orientation was seen by the coaches as the steering wheel of the BT, meaning that the surfer has to look to where he wants to go. Also, they all agreed that the head is first segment making a rotation towards the goal. Thus, during the BT the head should be to the bottom of the wave and then changes to the place to perform the maneuver (Lip). The surf coaches specifically mentioned that the gaze should be to the Lip and not to the pocket, because the last one is too vague. This give place a new feature in the action “head orientated to the Lip” and the correction of other feature “changing the head orientation to the Lip”.

The existing critical features from the consensus version relating to the quantity of rail engaged “engaging the rail (0-2/3)” were mostly misunderstand, but after a quick explanation they all agreed that this was a critical feature of the movement. The surf coaches with graduation

in sports specifically mentioned that they would see the amount of inclination, flexion and force that the surfer is performing, by the number of fins that he placed out of the water. These features were simplified to the final version: “length of the rail the rail = 2/3” and “length of the rail =0”.

The theme velocity was taken as very important during the analysis of the deterministic model, but during the analyze of the critical features this didn’t received such importance directly. However, they correlated the velocity acquired by the surfer with other features such as: weight distribution, the engagement of the rail and flexion-extension pattern. These features are related with the application of pressure or force over the surfboard, that will generate speed.

The lean of the body into the curve and the flexion of the body were most of the time considered as two features that work together to achieve the engagement of the rail, to apply more pressure over the internal rail. Some surf coaches expressed the lean of the body through the displacement of the COM.

Trunk rotation was also considered an important critical feature that would follow the head orientation and was most of the time mentioned through the position of the upper limbs. The trunk should be first orientated to the bottom of the wave and then to the place where the surfer wants to attack (Lip). This allowed to the creation of new features such as: in the preparatory phase “Trunk over the front foot - orientated to the bottom (FS – leading arm over outer rail, rear arm over inner rail; BS – leading arm over inner rail, rear arm over outer rail)”, in the follow through “Leading arm (from the outer rail) points to the Lip”.

During the interviews all the surf coaches stated that they felt that was missing a phase during the bottom of the wave and, when they were shown the 3 phase option, they preferred the movement divided in three phases.

Furthermore, for each phase the surf coaches described the sequence of the critical features and we rearrange the order of the items accordingly. Namely, the head orientation leads the movement, followed by the trunk with one arm each side and slight flexion of the lower limbs (between 90º and 110º). Arriving at the bottom of the wave the surfer should shift his gaze to the Lip, bent even more (≤90º), lean into the curve (hand of inner rail approaches the water) and engage the rail (2/3). After engaging the rail, the surfer mostly has the head orientated to the Lip. Then, dictating the end of fundamental phase and the start of the climb of the wave, the hand (from the inner rail) should leave the water, and in the case of FS BT the hand from the inner rail makes an abduction, in the case of the BS BT the hand from the outer rail projects to the Lip. The follow-through phase starts with the progressive extension of the lower limbs (≤150º) and extension of the Hip (≈90º). This extension and release of pressure will disengage the rail (0), and should project the surfboard to the Lip with the help of the trunk rotation and raise of the leading arm (outer rail) towards the Lip.

The surf coaches stated that almost all features are similar to both side of the BT, but there are some few differences as: the points of pressure (heels or toes); the hand approaching the

water (FS – rear arm and BS – leading arm); and the movement that the hand does when is leaving the water (FS – is an abduction and BS – is an elevation of the arm). The scale was adapted accordingly by specifying the appropriate critical features.

The surf coaches seemed to prefer a numerical scale and the majority of the surf coaches preferred a scale 1 to 5 (1- very poor; 2 – poor; 3 – average; 4 – good; 5 - very good), a scale to which they are used to, because although the judges scale is from 1 to 10, they have the same descriptors for each 2 points, and thus we adopted this scale. However, we are aware that 5 levels maybe not be suitable for the classification of all of the items. A future study testing several athletes with different technical levels will help to clarify this issue, as well as to select the most important items, or to attribute different weights according with the item importance to the movement overall technique.

