“Eddie would(n't) go!” perceptual-cognitive expertise in surfing

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ABSTRACT

Objectives: The goal of the present research was to investigate the decision making skills of surfers as a function of surfing experience.

Design: We used a between-subject quasi-experimental design.

Method: Participants (N = 76) with different levels of surfing expertise were asked to indicate via a button press which waves they would try to catch in a computer-based video decision-making task that presented videos of approaching waves.

Results: The quality of participants’ decisions corresponded in a linear manner with the amount of surfing experience, i.e. the more experience a surfer had, the better they were able to decide which waves were surfable and which waves were not. Specifically, more experienced surfers were superior at deciding which waves not to surf.

Conclusions: We provided first evidence that highly experienced surfers possess a cognitive advantage compared to less experienced surfers or a non-surfing control group by being better able to distinguish between surfable and non surfable waves. The results are discussed within the expert performance approach as being supportive of the notion that surfing experience led to perceptual-cognitive adaptations that allow surfers to pick the right waves.

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Eleven time world champion of surfing, Kelly Slater once said that “a big part of my success has been wave knowledge” (http://www.surfertoday.com/surfing/8267-the-best-surfing-quotes-of-all-time, retrieved on the 30.07.2014). Wave knowledge refers to the essential skill in surfing of “picking the right wave to surf on”. Just how important this cognitive skill is was highlighted in the world championship finale in December 2013 on the North shore of Oahu, Hawaii when Australian Mick Fanning managed to secure the world title over Kelly Slater. In both of his decisive heats, Fanning was close to losing and time was running out. In both heats Fanning waited patiently letting one wave after the other go by and only decided to go on a wave in the final minutes of the heat. Both times Fanning waited near perfect scores—that none other of the prior waves would have offered—enabling him to not only win the heats in the last minute, but more importantly to win the world title: “I just saw the set on the horizon, and I thought alright, whatever’s going to come, I’m just going to try and pick the right one” (http://www.theguardian.com/sport/2013/dec/15/mick-fanning-wins-world-surfing-title-kelly-slater, retrieved on the 30.07.2014; quote from Fanning in the interview directly after winning). Although, this anecdotal example suggests an important role of “wave knowledge” and decision making in surfing, to date no empirical research has been conducted investigating the perceptual-cognitive skills underpinning surfing expertise. This is surprising considering the growing body of evidence highlighting the importance of perceptual-cognitive skills in sporting expertise (Mann, Williams, Ward, & Janelle, 2007; Williams & Ericsson, 2005; Williams & Ford, 2008; Yarrow, Brown, & Krakauer, 2009). According to Marteniuk (1976) a perceptual-cognitive skill can be defined as the ability to identify and acquire environmental information for integration with existing knowledge to facilitate the selection of an appropriate response to be executed. Given the missing research on perceptual-cognitive skills in surfing, the present study investigates decision making in surfing as to date only physical factors such as postural control (Chapman, Needham, Allison, Lay, & Edwards, 2008) or upper body strength and fitness (Mendez-Villanueva & Bishop, 2005; Mendez-Villanueva et al., 2005) have been shown to be important factors in elite surfing.

Perceptual-cognitive expertise in sports

The study of how athletes reach and stay at the pinnacle of their respective sports or what factors contribute to superior
performance in sport has received a great deal of attention by sport expertise researchers (Starkes & Ericsson, 2003 for a review). On a very general level expertise can be defined as the ability of a person to consistently demonstrate superior levels of performance in a specific domain over an extended time period (Starkes, 1993). Knowledge of the factors that limit and contribute to superior sport performance are important for several reasons: (a) this knowledge provides a basis for deriving types of practice and training that are most efficient for performance enhancement (Ericsson, 2006); (ii) to predict who has the best chances of being successful in a particular sport (Williams & Reilly, 2000); (iii) on a theoretical level to test general theories of skill acquisition and expertise (Williams & Ericsson, 2005).

