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Decision making in beach volleyball defense: Crucial factors derived from interviews with top-level experts

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ABSTRACT

Objectives: In fast ball sports like beach volleyball, decision-making skills are a determining factor for excellent performance. The current investigation aimed to identify factors that influence the decision-making process in top-level beach volleyball defense in order to find relevant aspects for further research. For this reason, focused interviews with top players in international beach volleyball were conducted and analyzed with respect to decision-making characteristics.
Design: Nineteen world-tour beach volleyball defense players, including seven Olympic or world champions, were interviewed, focusing on decision-making factors, gaze behavior, and interactions between the two.
Methods: Verbal data were analyzed by inductive content analysis according to Mayring (2008). This approach allows categories to emerge from the interview material itself instead of forcing data into pre-set classifications and theoretical concepts.
Results: The data analysis showed that, for top-level beach volleyball defense, decision making depends on *opponent specifics*, *external context*, *situational context*, *opponent's movements*, and *intuition*. Information on gaze patterns and visual cues revealed general tendencies indicating optimal gaze strategies that support excellent decision making. Furthermore, the analysis highlighted interactions between gaze behavior, visual information, and domain-specific knowledge.
Conclusions: The present findings provide information on visual perception, domain-specific knowledge, and interactions between the two that are relevant for decision making in top-level beach volleyball defense. The results can be used to inform sports practice and to further untangle relevant mechanisms underlying decision making in complex game situations.

In beach volleyball, only two players have to defend an area of 8 × 8 m, which is immense compared with indoor volleyball where six players cover a court size of 9 × 9 m. To defend optimally, beach volleyball players usually specialize as block or defense players. Consequently, the defense player has to take care of all balls that pass the block and end up within the court. These balls that pass the net can be classified into smashes and shots. In contrast to smashes, shots are not spiked hard but precisely directed over the block to specific areas (see Fig. 1). Whereas in women's competitions smashes and shots are almost equally distributed (49% vs. 51%), smashes are more frequent (59%) than shots (41%) in men's beach volleyball (Koch & Tilp, 2009). According to Koch and Tilp (2009), line shots are most common among shots (30% for women, 27% for men), followed by cut shots (21% for women, 15% for men). To optimally face these circumstances, different block-defense systems have been developed. In the standard system, which is used in 48% of all defense situations (Künkler, 2009), the block player is responsible for covering line smashes whereas the defense player is responsible for all balls played crosscourt as well as for line shots (see Fig. 1).

Considering balls that cross the net at 80 km/h to 130 km/h from a distance of 4–10 m (Hömberg & Papageorgiou, 1994; Künkler, 2009), and the aggravating surface of a beach court, it is obvious that a high level of expertise in beach volleyball-specific decision making is needed in order to perform successfully. Due to immense time pressure, defense players have to be able to perceive relevant information, make correct decisions, and act efficiently and accurately within a very short amount of time.

Just as in beach volleyball, expert athletes in fast ball sports generally need to make decisions based on anticipated and often partial information about an opponent's next action in order to successfully execute appropriate motor responses, as it is

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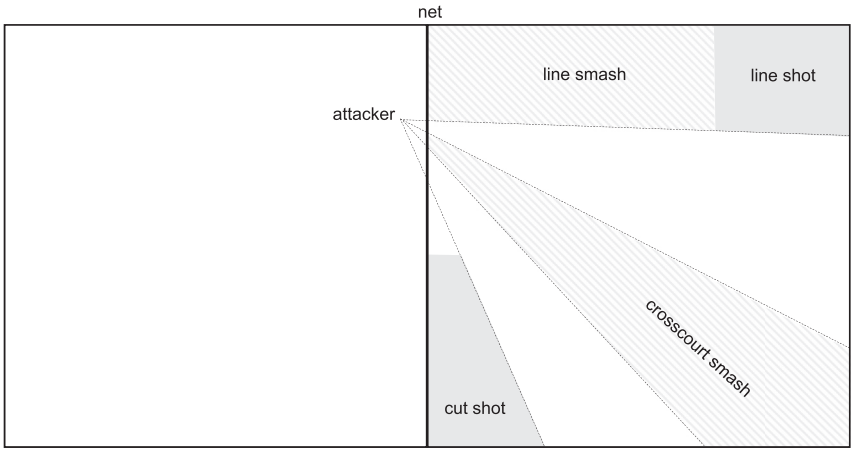

Fig. 1. Attacking zones and decision options in beach volleyball defense. In the "standard system," the defender typically has to cover a diagonal "smash," a diagonal "cut shot," and a "long-line shot."

frequently not sufficient to just react to an opponent's action (David, Pleasants, & Gomez-Meza, 1990). The awareness that, in turn, successful action requires well-developed cognitive and, in particular, perceptual skills has led researchers to examine these skills' role in sport performance. As expected, several studies have confirmed that, in addition to accurate and efficient movement execution, expert performance in sports is hallmarked by superior perceptual-cognitive skills (e.g., Savelsbergh, Williams, Van der Kamp, & Ward, 2002; Williams, Davids, & Williams, 1999). On the one hand, perceptual-cognitive skills that are crucial for expert performance may be assigned to perception and the use of visual information (e.g., Williams et al., 1999). On the other hand, these skills may be connected to domain-specific knowledge (e.g., McPherson, 1994). It seems worthwhile to dwell on the relevance of these two aspects on expert decision-making a little bit further.