Finally, the surf coaches agreed that they having an observation tool would help into theirs daily job or that they use something similar. They still mentioned that an observation tool like this will have better application over the formation layers and with less experienced surf coaches, which seems natural, as the BT is a fundamental maneuver for beginners, one of the first to be taught.

Since that this observation tool was developed with Portuguese surf coaches a Portuguese version of the final version was also created (see appendix VII).

Future Works

The future works should first focus on assessing the content validity of the tool with a wider group of surf coaches, to determine its comprehensiveness, comprehensibility and relevance. Then, the remaining measurement properties (validity, reliability and responsiveness) should be tested.

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Appendix I – Interview Transcript

DATA:___/___/___	CÓDIGO DO PARTICIPANTE:_____

Entrevista ao perito na área do treino de surf

1. Para si, qual o critério de performance de um bom BT, isto é, o que distingue uma boa de uma má performance? (pedir exemplos concretos na sequência da resposta)		
2. Tendo em conta esse critério de performance, quais os fatores/componentes que considera serem determinantes para essa performance? E porquê? (pedir exemplos concretos na sequência da resposta)		
3. Considera que o critério de performance que mencionou está espelhado neste modelo teórico? Se não porquê?	**Sim**	☐
4. E quanto às relações entre os diferentes fatores que influenciam esse critério de performance? Considera que também estão espelhados no modelo? Se não porquê?	**Sim**	☐
5. Considerando a tabela das componentes críticas, concorda com a sistematização apresentada? 5.1 E considerando os itens atribuídos a cada fase? Pensa que são ajustados para se analisar/avaliar o BT?	**Sim**	☐
Se a resposta foi **não** quais são, para si, os fatores mais importantes para a técnica (que feedbacks dá mais frequentemente quando dá treinos; eventualmente comparar elites com principiantes se o entrevistado não tiver sido claro)?		
6. Ainda em relação à tabela, considera que existem itens relevantes (críticos) para avaliar a técnica BT que **não** estão considerados?	**Não**	☐
Se a resposta foi **sim** indique quais e porquê.		
7. Pensa que todas as componentes críticas se podem utilizar na análise da técnica BT tanto no frontside como no backside? Se não, quais as que considera diferentes e porquê? 7.1 Só para que fique claro, quais serão então as componentes críticas para o frontside e para o backside?		

8. Uma questão controversa no BT é a colocação da mão na água. Considera que este fator é importante para uma boa performance do Bottom-Turn? Porquê? (verificar se o entrevistado faz referência à inclinação do tronco)
   8.1 Então e a utilização do rail considera importante? Porquê? (verificar se o entrevistado faz referência à inclinação do tronco)
   8.2 É através desta utilização do rail que avalia a inclinação do corpo?

9. Pensa que se deveria considerar o tempo total de execução ou a forma da trajetória como uma CC? Ou será um critério de performance?

10. Se dividíssemos a execução do BT por fases, pensa que fases de movimento que apresentamos estão bem divididas? **Sim** ☐

Se a resposta foi **não**, porquê e se tem alguma sugestão para a sua divisão.
(se sim, mostrar a proposta por 3 fases e pedir para indicar qual a que consideraria como melhor opção para a análise/avaliação do BT e porquê)

Fase	**Componentes Críticas**	**Movimento total**
Fase Preparatória	- Cabeça orientada para a base da onda. - Flexão dos joelhos entre 90º e 110º.	- Duração do Bottor - Desenho da Curva
Fase Fundamental	- Mudança do olhar da base para o pocket da onda. - Utilização do rail (0- 2/3). - Aproximação da mão da água. - Rotação do tronco em direção à onda.	
Fase Final	- Extensão dos joelhos entre 150º e 170º. - Retirada do rail da água (2/3-0). - Mão afasta-se da água. - Distância da prancha ao pocket.	