Athletes are required to adapt to specific constraints (Davids, Button, & Bennett, 2008) imposed by the sporting environment to perform successfully or circumvent potential performance decrements. Until fairly recently great athletes were considered an “assemblage of physical prowess” as researchers did not pay much attention to cognitive factors involved in expert sport performance (Starkes, Helsen, & Jack, 2001). Today most scientists acknowledge the important role of cognitive processes in sporting performance which has led to a substantial accumulation of literature (Ericsson, Charness, Feltovich, & Hoffman, 2006; Starkes & Ericsson, 2003; Williams & Hodges, 2004) which broadly states that expert sport performers gain an advantage by acquiring cognitive skills and strategies through deliberate practice that increase their efficiency of processing information (e.g., Eccles, 2006). While research on expertise has provided limited support that expert and less skilled performers differ on basic visual (e.g., acuity) or neural (e.g., memory) capacities (Furley & Memmert, 2010, 2011), there has been an accumulation of findings suggesting differences between these groups in terms of how information in the performance domain is processed (e.g., Eccles, 2006). Specifically, it has been suggested that experts attend, perceive, encode, store, and recall information in a qualitatively different way (e.g., Macquet, Eccles, & Barraux, 2012) which enables them to circumvent and extend their basic limits on information processing. By engaging in a large amount of deliberate practice (Ericsson, Krampe, & Tesch-Romer, 1993) expert performers increase their domain-specific knowledge and acquire adaptations to memory that allow for highly efficient encoding and retrieval while performing (Ericsson & Kintsch, 1995). For example, research in team- and racket sports has shown that expert athletes show a superior visual search behavior, utilize early cues in the performance environment more efficiently, detect meaningful patterns of information in the performance environment instead of processing every source of information individually, and are better able to predict situational probabilities which in turn lead to superior decision making skills (Williams & Ford, 2008). However, it is currently not clear whether these findings transfer to sports such as surfing as the constraints in surfing are considerably different from e.g., association football or tennis. A major difference is that performance in surfing is highly dependent on ecological factors such as wind, swell direction, swell period, tide, and surface conditions (Butt, 2014). Hence, the present research sought to extend previous work on expertise by investigating whether skilled surfers demonstrate perceptual-cognitive skills that allow them to read their respective performance environments more effectively which in turn results in superior decision making.

The present research

According to the expert performance approach (e.g., Williams & Ericsson, 2005) an essential first step in the systematic study of perceptual-cognitive sport expertise is to initially capture superior performance in a representative laboratory task in a reliable manner. Therefore, we created a laboratory task modeling the situation in which wave surfers have to decide on which waves to catch (i.e. which waves were surfable) and which ones not (i.e. which waves were not surfable) in a sample of video clips that resembled the first person perspective a surfer has of approaching waves.

Somewhat intriguingly, surfers only spend a small fraction of the time during a surfing contest or a recreational surfing session actually surfing (approximately 4%, Mendez-Villanueva, Bishop, & Hamer, 2006). The remaining time they spend with behaviors aimed at preparing to catch the “right” waves. This large proportion of time spent preparing for catching waves indicates how important cognitive factors such as deciding on where to position oneself or which waves to paddle for are in surfing. Therefore, it is important to initiate the scientific investigation of the perceptual-cognitive skills that mediate expertise in surfing.

As every wave is different depending on a whole range of complex factors (Butt, 2014) an important feat of successful surfing is to decide on which waves to surf. Typically surfers sit on their surfboard in the line-up (the location in the water where the waves break) looking towards the horizon at the approaching waves. In this situation surfers have to use visual cues such as “bumps” on the horizon, height and steepness of the approaching wave or how the light is refracted from the water to anticipate whether this is a good wave to surf on (cf. Fig. 1). To the untrained eye most waves at a particular location look highly similar. However, experienced surfers seem to know which waves offer the greatest potential for surfing on, probably based on the vast amount of deliberate practice (Ericsson et al., 1993) activities they have invested in their respective performance environment. But whether this observation can be transferred to a laboratory setting in a quantifiable manner is yet to be elucidated. Following the expert performance approach (Williams & Ericsson, 2005) which necessitates “to design representative tasks that allow component skills to be faithfully reproduced in the laboratory” (p. 285), we created video stimuli resembling the perspective a surfer has when waiting for waves (cf. Fig. 1) and asked surfers to decide which waves they would try to catch and which ones not. The term representative design refers to the arrangement of the experimental conditions with the intention to represent the behavioral settings to which the results are intended to apply (e.g., Araujo, Davids, & Passos, 2007; Brunswik, 1956). We hypothesized that the more domain-specific experience surfers had, the more domain-specific knowledge they would have acquired, allowing them to discriminate between surfable and not surfable waves more effectively.

