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Athlete and Support Staff Perceptions of Training Modalities for the Development of Surfing-Specific Manoeuvres: A Concept Mapping Approach

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Abstract

This study investigated the perspectives of surfers and support staff on the importance and feasibility of common surfing training modalities. The Concept Systems groupwisdomTM web platform was used to collect and analyse data from 29 participants (18 support staff and 11 surfers). The concept mapping methodology was employed due to its effectiveness in identifying context-specific factors and real-world perspectives. Participants brainstormed statements identifying training modalities that should be incorporated in training to develop surfing-specific manoeuvres. Participants then sorted statements into clusters before rating them on importance and feasibility using a 10-point scale. Twenty-nine participants brainstormed 101 statements, which the research team synthesised and condensed to 58. Following multidimensional scaling and hierarchical cluster analysis, a 4-cluster solution was identified as the most appropriate representation of the participants sorting data: education and mindset (8 statements), physical preparation (24), in-water training (13) and dry-land training (13). Mean ratings for each cluster and statement determined the education and mindset cluster as the most important (mean = 7.5) and feasible (8.1), while the dry-land training cluster was the least important (mean = 5.9), and feasible (mean =6.0). A significant difference was found (< 0.001) between the surfers' (mean = 6.48) and coaching staff's (mean = 5.61) perceived importance of dry-land training. The four modalities of surfing-specific training, rated from most to least important were: education and mindset, physical preparation, in-water training and dry-land training. Support staff should factor these four key areas into training program design and consider the potential differing views when it comes to implementing dry-land training. Additionally, these findings highlight the unique environment, task and individual constraints found within surf-training and promote the integration of a constraints led approach to training designs. This study is the first to report on the perceptions of competitive surfers and should inform both research and practice regarding the design of training environments for the development of skill-based surfing-specific manoeuvres.

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INTRODUCTION

Competitive surfing has undergone significant professionalisation and institutionalisation in the past decade (Ellmer & Rynne, 2019; IOC, 2016). Despite a developing body of literature on the physiological demands of surfing (Farley, et al., 2012; Klingner et al., 2021), there is a dearth of research regarding the training design underpinning the skill acquisition and development of surfers

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(Ellmer et al., 2020). As surfing is skill-based, identifying and understanding the utility of commonly used training modalities is paramount. This lack of empirical knowledge has been acknowledged by numerous studies within the action sports field and warrants further investigation (Correia & Bertram, 2018; Ellmer et al., 2020; Ellmer & Rynne, 2019; Farley et al., 2019).

A major challenge competitive surfers face is the availability of appropriate and authentic training environments, given the inherent reliance on ocean-based practice and competition. While traditional sports mitigate undesirable environmental conditions (e.g., weather conditions) with purpose-built practice facilities (i.e., indoor football fields) affording largely uninterrupted practice, this solution has historically proved more difficult for surfers. In response, surfing coaches and organisations have invested in cutting-edge training facilities to increase athlete exposure to surf-like environments, which are believed to reflect competition settings. The advent of these training facilities and alternative training modalities, such as skateboard parks, ramps and jumps, gymnastics halls, trampolines, foam pits, and virtual reality, provide surfers with unprecedented access to out-of-ocean training methods modelled on established skill-based Olympic sports, such as diving (Barris et al., 2013), skiing (Aleshin et al., 2009), and snowboarding (Dann & Kelly, 2022; Künzell & Lukas, 2011).

From a theoretical perspective, a key consideration for implementing these alternate training modalities rests on how accurately the task's constraints match those of the intended performance environment (i.e. the ocean) (Henry, 1958; Renshaw et al., 2020). As part of an Ecological Dynamics (Davids et.al, 2013) approach to skill acquisition and development, a Constraints Led Approach (CLA) (Newell, 1986) and a Representative Learning Design (RLD) (Pinder et al., 2011; Renshaw, 2020) offer a principled framework for researchers and practitioners to reference when considering how effectively the constraints (individual, environmental, task) of a training environment sample those of the intended performance environment (Newell, 1986; Renshaw et al., 2020). This premise is underpinned by a constraints-led approach (Newell, 1986) and Representative Learning Design (Pinder et al., 2011; Renshaw, 2020). As part of an ED approach to skill acquisition and development, CLA and RLD offer a principled framework for researchers and practitioners to reference when considering how effectively the constraints (individual, environmental, task) of a training environment sample those of the intended performance environment (Newell, 1986; Renshaw et al., 2020). From this perspective, determining the alignment between a training activity and performance environment is based on the two principles of RLD: action fidelity and functionality. Action Fidelity exists when the individual's emergent behaviour and physical movements remain the same between training and competition environments. Functionality exists when there is a functional coupling between cognitions, perceptions and actions, similar to that in the competitive environment (Pinder, 2014).

The benefits of implementing a CLA approach have been reported across various sporting contexts, including emerging applications in action sports (Figueiredo et al., 2017; Fitzpatrick et al., 2018; Gray, 2018; Jamil et al., 2023). From a surfing context, various environmental (cost, location, access to facilities, weather, swell availability and use of specialist coaches or equipment) and sociocultural constraints (training culture, preconceived perceptions, cultural trends and localism) may influence training modalities' perceived importance and feasibility. Due to major environmental constraints (reliance on conducive weather and swell conditions for training), it makes sense that surf coaches and athletes seek alternative training modalities to supplement conditions and opportunities offered in the ocean.