Concerning the first above-mentioned aspect, *visual information*, several studies have shown that expert athletes are able to anticipate the opponent's action on the basis of early visual cues more accurately than novices (e.g., Abernethy, Gill, Parks, & Packer, 2001; Abernethy & Russell, 1987; Goulet, Bard, & Fleury, 1989; Williams et al., 1999; Williams, Ward, Knowles, & Smeeton, 2002). Experts' superior ability to effectively pick up early information from the opponent's movement pattern has been shown for several sports, such as badminton (Abernethy & Russell, 1987; Hagemann, Strauss, & Cañal-Bruland, 2006), tennis (Farrow, Abernethy, & Jackson, 2005; Goulet et al., 1989; Rowe & McKenna, 2001; Shim, Carlton, Chow, & Chae, 2005; Williams et al., 2002), soccer (Williams, Davids, Burwitz, & Williams, 1994), squash (Abernethy et al., 2001), cricket (Müller, Abernethy, & Farrow, 2006; Müller et al., 2009), indoor volleyball (David et al., 1990), and baseball (Takeuchi & Inomata, 2009). Furthermore, it could be shown that experts are better able to effectively interpret relative motion features of animated point-light figures (Ward, Williams, & Bennett, 2002) and to identify patterns of play based on recall and recognition processes (e.g., Williams, Hodges, North, & Barton, 2006).

As gaze behavior may unravel crucial mechanisms underlying the use of visual information in decision making, a number of studies have analyzed expert-novice differences in decision situations by applying eye-movement registration systems (e.g., Vickers, 2007; Williams, Janelle, & Davids, 2004; for a review, see Gegenfurtner, Lethinen, & Säljö, 2011). In these studies, experts were generally shown to use more efficient visual search strategies (e.g., Farrow & Abernethy, 2003; Savelsbergh et al., 2002; Ward & Williams, 2003; Williams et al., 1999, 2004) than novices. Expertise-related differences in visual search behaviors were found in various sports, such as basketball (Bard & Fleury, 1976), cricket (Abernethy & Russell, 1987), tennis (Williams et al., 2002), soccer (Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007), and, in particular, soccer penalty shooting (Savelsbergh et al., 2002). As these studies were conducted across different sports and with different experimental setups, it is difficult to extract general conclusions (Raab & Johnson, 2007). However, an overall tendency might be identified, which is that elite players, compared with novices, use fewer fixations of longer durations and direct their gaze to more important areas in the visual field (for a review, see Williams et al., 1999). However, some studies have reported more fixations of shorter duration for experts than for novices in certain cases (e.g., Williams et al., 2002), indicating that optimal gaze behavior seems to be task dependent. In this respect, in their review on gaze behavior in decision making in several professional domains, such as medicine, transportation, and sports, Gegenfurtner, Lehtinen, and Säljö (2011) conclude that experts, compared with non-experts, conduct more fixations on task-relevant and fewer fixations on task-redundant areas, accompanied by shorter fixation durations as well as longer saccades. Furthermore, due to superior parafoveal processing and selective attention allocation, experts are able to fixate relevant information faster.

Opposite to the extensive amount of gaze-related research, and even though *domain-specific knowledge* is considered as a "key attribute of expertise" (Crognier & Féry, 2005, p. 647), only a small number of researchers so far have tried to tackle the influence of domain-specific knowledge on decision making in sports (e.g., Klein, Calderwood, & MacGregor, 1989; Macquet, 2009; McPherson & Kernodle, 2003; see also the PSE special issue on decision making edited by Bar-Eli & Raab, 2006). Among the works on domain-specific knowledge, research on "naturalistic decision making" (NDM) plays a major role, as it focuses on decisions in natural situations. These situations come along with ill-structured problems, dynamic and uncertain conditions, ill-defined and evolving goals, time pressure, action-feedback-loops, a large number of involved players, and high risks (Macquet & Fleurance, 2007). In NDM studies, it has been investigated how professional decision-makers from different fields (e.g., fire fighting, nuclear power, aviation, military, paramedics) use their experience when making decisions (Macquet, 2009). A major result of research on NDM is that experts