11. Pensa que estas CC poderiam ser transformados em parâmetros/itens de avaliação do BT? Se sim, que tipo de escala se poderia/deveria aplicar? Faz/Não faz, 1 a 5, 1 a 10 ou outro? Porquê?

12. Se fosse elaborada uma escala para avaliação da técnica de BT a partir deste modelo e destas componentes críticas em que medida poderia ser uma ajuda para o processo de treino? Porquê?

13. Gostaria de acrescentar mais algum comentário em relação a este modelo e/ou às componentes críticas para esta técnica desportiva?

Appendix II - Social Questionnaire

CÓDIGO DO PARTICIPANTE: BIOMECSURF_____

Questionário Sociodemográfico

Data de nascimento: ___/___/_____ Sexo: masculino ____ feminino ____

Habilitações literárias: _____ Profissão principal: _____

Formação académica de base (licenciatura):

- Não aplicável
- Ciências do Desporto ou similar
- Outra. Qual? _____

Grau de treinador (se aplicável): _____

Área de especialização para a qual está a ser convidado a participar neste painel:

- Biomecânica
- Treino de surf
- Validação de instrumentos

Há quantos anos trabalha na área referida acima? _____

Se foi convidado como treinador de surf, por favor responda também às seguintes questões.

Há quantos anos treina atletas que participam em competições? _____

Atualmente, treina atletas de que escalões?

_____

Qual o melhor resultado que obteve como treinador?

_____

Foi atleta de surf? sim ____ não ____ Se sim, durante quantos anos? _____

Participou em competições? sim ____ não ____ Se sim, qual o melhor resultado que obteve como atleta? _____

Muito obrigado pela sua colaboração e tempo dispensado!

Appendix III – Informed Consent

[Type here]

CÓDIGO DO PARTICIPANTE: BIOMECSURF_____

CONSENTIMENTO INFORMADO LIVRE E ESCLARECIDO **PARA INVESTIGAÇÃO CIENTÍFICA COM SERES HUMANOS**

Título do projeto ou estudo: Development and Validation of an observation tool for the Bottom-Turn manoeuvre in surfers.

Pessoa responsável pelo projeto: Vera Moniz-Pereira

Mestrando: Micael de Sousa

Instituição de acolhimento:

Faculdade de Motricidade Humana – Universidade de Lisboa

Este documento, designado **Consentimento, Informado, Livre e Esclarecido**, contém informação importante em relação ao estudo para o qual foi abordado/a, bem como o que esperar se decidir participar no mesmo. Leia atentamente toda a informação aqui contida. Deve sentir-se inteiramente livre para colocar qualquer questão, assim como para discutir com terceiros (amigos, familiares) a decisão da sua participação neste estudo.

Informação geral

A técnica do *Botttom-Turn* é uma das técnicas base do surf, pois proporciona o surfista voltar para a onda e não continuar uma trajetória retilínea, fugindo da onda. Sendo um dos objetivos do/da surfista estar sempre na zona de maior força da onda, este movimento é essencial para tal, ainda mais para surfistas competidores, pois as manobras na zona crítica da onda contabilizam mais.

O objetivo deste projeto é a criação e a validação de uma escala de observação para a manobra *Bottom-Turn*. De forma a atingir o resultado desejado, um dos passos necessários é definir quais as componentes críticas do gesto técnico de forma a ser possível construir uma escala de observação. Neste sentido, vimos convidá-lo a fazer parte do painel de peritos a avaliar o modelo determinístico criado e as componentes críticas determinadas.

Qual a duração esperada da minha participação?

A reunião de peritos terá a duração aproximada de 2horas.

Quais os procedimentos do estudo em que vou participar?