Despite the widespread but often piecemeal adoption of these alternate training modalities, the perceptions of surfers and support staff regarding their relevance to improving surfing performance remain unexplored. Gaining insights into the perceived importance of these modalities will help understand the underlying motivations behind implementing current surf-training practices. In addition to their importance, establishing the perceived feasibility of each modality will help explain accessibility, affordability and practicality. Perceptions of feasibility will uncover rich contextual information to help explain the prevalence of each type of training modality and potential barriers and facilitators for adoption in practice. Furthermore, knowledge of the most important training modalities can guide future research to examine whether these training modalities effectively transfer to surfing performance.

Therefore, the key aim of this study was to investigate the perceptions of surfers and support staff on the importance and feasibility of current surfing training modalities. The insights intend to provide surfers and support staff with an end-user and context-informed rationale for the development of surfing-specific training programs. Additionally, this study can help uncover and understand what constitutes common practice in surf coaching and inform future research on the associations between training practices and competitive surfing performance.

METHOD

Concept mapping investigated what surfers and support staff believed were the most important and feasible training variables. This mixed-method approach was first introduced by Trochim and colleagues (Trochim, 1989) and is accepted as an effective tool for integrating practice into science (Rosas & Kane, 2012; Van Bon-Martens et al., 2014). The concept mapping process involved four phases: (i) preparation, (ii) brainstorming (ideas generation), (iii) sorting and rating (statement structuring) and (iv) analysis (Trochim & McLinden, 2017). This study completed each phase using the Concept Systems groupwisdom™ web platform (groupwisdom.com). Institutional approval was provided by the Griffith University Research Ethics Committee (GU #2021/284).

Participants

Twenty-nine participants (18 support staff and 11 surfers) were recruited for this study through state-level surfing organisations and existing relationships with surfers. This included eighteen support staff (13 male, 5 female; 35±6.1 years of age with 6.5±5.5 years' experience) and eleven surfers (8 male, 3 female, 22±4.7 years of age with 5.3±3.6 years of competitive experience). Recreational and competitive surfers were required to have a minimum of 12 months of surfing experience and currently surf at least two days per month. Retired and injured surfers were also invited to participate. They were exempt from the 'currently surfing two days per month' criteria, as their experiences and insights into the training process provided unique perspectives on important training variables. Support staff included skills/technical coaches, skill acquisition specialists, strength and conditioning coaches, physiotherapists, and massage therapists. Support staff were eligible if they worked directly with at least one competitive surfer to improve their surfing performance, physical capabilities or mental skills. All eligible participants who expressed interest were emailed a participant information sheet and hyperlinks to the groupwisdom™ platform. Prior to completing the first concept mapping task, each participant gave consent and completed a short online survey to identify whether they were support staff or a surfer, including demographic questions (i.e., age, sex), current level of surfing, relevant qualifications, and past experiences (supplementary material, Table 1).

Table 1: Twenty-nine participants contributed to *the brainstorming phase,* 25 contributed to the sorting and rating phase, and 22 completed all steps.

Cohort survey questions	Support Staff (n=18)	Surfers (n=11)
Age (years)	35 ± 6.1	22 ± 4.7
Sex (m & f)	M=13 F=5	M=8, F=3
Residing Country		
Australia	13	11
New Zealand	3	-
United States	1	-
England	1	-
Current role		
Head of Performance	1	-
Skills/ Technical Coach	3	-
Strength and conditioning Coach	5	-

Cohort survey questions	Support Staff (n=18)	Surfers (n=11)
Skill Acquisition Specialist	2	-
Personal Trainer	4	-
		-
Researcher	3	-
Experience in role (years)	6.5 ± 5.5	-
Competitive Surfing Experience (years)	-	5.3 ± 3.6
Highest Qualification		
PhD.	3	
Masters/ MPhil	2	-
Bachelors/ Honours	5	-
Certificate 4	1	-
Level 1 or 2 Surf Coach	7	-
Surfers you train/ work directly with*		
CT Athletes	2	
QS Athlete	7	-
Junior National Level	6	-
Junior State Level	5	-
Semi-professional	3	-
Recreational Surfers	2	-
Big Wave Surfer	7	-
	1	-
Current Level of Competition		
QS Tour	-	2
National Junior Championships	-	5
Recreational Surfer	-	4
Support Staff you have used*		
Skills/ Technical Coach	-	2
Strength and conditioning Coach	-	2
Personal Trainer	-	2
Physiotherapist	-	1
Psychologist	-	1

* Indicates more than one selection could be made

Preparation Phase

A pilot test was conducted with five individuals (three coaches and two surfers) in the development stage to assess the suitability of the proposed focus prompt and ensure the statements extracted were relevant to answering the research question. The pilot test used the following focus prompt: "Based on your knowledge and experience, what training factors do you believe play a role in the improvement of surfing-related, point-scoring manoeuvres?". Given their broad nature, most of the pilot statements did not effectively address the research question, prompting revisions before commencing the study. The research team revised the focus promptly, and the same five individuals provided further statements deemed appropriate for the research questions. The individuals involved in this pilot test were not included as participants in the main study.