Fig. 1. Frozen frame from an experimental stimuli used in the study.
**Experiment: deciding when to go on a wave**

**Method**

**Participants**

76 male participants (Mage = 25.9, SD = 6.7) took part in the study. Participants were assigned to one of three quasi-experimental groups based on their surfing experience. The first group was the control group without any kind of surfing experience (0 days of surfing; N = 25; Mage = 24.4, SD = 8.1). We choose a predefined criterion for dividing the participants with surfing experience into novices and experts by the cumulative amount of practice they had in surfing. Based on the recommendation of experienced surfing instructors, novices had to have below 100 days of cumulative surfing experience. The novice group (N = 26; M_age = 25.8, SD = 5.3) differed significantly from the expert group (N = 25; M_age = 27.6, SD = 6.3) on their average surfing experience in years (M_experts = 10.0, SD = 5.4; M_novices = 3.3, SD = 4.8; t(49) = 4.655, p = .0001), in their estimated cumulative days spent surfing (M_experts = 574.6, SD = 622.5; M_novices = 30.5, SD = 26.6; t(24.08) = 4.366, p = .0001), in their estimated cumulative amount of waves they have surfed (M_experts = 8646.8, SD = 20356.3; M_novices = 100.7, SD = 89.6; t(24.01) = 2.099, p = .047), and their estimated average waves surfed per year (M_experts = 49.9, SD = 26.7; M_novices = 10.3, SD = 10.1; t(30.6) = 6.936, p = .0001). Written informed consent was obtained from every participant before commencing the experiment. The study was carried out in accordance with the Helsinki Declaration of 1975.

**Stimuli**

Altogether 33 waves from the first person perspective—resembling the view a surfer has in the line-up when sitting on the board waiting for waves—were created as stimulus material. The stimulus material was captured in full HD (1920 x 1200 pixel) using a GoPro Hero 3 camera at a frame rate of 29 frames per second. The filming took place at a beach brake on the Atlantic coast in the south of France. The average length of the experimental stimuli was 4.9 s (SD = 1.5) and a video always came to an end exactly one frame before the surfer (the cameraman) was on top of the wave.

Four experts who were all in possession of a surf instructor license assisted with the selection of the stimulus material. They were asked to first indicate whether a wave was surfable or not surfable. Then the expert raters gave a more differentiated rating on continuous 26 cm scales (which were transformed into values between 0 and 100 by using an mm-based ruler; 2 mm = 1 unit) ranging from “not at all surfable” and “definitely surfable” by marking a cross on the line. On the dichotomous ratings the 4 raters showed an overall agreement of 88.3% per cent for all the 33 stimuli. Also the intra-class correlation (using a consistency type, two-way fixed model) for the wave ratings was high for both the individual wave ratings (ICC = 0.817; [95% CI: 0.716, 0.894]) and the average wave ratings (ICC = 0.947; [95% CI: 0.91, 0.971]). However, the fixed-marginal kappa coefficient (Siegel & Castellan, 1988) for the surfable vs. not surfable categorization was only at 0.661 (Randolph, 2008). Therefore, we decided to only use those stimuli as our experimental stimuli for which there was perfect agreement amongst the raters on the dichotomous classification of surfable vs. not surfable (i.e. a fixed-marginal kappa coefficient of 1.0) while the remaining stimuli were used as filler stimuli. The rationale for this was to have a solid criterion to test against when evaluating the decisions of the experimental participants.

The following waves were selected as the experimental stimuli: Seventeen waves were consistently rated as not surfable by the 4 experts. Their average rating was 5.51 (on the scale ranging from 0 = definitely not surfable and 10 = definitely surfable) with an average SD of 6.3. Five waves were consistently rated as surfable with an average rating of 93.3 and an average SD of 11.64. The remaining waves for which the 4 experts gave ambiguous ratings without a consensus were rated on average 29.5 with an average SD of 19.9. These stimuli were included in the experimental procedure and served as filler stimuli but were not included in the data analysis. The rationale for this unbalanced number of surfable and non surfable waves was that a much larger proportion of waves during a surfing contest or recreational surfing session is not surfed compared to surfed (Butt, 2014; Mendez-Villanueva et al., 2006).

**Procedure and measures**

E-prime 2.0 professional (Psychological Software Tools, 2007) was used to present the stimuli and collect the responses on a standard 15-inch laptop screen. Participants first viewed an example video to familiarize themselves with the procedure prior to the 33 stimuli that were presented in random order. Every participant got the same instructions, except for the control group, who were handed out an illustrated information sheet about how to surf and in particular on how to catch waves. The rationale for this was to explain how the task modeled the decision of trying to catch a wave when surfing. Participants were instructed that they would be presented with videos of waves approaching them while sitting in the line-up on a surfboard. Further they were informed about the type of surfboard they were using as this can affect the decision of paddling for a wave or not. They were informed that while watching the video they should decide if they would paddle for this wave and try to catch it. Participants were asked to give their responses by pressing the “arrow-down-key” if they decided to paddle for the wave or the “arrow-up-key” if they decided not to paddle for the wave. They were informed that they could press the corresponding key while the video was running or after the video had ended, but only up to 3 s after the video had ended as this was the point when automatically the next stimulus presentation would commence. Before every video stimulus a white screen with a fixation cross was presented for 1 s with the instruction to concentrate on the next stimulus. After having made their dichotomous “paddle-for-the-wave” or “don’t-paddle-for-the-wave-decision” the participants further rated how confident they were that the wave was surfable on an 11 point digital scale ranging from “not at all confident” to “very confident”. In order to give their ratings, perceivers moved a mouse cursor from the middle of the scale towards either pole of the scale and logged in their rating by clicking the left mouse button. The software converted the ratings into a value (with 3 decimals) between 0 reflecting the left pole of the scale with the label “not at all confident” and 1 reflecting the right pole of the scale with the label “very confident”.