Na realização deste estudo vamos convidá-lo(a) a fazer parte do painel de peritos com o objetivo de avaliar a escala de observação para a manobra *Bottom-Turn*.
Mais concretamente, iremos pedir-lhe para: preencher um questionário de caracterização sociodemográfica (1) e responder a algumas questões acerca do modelo determinístico criado e as respetivas componentes críticas que daí resultaram (2).
Dada a pandemia da COVID-19, os documentos serão enviados de forma digital e a entrevista será realizada através da internet. No final deste documento iremos, também, pedir-lhe a sua autorização para gravar a entrevista.

A minha participação é voluntária?

A sua participação é voluntária e pode recusar-se a participar. Caso decida participar neste estudo é importante ter conhecimento que pode desistir a qualquer momento, sem qualquer tipo de consequência para si. No caso de decidir abandonar o estudo, a sua relação com a Faculdade de Motricidade Humana (FMH) não será afetada. Se for o caso, o seu estatuto enquanto estudante ou funcionário da FMH será mantido e não sofrerá nenhuma consequência da sua não-participação ou desistência.

Quais os possíveis benefícios da minha participação?

Obter uma escala de observação que tornará mais objetiva a avaliação da técnica de Bottom-turn do atleta.

Quais os possíveis riscos da minha participação?

Uma vez que as atividades em que vai participar envolvem apenas a realização de uma reunião, atividade que não envolve risco maior do que aquele que está sujeito no dia a dia, não são expectáveis quaisquer riscos ou desconforto decorrentes da participação deste estudo.

Há cobertura por uma companhia de seguros?

Visto não ser esperados quaisquer riscos ou desconfortos associados à participação neste estudo, não está prevista cobertura de riscos por apólices de seguro.

Como é assegurada a confidencialidade dos dados?

A informação obtida neste estudo é confidencial e não será revelada a pessoa alguma sem o seu prévio consentimento, exceto à equipa responsável por este estudo. Os resultados do estudo serão tratados e apresentados de forma inteiramente **anónima**. A confidencialidade dos dados será garantida substituindo o nome do participante por um código conhecido exclusivamente pelos investigadores. Este código consta no canto superior direito da primeira página deste documento. Após a recolha, os dados serão armazenados, devidamente

codificados, no Laboratório de Biomecânica e Morfologia Funcional e as respetivas bases de dados no servidor do mesmo Laboratório.

O que acontecerá aos dados quando a investigação terminar?

Os dados recolhidos passarão a fazer parte da base de dados da Laboratório de Biomecânica e Morfologia Funcional e serão posteriormente usados para fins de investigação, sempre com garantia do anonimato do participante.

Como irão os resultados do estudo ser divulgados e com que finalidades?

Os resultados serão divulgados através da publicação de 1 tese de mestrado e de 1 artigo científico.

Em caso de dúvidas quem devo contactar?

Para qualquer questão relacionada com a sua participação neste estudo, por favor, contactar:

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ou

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biomecânica
Laboratório de Biomecânica e Morfologia Funcional

Assinatura do Consentimento Informado, Livre e Esclarecido

Li (ou alguém leu para mim) o presente documento e estou consciente do que esperar quanto à minha participação no estudo Development and Validation of an observation tool for the Bottom-Turn manoeuvre in surfers. Tive a oportunidade de colocar todas as questões e as respostas esclareceram todas as minhas dúvidas. Assim, **aceito voluntariamente participar neste estudo e aceito que a minha entrevista seja gravada**. Foi-me dada uma cópia deste documento.

Nome do participante	**Assinatura do participante**
	Data

Investigador/Equipa de Investigação

Os aspetos mais importantes deste estudo foram explicados ao participante ou ao seu representante, antes de solicitar a sua assinatura. Uma cópia deste documento ser-lhe-á fornecida.