Brainstorming Phase

In the brainstorming phase of this study, the following focus prompt was used: *“In a perfect world (access to any equipment or facilities), what do you believe surfers should be doing in training to help improve surfing-specific manoeuvres (turns, snaps, aerials, barrel riding etc.)?”* This prompt was framed using “in a perfect world (access to any equipment or facilities)” to promote responses that were not restricted by current personal/ situational constraints. Participants were encouraged to provide as many statements as possible to this focus prompt. Participants could view all anonymised statements contributed by others, which served the dual purpose of minimising duplication and fostering critical thinking and idea generation. The Brainstorming phase was open for five weeks to promote a saturated list of statements. Participants could access the platform as often as they wished to contribute statements through this phase. A reminder email was sent to all participants one week from the closing date to encourage further contributions.

Once the brainstorming phase was closed, the research team synthesised the raw participant-generated statements (Rosas & Kane, 2012; Trochim & McLinden, 2017; Van Bon-Martens et al., 2014). This involved splitting statements with multiple ideas and replacing duplicate statements with statements that reflected the agreed meaning without denaturing the participants' statements. This process was repeated until the final list represented unique, clear, and relevant statements. Synthesising the responses allows participants to sort and rate each unique response in the proceeding phases without confusion over duplicated responses.

Sorting and Rating Phase

In the sorting phase, the same participants were given the synthesised list of statements (n=58) presented randomly and instructed to group those with similar meanings and/or themes. Participants were required to allocate each response to a group. Single statement groups were allowed if participants perceived a statement to be unrelated to the others. Participants were then asked to name each group they created based on its collective theme and/or meaning. Participants were instructed not to create groups of unrelated statements (e.g., other/miscellaneous) or groups based on a value (e.g., importance or relevance). Participants could access the platform as often as they wished to continue and complete this phase. The Sorting and Rating phase was open for five weeks, with a reminder email sent to all participants one week from the closing date to encourage completion.

The rating phase required participants to rate each response statement (n=58) according to its perceived importance and feasibility. A sliding (1–10) scale was used to generate ratings from the questions: "How important is this for competitive surfers?" (1 = least important to 10 = most important); and "How feasible is this for competitive surfers?" (1= least feasible to 10 = most feasible). Statements were presented in random order, and a reminder was included to encourage participants to consider all scale increments to avoid exclusively polar (1 or 10) ratings.

Analysis

Concept Systems® groupwisdom™ software (Concept Systems, Incorporated, NY, USA) was used for statistical analysis (Concept Systems 2012). A square similarity matrix was created from the sorted statements, and then a two-dimensional scaling analysis was applied to position/locate each statement as a distinct point on an X-Y spatial "point map". To separate the statements into non-overlapping clusters of related ideas, "cluster maps" were created using Ward's agglomerative hierarchical cluster analysis, with the X-Y coordinate matrix from the multidimensional scaling as the input (Trochim & McLinden, 2017).

To decide the most appropriate number of clusters, Trochim et al.18 recommendations were used to reduce the cluster maps from a 14-cluster solution to a three-cluster solution, paying attention to which statements were grouped together as the number of clusters decreased. A four-cluster map was selected as the most appropriate representation of the sorting data. The commonality of statements in each cluster was ranked using a bridging value (BV), ranked on a scale of 0 (extremely strong) to 1 (extremely weak) (as seen in Table 1). This value explains how frequently participants grouped the statements in each cluster.

The mean importance and feasibility of each cluster between surfers and support staff were compared using Welch's t-test (using the number of items in the cluster as the sample size for cluster comparisons). The Welch's t-test assumes unequal variances and sample sizes to test the differences in cluster means between surfers and coaching staff. The calculation of cluster means comes from the item averages, thereby producing data at an interval level. Multiple (n=8) t-tests were conducted, with alpha level set at 0.05.

RESULTS AND DISCUSSION

Results

Athletes and support staff collectively brainstormed 58 unique responses to the focus prompt (table 2). A multidimensional scaling and hierarchical cluster analysis based on the rating phase (figure 1) determined four key themes. These include, in order of perceived importance, education and mindset (8 statements), physical preparation (24), in-water training (13) and dry-land training (13). When comparing surfer and coaching staff ratings within individual clusters, a significant difference was found for dry-land training, indicating that surfers' (mean = 6.48 ± 0.28) rated this modality more important than coaching staff (mean = 5.61 ± 0.35), $t(24) = 3.99$, $p=0.0003$. All other comparisons reported no statistical differences suggesting agreement between the surfers and coaching staff.

Table 2. Summary of Statements. Statements generated (n=58) during the brainstorming stage included clusters in which the statement fits, mean importance and feasibility ratings, Go-Zone Quadrant (Q), and Bridging Value (BV) for each statement. This table is ordered by perceived importance.