**Data analyses**

We analyzed the percentages of good decisions—defined as corresponding with the expert ratings—with a 1 x 3 (surfing experience [experts vs. novices vs. controls]) univariate ANOVA, followed by polynomial linear trend analyses and simple planned contrasts. We ran the same analyses individually for the surfable waves and not surfable waves. Finally, we subtracted the mean confidence ratings of the surfable and not surfable waves to obtain an index of how well the respective groups could discriminate between these waves and analyzed the mean difference scores with the equivalent 1 x 3 (surfing experience [experts vs. novices vs. controls]) univariate ANOVA and follow-up comparisons.

**Results**

The descriptive results of the combined good decisions are displayed in Fig. 2. A 1 x 3 (surfing experience [experts vs. novices vs. controls]) univariate ANOVA was run to determine whether the combined good decisions differed significantly among the groups. A significant main effect of surfing experience was found (F(2, 70) = 8.552, p = .001), with experts showing significantly more good decisions than novices and controls, and both novices and controls showing significantly more good decisions than controls. A polynomial trend analysis showed a significant polynomial trend (adjusted R² = .24, F(2, 70) = 10.0, p = .001) such that good decisions increased significantly from the control group through the novice group up to the expert group. A simple planned contrast between experts and controls showed a significant effect (F(1, 71) = 19.8, p < .001, adjusted R² = .25). Simple planned contrasts between experts and novices and between novices and controls showed a non-significant effect (F(1, 71) = 1.9, p = .17, adjusted R² = .01).
Discussion

The goal of the present research was to investigate the decision making skills of surfers as a function of surfing experience. Using a quasi-experimental between-group approach, we provided first evidence that highly experienced surfers have perceptual-cognitive skills enabling them to distinguish between surfable and non-surfable waves more sufficiently. The results are supportive of the notion that surfing experience led to perceptual-cognitive adaptations that allow surfers to pick the right waves. The fact that expert surfers in particular could more reliably judge which waves were not surfable is in line with the anecdotal observation of beginning surfers trying to paddle for every wave and thereby wasting their energy which they are then missing when a good wave approaches. This was not only evident in the decision of paddling for a wave but also in the participants’ ratings of how confident they were that the wave was surfable.

At present there is a lack of theory explaining how perceptual discriminations develop amongst skilled performers, especially in dynamic environments such as surfing. In this respect the present research was the first to show that a large amount of practice in the domain of surfing (although we did not assess the specifics of practice the surfers engaged in) was associated with an increased efficiency in processing visual information, leading to superior decision making skills in this performance domain. This finding is in line with the theoretical account of Ericsson and colleagues arguing that large amounts of deliberate practice (Ericsson et al., 1993) lead to increased domain-specific knowledge and the
acquisition of adaptations to memory that allow for highly efficient encoding and retrieval while performing (Ericsson & Kintsch, 1995); i.e. advance cue utilization, efficient pattern recognition, superior visual search behaviors, and knowledge of situational probabilities (Williams & Ford, 2008). The present study adds to this literature by showing that this theorizing seems to also apply to skilled activities that require rapid visual discrimination of naturally occurring events, such as surfing waves. Therefore, it seems likely that the theorizing of Ericsson and colleagues further applies to activities such as reading river currents in kayaking or rafting, or detecting wind patterns on the water during sailing or wind- and kite-surfing. Whilst speculative based on the present study, it seems likely that athletes in these natural performance settings similarly acquire adaptations enabling them to pick up early cues (e.g. a visible bump on the ocean at a certain point on the horizon), recognizing certain patterns of information (e.g. ocean surface texture, reflecting light, speed of swell movement, ocean surface conditions, etc.) that render certain situational probabilities (e.g. a right-hand wave breaking far outside) more likely and thereby facilitating anticipation and decision-making. We are aware, that the findings based on the present task of distinguishing between surfable and unsurfable waves can only be regarded a starting point in providing evidence for this theorizing and acknowledge that future converging research is needed to gain a more complete understanding of the acquisition and development of perceptual-cognitive skills in surfing.