Nome da pessoa que obtém o consentimento	**Assinatura da pessoa que obtém o consentimento**
	Data

Appendix IV – Codes and Description

CÓDIGOS: DESCRIÇÃO

Código	Descrição
DT	Desenho/forma da trajetória/curva; ou preencher bem ou não a onda, ao longo do percurso; ir para a frente e para trás na onda; U, V W; fazer a ondas aos bocados. DT_DBT: duração da fase fundamental; duração do BT na base DT_PCK: quando o BT é executado (ou não) na zona crítica onde queremos fazer a manobra; zona mais vertical da onda; sempre que se refere o vir ou não à base ou estar mais afastado da onda, distância à base da onda ex: "O BT feito no sítio certo"
OC	Orientação da cabeça/olhar para onde quer ir.
RT	Rotação do tronco; tronco/ombros paralelos à água
IC	Inclinação do corpo (exemplos: mandar o tronco para baixo; vir cá a baixo; sentado na cadeirinha para o BS, tronco paralelo à água)
BOS	Base de suporte (posição dos pés)
MIT	Ângulo dos membros inferiores e tronco (Flx/Ext) (exemplos: encolher, dobrar, esticar, apertado, ângulo mais baixo, agachadinho, encolhidinho, comprimido/expandido se for referido à posição dos segmentos corporais (âgulos))
F	Força exercida (MI) ou agressividade ou pressão expressada pelo surfista (ex: "pisar a prancha", "aliviar ou colocar mais peso")?
DFRAIL	Utilização genérica do rail OU quantidade de rail dentro de água sem ficar explícito a que eixo do movimento se refere DFRAIL_IC: colocar o peso mais nos calcanhares ou nas pontas dos pés (terço anterior do pé); fazer troca de rails; eixo longitudinal DFRAIL_VEL: Distribuição da força/peso pelos apoios; colocar mais o peso na perna de trás ou da frente (ex: referência ao pisar seguido de diferença/igualdade na distribuição de peso/força no eixo antero-posterior) ex: o nose está levantado ou não; pressão sobre as quilhas.
SCORE	Pontuação atingida pelo surfista, i.e. atribuída pelo juiz, como critério de performance da técnica. Quando o BT é valorizado por permitir uma melhor pontuação da técnica seguinte
CTRL	Controlo Postural; postura corporal; equilíbrio
VEL	Velocidade do atleta quer seja aumentar ou diminuir, acelerar ou travar
FASES	Divisão da tarefa por fases; quando é especificado o início e final de cada fase FASES_CC – sempre que dá enfase a quando ocorre determinada CC (timings/instantes de temp9) e não às descrição da CC em si - Especificar a que fase e CC se refere FASES_CC_P – ccs da fase preparatória FASES_CC_FU – ccs da fase fundamental FASES_CC_FI – ccs da fase final
PMS	Posição do membro superior (inclui braço, antebraço, mão)
OUTROS	Inclui fatores como: - referência a expressões como harmónio, banda a tocar, corpo como um todo, "tudo encaixado" para exemplificar combinação de fatores; - referência ao especialista - referência à influência da experiência na leitura da onda e consequentemente na técnica do BT
FEX	Influência dos fatores externos nos aspetos técnicos do Bottom turn FEX_O: características das ondas como inclinação, velocidade e altura; ex: "onda grande ou pequena"; "deitada, mole, buraco, gorda, cavada, em pé"; "rápida, lenta"

	FEX_MN: o BT varia com as características da manobra que se segue FEX_PR: o BT varia com as características da pranchas
NC	Níveis de classificação das componentes críticas
UE	Se utilizaria a escala no processo de treino
IT	Importância da escala para processo de treino
CM	Centro de massa (altura)
BSFS	Sempre que se faz a distinção da técnica do Backside para o frontside BSFS_CC – quando se distingue especificamente as componentes críticas das duas técnicas (semelhante a FASES – 25/3) especificar a CC, por exemplo BSFS_CC_OC
LIP	Posição final do surfista no topo da onda; parte da aresta/crista da onda onde a onda está a quebrar (exemplos: spot que determinamos para manobra; onde queremos a manobra)
MD	Sempre que expressem a sua opinião sobre o modelo quer seja concordante, quer discordante, quer seja colocar dúvidas em relação ao modelo determinístico ou às componentes críticas da tabela _CC quando vão ao detalhe de uma CC
SG	Sugestões para a construção da escala: como especificar mais as componentes críticas; colocar imagens para clarificar; utilizar linguagem mais simples Sugestões para um documento com uma forma mais simples