#	Statement	Mean Importance	Mean Feasibility	Q	BV
Cluster 1: Education and Mindset		**7.5 ± 0.5**	8.1 ± 0.4		**0.78**
26	Understand the characteristics of the breaking wave and how to develop speed	8.5	8.7	1	0.65
12	Ensure surfers understand the breakdown of a manoeuvre into movements and in which order the movements must be performed	7.7	8.2	1	0.76
50	Practice mental skills to control arousal/ energy on the wave	7.6	8.3	1	0.10
10	Visualisation practice with a focus on imitating the task and being present	7.5	8.6	1	0.98
6	Educate surfers on the biomechanics of all new manoeuvres before attempts.	7.5	7.5	1	0.67
46	Deconstruct the complexity of a specific manoeuvre into smaller tasks to simplify the process	7.4	8.0	1	0.68
56	Achieve a deeper understanding of each body part's role in successful manoeuvre completion.	7.1	7.9	1	0.78
40	Education sessions on board qualities for different types of manoeuvres	6.7	7.7	3	0.71
Cluster 2: Physical Preparation		**7.1 ± 1.2**	**7.8 ± 1.4**		**0.23**
1	Incorporating a comprehensive strength and conditioning program	8.7	8.7	1	0.03
7	Including a resistance training program that considers all training principles (specificity, individualisation, progressive overload, variation and reversibility)	8.5	8.4	1	0.01
13	Lower limb mobility	8.3	8.9	1	0.04
27	Emphasis on lower body strength and power	8.3	8.8	1	0.01
29	Work with sports science and medicine team	8.2	7.2	1	0.69
16	Upper body pulling strength and shoulder health	7.9	8.9	1	0.02
22	Isometric, eccentric and concentric strength	7.8	8.6	1	0.05
48	Establish a daily stretching/ flexibility/ mobility routine	7.7	8.9	1	0.03
21	Strength focused on end-range joint positions that are specific to each manoeuvre	7.6	8.3	1	0.05

#	Statement	Mean Importance	Mean Feasibility	Q	BV
34	Training for body awareness. Surfers need to understand their body's limitations and potential	7.5	7.0	1	0.71
45	Paddling drills to develop endurance, strength and explosive speed for catching waves	7.5	9.0	1	0.76
52	Stability exercises that focus on trunk stability	7.4	8.3	1	0.05
57	Full-body, muscular endurance	7.3	8.5	1	0
30	Physiotherapy exercises to improve movement deficiencies	6.9	7.5	1	0.13
25	Underwater breath training	6.9	7.7	1	0.49
15	Lower limb stiffness and force attenuation	6.8	7.6	3	0.06
33	Balance and proprioception training	6.1	7.9	3	0.27
35	Myofascial Release Techniques to commonly tight areas	6.0	8.0	3	0.09
41	Use Foam Roller, Massage Ball/Gun, Myotherapists	6.0	8.0	3	0.07
28	Gymnastics training	5.8	6.1	4	0.56
47	Soft Tissue Therapy	5.7	7.7	3	0.19
54	Activation exercises with resistance bands	5.6	8.7	3	0.04
44	Balance trainer combined with virtual reality	4.9	3.0	4	0.81
38	Reactive agility kit (those flashing light buttons)	4.1	4.5	4	0.43
Cluster 3: In-Water Training		**7.0 ± 1.5**	**6.0 ± 2.0**		**0.54**
3	Wave pool session with filming, immediate coach feedback and high repetitions	9.0	6.2	2	0.46
9	Video analysis for technique in the wave pool	8.8	6.3	2	0.63
24	Access to a wave pool with a wide range of waves for different manoeuvres	8.6	5.2	2	0.45
32	The ramp section in the wave pool is designed for aerials	8.1	5.5	2	0.43
5	Surf as much as possible	8.0	8.9	1	0.60
43	Access to facility with wave pool and skate ramps so the athlete can change quickly between the two in practice	7.3	3.3	2	0.49
39	Practice heat in the ocean with mates	7.1	9.3	1	0.61
20	Jet ski tow-ins/step-offs to practice airs on smaller days	6.8	4.0	4	0.46
49	Access to a wave pool with a 'random/natural' setting so the waves are not predictable	6.7	3.2	4	0.46
18	Mock heat (5 waves in 30 mins) in the wave pool	6.5	6.3	4	0.50
58	Virtual reality enhances attentional focus, reading the wave, preparation, decision-making, and reaction to the external stimuli	5.4	3.1	4	0.86
11	Surfing with longboards to develop an appreciation for shifting weight and board control	4.7	7.6	3	0.50
51	Body surfing and Boogie boarding to help with confidence in the water	3.7	8.0	3	0.52
Cluster 4: Dry-Land Training		**5.9 ± 0.5**	**6.0 ± 1.0**		**0.26**
17	Guided skateboarding/Smoothstar training with an experienced coach to ensure correct technique	6.6	7.1	3	0.17
8	Carver skateboarding in bowls	6.4	6.7	4	0.19
36	Skate ramp into the foam pit for aerial practice	6.4	5.2	4	0.21
19	Foam pit for aerial landing	6.4	5.0	4	0.23

#	Statement	Mean Importance	Mean Feasibility	Q	BV
37	Trampoline work to focus on body control, rotations/inversions, body positional awareness	6.2	5.0	4	0.59
4	Trampolining with and without straps (e.g., snowboards) for dry land aerials	6.1	4.5	4	0.41
31	Surf skates designed even more specifically for certain boards or waves	5.8	5.0	4	0.24
55	Practice other similar sports like snowboarding, skateboarding, wakeboarding, and surfing in their spare time	5.8	5.1	4	0.30
23	Skate bowl, which is specifically built more closely represent wave shapes	5.7	5.2	4	0.19
14	‘Regular’ skateboarding in bowls	5.6	7.1	3	0.21
2	Carver skateboarding on flat ground	5.5	7.7	3	0.17
42	General ‘park’ skateboarding	5.1	7.1	3	0.24
53	Skateboarding directly before the surfing session	5.1	7.0	4	0.20