However, the rules and regulations of professional surfing contests highlight the importance of acquiring and developing certain perceptual-cognitive skills that allow surfers to integrate environmental information with stored knowledge to select an appropriate response to be executed. A competitive surfing contest usually consists of several rounds (termed heats) in which two surfers compete for a limited period of time (e.g. 30 min) against each other. Every surfed wave is then rated by a judging panel and the two waves that were rated highest count towards the final score of the surfer. At the end of a heat the surfer with the highest two wave score wins. An important rule within every heat concerns who has priority to surf on an approaching wave. While there is no priority regulation on the first wave of a heat, the surfer who did not take the first wave gets automatic priority. The surfer with priority has unconditional right to take whichever wave he decides to surf on while the surfer without priority cannot take the same wave as the priority surfer. A surfer will lose priority once he catches a wave. According to the official organization of competitive surfing ASP, one of the purposes of the priority rule is to: “…allow for a tactical element to exist in competitive surfing. Surfers tend to become much more selective of their wave choice in order to retain priority for the optimal amount of scoring” (http://www.aspworldtour.com/pages/faq, retrieved on 20.08.2014). In this respect the present study was able to show that the perceptual-cognitive skill of knowing when not to go on a wave is likely to be of high practical importance in competitive surfing. This feat will enable surfers to maintain priority to pick the best wave, just as Mick Fanning did in the introductory example. Therefore, based on the findings of the present study the popular slogan in surfing “Eddie would go”—which refers to surfing legend Eddie Aikau’s bravery of going in the most dangerous conditions on the biggest waves—could be modified to “Eddie wouldn’t go” to emphasize the importance of knowing which waves not to surf in elite surfing.

Despite the contribution of the novel findings to the surfing expertise literature, the present study is not without its limitations. First, the present findings do not shed light on the relative contribution of decision making skills relative to other performance-influencing factors in surfing. Hence, future research should increase the ecological validity of the decision making situation and thereby start to gain a more complete understanding of the relative contributions of both physical and cognitive factors in elite surfing. In addition, the quasi-experimental approach adopted does not allow for inferring causality. Hence, it is not clear whether surfing experience led to perceptual-cognitive adaptations that in turn facilitate domain-specific decision making or whether individuals with certain perceptual-cognitive advantages are more likely to engage in the sport and are therefore more likely to gather more experience. Further, the study was only conducted with male surfers and not female surfers, questioning the generalizability of the findings.

Within professional and recreational surfing a multi-million dollar industry has emerged (Butt, 2014) that integrates vast amounts of information to create precise wave models that allow forecasting at which locations and when to expect the best surfing conditions (e.g. surffline.com). This information helps surfers and surf contest directors to decide where and when to go surfing for optimal performance conditions as wave quality is highly dependent on a range of complex interacting factors (Butt, 2014). However, once surfers are in the water they do not have the assistance of complex computer-based models in interpreting the vast quantity of relevant environmental data, but have to rely on their own information processing system to make good decision on which waves to surf on. Although the present data suggests that the amount of domain-specific practice in surfing, leads to measurable perceptual-cognitive adaptations which could reliably be captured in the present laboratory task, the present research only covered the first step of the expert performance approach (Williams & Ericsson, 2005). The next research step has to identify the perceptual-cognitive processes that expert surfers use that mediate their superior performance. For example, the expert performers tested in this study indicated that the light reflecting from the approaching wave was an important cue informing them about whether the wave was surfable or not. In this respect, future research should conduct verbal protocol analyses, occlusion techniques, or eye-tracking analysis (Williams & Ericsson, 2005) to identify the important visual cues during surfing. Once the mediating mechanisms that account for expert performance have been identified, it is important to assess and determine how experts acquire and develop the component skills needed to demonstrate reliably superior performance (i.e. the learning and acquisition processes; Step 3 of the expert performance approach). Subsequently, this research will allow developing evidence-based training programs to improve performance in surfing.

Taken together, the pattern of results shows that experienced surfers demonstrate perceptual-cognitive skills that allow them to “read” their performance environment more effectively which contributes to their superior performance. In this respect, the study is the first to indicate that beside physical factors such as postural control (Chapman et al., 2008) or upper body strength and fitness (Mendez-Villanueva & Bishop, 2005; Mendez-Villanueva et al., 2005) cognitive factors such as decision making also play an important role in elite surfing.

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