Appendix V – Codes Saturation

Códigos	BiomecSurf2	BiomecSurf3	BiomecSurf5	BiomecSurf4	BiomecSurf 1	BiomecSurf 6	BiomecSurf 7
FEX_PR		X					
FEX_O					X (novo)	X	X
FEX_MN					X (novo)		X
DT	X	X	X	X	X	X	X
DT_DBT		X (novo)	X		X	X	X
DT_PCK				X (novo)	X	X	X
Vel	X	X	X	X	X	X	X
F	X	X	X	X	X	X	X
OC	X	X	X	X	X	X	X
RT	X	X	X	X	X	X	X
PMS	X (novo)	X	X	X	X	X	X
Outros	X	X		X	X	X	X
MIT	X	x	X	X	X	X	X
Score	X	X	X	X	X		X
Ctrl	X				X		
BOS	X			X		X	
CM	X	X			X	X	X
Fases	X	X		X	X	X	X
Fases_CC		X (novo)	X	X	x	X	X
FASES_CC_P			X (novo)	X	X	X	X
FASES_CC_FU			X (novo)	X	X	X	X
FASES_CC_FI			X (novo)	X	X	X	X
IC	X	X	X	X	X	X	X
NC	X	X	X	X	X	X	X
UE	X	X	X	X	X	X	X
IT	X			X	X	X	X
BSFS	X (novo)	X		X	X	X	X
BSFS_CC		X (novo)	X	X	X	X	X
MD	X (novo)	X	X	X	X	X	X
MD_CC					X (novo)		X
LIP	X (novo)	X		X	X	X	X
SG	X (novo)	X		X	X	X	X
DFRAIL_VEL			X (novo)	X	X	X	X
DFRAIL_IC			X (novo)	X	X	X	X
DFRail				X (novo)	X	X	X

Appendix VI – Escala de Observação

Fases	Imagens	Componentes Críticas	Escala de Avaliação				
			Mau	Razoável	Bom	Muito Bom	Excelente
Preparação	 	Cabeça orientada para a base da onda	1	2	3	4	5
		Tronco sobre o pé da frente - orientado para a base da onda (FS – braço da frente do lado do rail externo e braço de trás rail interno; BS – braço da frente do lado do rail interno e braço de trás rail externo)	1	2	3	4	5
		Flexão do Joelho entre 90º e 110º	1	2	3	4	5
Fundamental	 	Mudança da orientação da cabeça para o Lip	1	2	3	4	5
		Ângulo de Flexão do joelho ≤90º	1	2	3	4	5
		Ângulo de Flexão da anca ≤90º	1	2	3	4	5
		Inclinação do corpo sobre a curva (mão do rail interno aproxima da água).	1	2	3	4	5

		Colocação do rail a 2/3	1	2	3	4	5
		Cabeça orientada para o Lip	1	2	3	4	5
		- Mão do rail interno afasta-se da água e o tronco começa a rotação (FS – abdução; BS - levanta)	1	2	3	4	5
Final	 	Extensão progressiva dos joelhos	1	2	3	4	5
		Extensão progressiva da anca	1	2	3	4	5
		Ângulo de Extensão dos Joelhos ≤150º	1	2	3	4	5
		Ângulo de Extensão da anca ≈90º	1	2	3	4	5
		Retirada do rail para 0	1	2	3	4	5
		Peito virado para o Lip	1	2	3	4	5
		Braço da frente (do rail externo) aponta para o Lip	1	2	3	4	5
Parâmetros globais	Foi à base da onda.		1	2	3	4	5
	A melhor linha de trajetória (U, V ou W), considerando os fatores externos.		1	2	3	4	5

BS – Backside; FS – Frontside