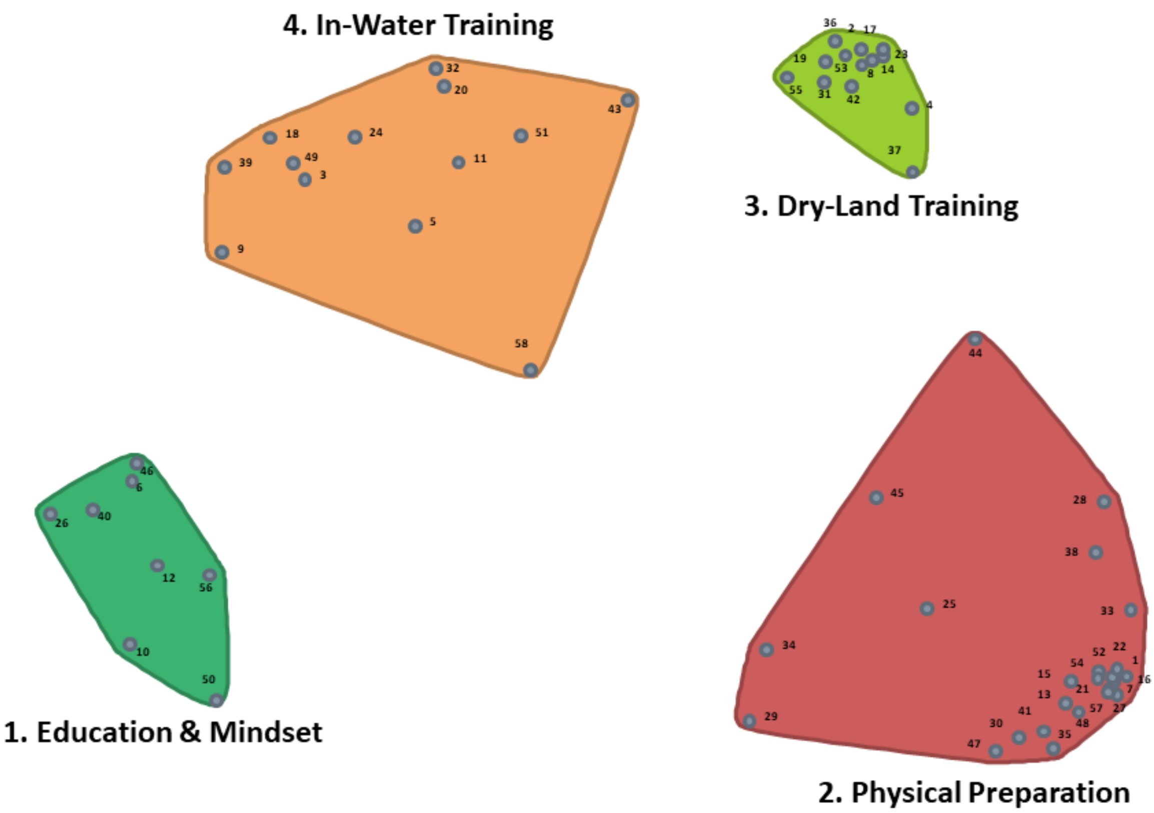

Figure 1. Cluster map. Four-cluster map of the themes emerging from the sorting phase. This illustrates the breakdown of commonly used training modalities for developing surfing manoeuvres.

The stress index value for this cluster map analysis (figure 1) was 0.16, which is lower than the average stress value (0.28) across a broad range of concept mapping projects (Kalema et al., 2022; Rosas & Kane, 2012; Trochim, 1989). This suggests that the map is unlikely to be random or devoid of structure and exhibits a better fit than most previous concept mapping studies.

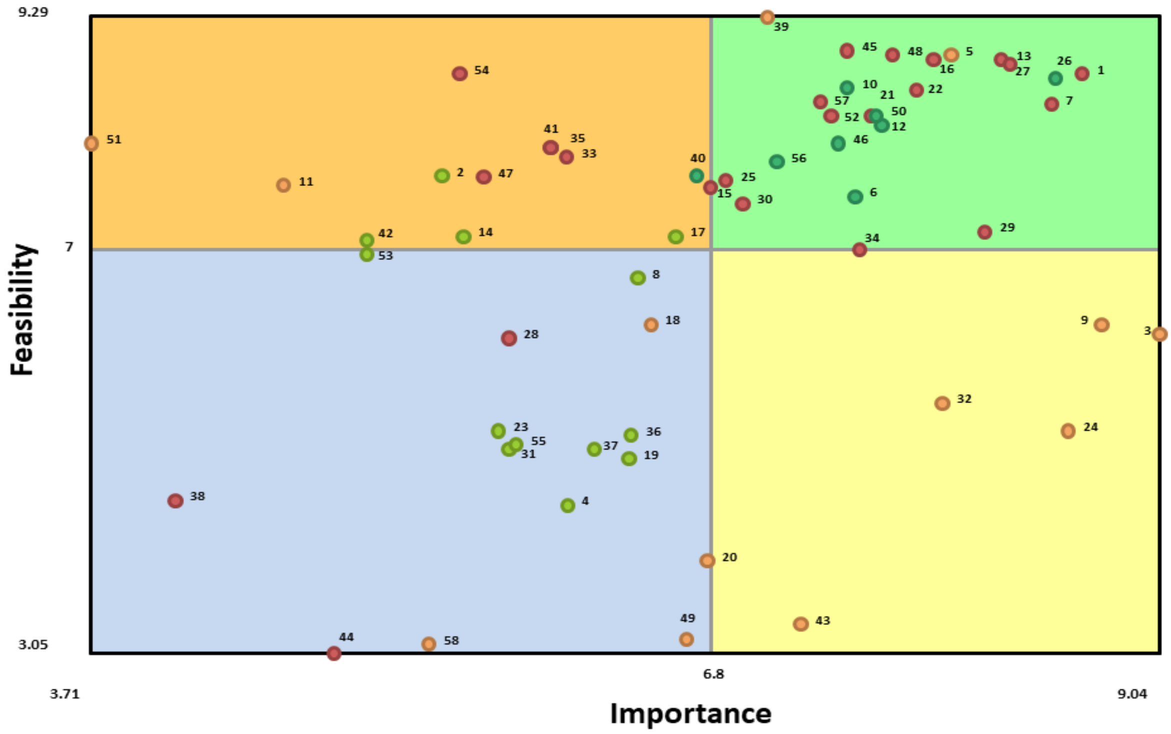

Figure 2. Go-zone graph. This graph contains all 58 brainstorming statements, with their location on the graph being determined by the rating phase. Grand mean importance = 6.74, and grand mean feasibility = 7.03.

Response Clusters Key

1. Education and mindset training
2. Physical preparation
3. Dry-land training
4. In-water training

Twenty-five participants rated all 58 randomised statements for importance, and 22 participants rated all for feasibility. Four participants failed to respond to follow-up notifications regarding the completion of the Rating phase. The Go-Zone graph above (Figure 2) presents mean importance (x-axis) and feasibility (y-axis) values for the 58 rated statements. To aid the interpretation of the Go-Zone, see Table 1 for details of each statement, including its mean importance and feasibility ratings. Q1 statements were rated above the grand mean for both importance and feasibility. Q2 statements were rated above the grand mean for importance and below the grand mean for feasibility. Q3 statements were rated below the grand mean for importance and the grand mean for feasibility. Q4 statements were rated below the grand mean for both importance and feasibility.

Discussion

This study aimed to elucidate the perceptions of surfers and support staff regarding the importance and feasibility of current surfing training modalities. The concept mapping approach allowed for empirically exploring context-specific and real-world perspectives (Donaldson & Finch, 2012). The results provide novel insights that surfers and support staff can use to develop surf-specific manoeuvres. The key training focus areas for competitive surfers, rated from most to least important and feasible, were education and mindset, physical preparation, in-water training and dry-land training.

Perceived Importance

The education and mindset cluster was perceived as the most important, with a mean importance value of 7.5 ± 0.5, suggesting the participants in this study perceive the statements representing this cluster as priorities for developing surf-specific manoeuvres. The highest-rating statements within this cluster were: Understand the characteristics of the breaking wave and how to develop speed (8.5 ± 1.9), Ensure surfers understand the breakdown of a manoeuvre into movements and in which order the movements must be performed (7.7 ± 2.2), Practice mental skill to control arousal/energy on wave (7.6 ± 1.6) and educate surfers on the biomechanics of all new manoeuvres before attempts (7.5 ± 2.1). The small standard deviation and range (SD=0.5, range= 6.7–8.5) also demonstrate a strong consensus among participants regarding the high relative importance of these activities. The advantage of superior wave characteristic identification (perceptual attunement)(Furley & Dörr, 2016; Luke et al., 2022), emotional regulation (Vickers & Williams, 2007), and manoeuvre biomechanical understanding (Irwin et al., 2005) are all supported in the literature.

Perceptual attunement and emotional regulation have emerged as common themes within this cluster. These concepts support the theoretical underpinning of functionality in training, whereby information sources should be closely sampled from the performance environment (Pinder et al., 2014). Perceptual attunement refers to the ability of expert surfers to identify and exploit key perceptual information relating to the formation and point-scoring opportunities of potential waves. A study by Luke et al. (2022) compared novice and elite surfers' eye gaze behaviours while riding waves and found that elite surfers were faster to detect high-scoring waves and spent more time fixating on key features of the wave that have been linked with high-scoring performances. These findings and theoretical concepts may help explain the advantage of superior wave and manoeuvre knowledge on overall performance, and the importance that surfers and support staff place on learning and improving these skills. To implement training approaches representing these statements, surfers would require access to a specialist skills or technical coach and/or mindset coach for regular consultations over an extended period (Brasil et al., 2020; Correia & Bertram, 2018).

Physical preparation (7.0 ± 1.2) and in-water training (6.9 ± 1.5) were the second and third-highest-rated clusters for perceived importance. The physical preparation cluster mostly comprises strength, endurance, mobility, and flexibility training. These results align with the large body of physical preparation research conducted in surfing (Farley et al., 2012; Farley et al., 2012; Klingner et al., 2021). Despite the known physiological benefits of physical preparation, this training modality may be perceived as less important than education and mindset for developing skilled surf-specific manoeuvres. Respondents may have considered physical preparation a predominantly dry-land activity, lacking alignment with RLD principles and offering a tenuous transfer to developing manoeuvres. In contrast, 'in-water training' lacks empirical evidence to support manoeuvre development. However, the highly representative nature (Pinder et al., 2011) of activities in this cluster may explain its perceived importance and link with specific manoeuvres.

The least important cluster was dry-land training (5.9 ± 0.5). The statements in this cluster included skateboarding, surf skating, snowboarding, trampolines with boards and balance trainers. This is somewhat surprising as some literature suggests participation in cross-training (i.e., skateboarding, snowboarding, and wakeboarding) is common among action sports athletes (Dann & Kelly, 2022; Ellmer et al., 2020). Despite this, no research currently examines their effectiveness and/or transfer to surfing performance. Further, the available research in other sports that examines the representativeness of wet versus dry-land training is mixed. An investigation into diving found that the kinematics of a springboard dive differed between wet and dry training environments (Barris et al., 2013). Therefore, the same lack of fidelity may be evident for training using skateboards, snowboards and wakeboards. Despite similar movements at face value, kinematic differences may have yet to be examined using valid tools. In contrast, (Künzell & Lukas, 2011) examined the transfer effect of skateboard (dry-land) training on subsequent snowboarding (wet) skill acquisition, finding significant snowboarding performance improvements in those receiving skateboard training, suggesting cross-training between these similar board sports may have either transferred to or influenced the learning process in snowboarding.

The lack of perceived importance for virtual reality-based training was also unexpected. Interestingly, virtual reality (VR) was featured in physical preparation and in-water training clusters but not dry-land training and rated quite low in importance in both cases. Despite advances and popularity in VR, these results suggest that the surfing community may not see practical value in using VR when developing technical manoeuvres. However, the use of virtual reality (VR) for surfers has been supported within the literature (Farley et al., 2019; Luke et al., 2022). Farley and colleagues (2019) suggested that, in theory, virtual reality may play a beneficial role in the development of skilled surfing manoeuvres. The lack of empirical data reflects this study's consensus of surfers and coaching staff. Only one investigation (Luke et al., 2022) has explored VR in an applied setting and demonstrated its utility in differentiating eye-tracking behaviour between novice and elite surfers. As the use of VR devices becomes more feasible, this training modality may become more prevalent and useful within the surfing community.

Perceived Feasibility

The education and mindset (8.1 ± 0.4) and physical preparation (7.8 ± 1.4) clusters presented higher mean perceived feasibility values than others. All statements in the education and mindset cluster involve consulting a skills coach for education, feedback or instruction on a specific component of surfing performance. It could be argued that the recent rise in professionalism and institutionalisation of competitive surfing (Ellmer & Rynne, 2019) may have increased the number and exposure to specialised surfing-skills coaches who can provide surfers with this type of support (Brasil et al., 2020; Correia & Bertram, 2018). Most statements within the physical preparation cluster referenced exercises that can be completed independently without needing expensive or specialised equipment. Statements such as: 'establish a daily stretching/flexibility/mobility routine', 'lower limb mobility', 'emphasis on lower body strength and power' and 'activation exercises with resistance bands' can all be completed with minimal equipment and at the athlete's convenience. Of particular note, the statement attracting the highest combined importance and feasibility ratings (8.7) fell within the physical preparation cluster 'incorporating a comprehensive strength and conditioning program'. As outlined previously, the ratings for this statement appear to accurately reflect the predominant body of work (and practice) in surf training focussing on physical preparation.

The least feasible clusters to arise from the data were in-water training and dry-land training. It is important to recognise that the in-water training cluster had the largest spread of responses (SD=2.0) and comprised training based on a wave pool and the ocean. There were seven responses, including the use of a wave pool, with a collective mean feasibility rating of 5.1, whilst the remaining four ocean-based responses had an average rating of 8.5. From this, it is clear that environmental constraints and access to wave pool facilities play a large factor in the feasibility of training under these conditions. Interestingly, the mean rating of 8.5 for ocean-based response is likely due to the dependence on conducive environmental constraints, which can often lead to the ocean not being a viable option for practice.

The statements in the dry-land training cluster primarily involved training that required access to highly specialised facilities or expensive training aids/ equipment. For example, 'trampolining with and without straps (e.g., snowboards) for dry land aerials' (4.5 ± 2.4), 'foam pits for aerial landings' (5.0 ± 2.4), 'trampoline work to focus on body control, rotations/inversions, body positional awareness' (5.0 ± 2.1) and 'skate bowl which is specifically built more closely representing wave shapes' (5.2 ± 2.5). These were also grouped with various skateboarding and surf skate statements, generally perceived as slightly more feasible. These findings were not surprising due to the scarcity and costs associated with the training equipment and facilities needed to undertake these training modalities.

Go-Zone Priorities

Statements in Q1 of the go-zone are of particular interest as they were perceived as the most important and feasible ways to train for surfing. The statements found within this quadrant are listed in Table 1. There was a strong consensus around the importance and feasibility of physical preparation education and mindset training for developing surfing-specific manoeuvres. These two clusters combined made up 17 of the 20 statements found in Q1. This represents the focus of previous surfing research and the current literature on surfing performance (Farley et al., 2012; Farley et al., 2012; Klingner et al., 2021). Due to the large amount of evidence supporting the benefits of these types of training, it makes sense that their overall perceived importance was also relatively high. As discussed earlier, it was unsurprising that the perceived feasibility rating for statements in both the physical preparation and education and mindset clusters was high. This is because both clusters are not limited by environmental constraints, such as requiring access to specialised facilities and/or equipment and the large number of surfing coaches and courses that can provide the education surfers value.

The statements in Q2 were deemed highly important yet less feasible (compared to Q1) for surfers to engage in. All five statements in this quadrant included the use of wave pool technology. This included mock heats, video analysis, speciality ramp sections for aerials and settings to generate variety and unpredictable waves. Despite the clear consensus surrounding the importance and utility of wave pool technology, environmental constraints impact its feasibility. For example, in Australia, only one commercial wave pool is currently open to the public, which requires a significant financial investment for regular use. An annual membership exceeds AUD 3000 and only allows access to one weekly session. Until such environmental constraints are overcome (more facilities, more accessible locations, reduced costs, etc.), the feasibility for both recreational and competitive surfers will likely remain limited.

The statements in Q3 were perceived as highly feasible; however, they lacked importance compared with Q1 and Q2. These included a mix of skateboarding (2), surf skating (3), and various statements on physical preparation (6). The lack of importance for skateboarding and surf skate statements may be explained by the lack of any investigations exploring their effectiveness for surfers to inform their uptake. In addition, the physical preparation statements in this quadrant lack conclusive evidence and are commonly perceived as 'controversial' training methods. These include balance/proprioception training (Tran et al., 2015), activation exercises with resistance bands, foam rolling (Wiewelhove et al., 2019), massage guns and soft tissue therapy (Poppendieck et al., 2016). These perceptions may present novel sociocultural constraints that limit the uptake and acceptance of such modalities, regardless of their respective value to manoeuvre development.

The statements in Q4 were perceived as lacking importance and feasibility. This quadrant contained somewhat random responses that varied across all four clusters. The only anecdotal theme emerging from this quadrant was the appearance of responses with a 'body awareness' focus. This included 'trampoline work to focus on body control, rotations/inversions, body positional awareness', 'trampolining with and without straps (e.g., snowboards) for dry land aerials', 'foam pit for aerial landing', 'gymnastics training' and 'skate ramp into foam pit for aerial practice'. The limiting nature of many of these training modalities can most likely be explained by various environmental constraints (reliance on costly equipment and training facilities). They require trampolines, skate parks, foam pits, jet skis, virtual reality devices and reactive agility kits, which are not easily and regularly accessible by surfers and their coaches. In addition, limited research (Forsyth et al., 2020; Secomb et al., 2017) on these training modalities may help explain the poor ratings of perceived importance.

Surfers vs Coaching Staff

The comparison of surfers' and coaching staff's mean perceived importance and feasibility of each cluster only found one significant difference (p= 000003) within their perceived importance of dry-land training. Athletes perceived dry-land training as more important when compared to the coaching staff. This could be attributed to a sociocultural factor in that older coaching staff may perceive training in the ocean (in-water training) as the historical gold –standard, with little appreciation or perceived value for any other modality. In contrast, the younger surfers may be more influenced by top-level athletes exposing themselves to various alternative 'dry land' modalities to supplement ocean-based activities in the relatively new era of professionalisation. Therefore, the coaching staff should acknowledge the potential for differing views and seek to understand and appreciate the perceptions of the surfers they work with. For all other clusters, the lack of statistical differences between surfers and coaching staff suggests an alignment in perceptions of the relative importance and feasibility of the respective training modalities. A likely suggestion for this alignment is that these clusters (education & mindset, physical preparation, and in-water training) are all well-established features of training with supporting evidence specific to surfing and the development of sports performance in general (Correia & Bertram, 2018; Farley et al., 2012; Klingner et al., 2021).

Limitations

Despite these final findings, there are multiple limitations to concept mapping as a research method that should be acknowledged. Concept mapping results in methodological limitations relating to the reliability, validity and generalisability of the findings caused by non-random sampling, small sample sizes and overreliance on the interpretative skills of the researcher (Burke et al., 2005). In this study, the research team made subjective but process-informed assessments when synthesising and editing the brainstormed statements and deciding on the number of clusters that best represented the participants' sorting data. Despite following the detailed guidance of Trochim (2017), a similar study involving the same participants conducted by a different team may produce slightly different results.

CONCLUSION

This study aimed to identify the perceptions of surfers and support staff on the importance and feasibility of training modalities for developing surfing-specific manoeuvres. Through multiple phases of questioning and analysis, this study identified four key focus areas for developing surfing-specific manoeuvres in competitive surfers: physical preparation, education and mindset, in-water training and dry-land training. The results showed that education and mindset were perceived as the most important and feasible training modality for surfers, whilst dry-land training is currently deemed the least important and feasible. These results reflect the surfing literature and support research targeting aspects of surf training that are currently overlooked, under-researched and/or misunderstood. Therefore, there is scope for future investigations targeting aspects of the remaining two clusters representing in-water and dry-land training.

Additionally, we suggest these findings may result from the unique environment, task and individual constraints found within surf training and, in turn, support the implementation of a CLA to training designs. These findings present important considerations for coaches, surfers, and academics when seeking to further uncover and understand surf-related coaching. Through the design of surf-specific studies targeting these aspects of training, there is potential to improve the understanding and application of these training modalities and their impact on competitive surfing performance.

AUTHOR CONTRIBUTION STATEMENT

Rick Dann: Conceptualisation, methodology, investigation, analysis, manuscript writing and editing. Llion Roberts: Supervision, analysis, manuscript editing. Jonathon Headrick: Supervision, analysis, manuscript editing. Vincent Kelly: Supervision, manuscript editing. Alex Donaldson: Software, data collection and analysis, manuscript editing. Alec McKenzie: Data analysis, manuscript editing. Steven Duhig: Supervision, methodology, analysis, manuscript editing.

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