

Differences Between Expert and Novice Tennis Coaches' Perceptual Capacities

Paul G. Schempp
University of Georgia

Sophie Woorons
Brookstone Tennis Academy

The purpose of this study was to examine analytic perceptions of expert and novice tennis coaches. Four expert and four novice tennis coaches volunteered as study participants. Both a video analysis and a recall test provided data for this investigation. In the video analysis protocol, participants were asked to describe what they observed while viewing a 10-minute video of a tennis practice session. In the recall test, a series of 10 tennis related slides were viewed by each of the coaches. After viewing each slide for five seconds, the coaches were asked what they recalled from the slide. The completed written accounts from the video analysis and the recall test audiotapes were transcribed and served as the primary data. The researchers looked for recurring themes and categories using the generic qualitative study technique. Data analysis revealed six themes: (a) the quantity of cues perceived, (b) attention to critical features, (c) analytic depth, (d) recognizing meaningful patterns, (e) anticipating the future, and (f) from description to prescription. These findings, while new to the coaching literature, supported previous research in other fields regarding the importance and domain specificity of experts' superior perceptual capacities.

Keywords: coaching, pattern recognition, perception, tennis instruction

Olympians pushing the limits of human performance, medical doctors discovering ways of fighting debilitating diseases, coaches finding fresh solutions to athlete development challenges—experts in every discipline make a difference in people's daily lives. Experts are those who possess "the characteristics, skills and knowledge that distinguish them from novices and less experienced people" (Ericsson, 2006, p. 3). Experts are those who regularly outperform all others in their chosen field of endeavor.

Research into expertise is rooted in cognitive psychology (Chase & Simon, 1973; De Groot, 1965). Stemming from this seminal work, scholars from a range of disciplines have focused their attention on understanding the characteristics and qualities that make an individual exceptional in their specialty (Ericsson, Charness, Feltovich, & Hoffman, 2006). Tan (1997) summarized the qualities and attributions experts possess that account for their outstanding performances. One of those attributes was acute perceptual capacities. In describing the perceptual capacities of experts, he noted that "experts see details or information that other people either miss or dismiss. They recognize patterns during events that allow them to draw on their sizable knowledge store. This process of pattern recognition involves the identification of critical cues (e.g., words, sounds, movements) as the event or performance unfolds" (pp. 31–32). Gibson and Pick (2000), believed perceptual capacities required the individual to become 'tuned' to 'pick up' (i.e., develop the ability to recognize) information in the environment essential for good decisions and strategic actions. Further, Giblin, Farrow, Reid, Ball and Abernethy noted that "expert performers are known to be characterised by their superior visual perceptual skills, especially their skills to make predictive judgements from observation of complex movement patterns of opponents" (2016, p. 6). The common theme among these perspectives appears to be that

perceptual capacities represent the ability to identify and extract meaningful information from observations that can then be used to perform required tasks. Further, this ability is a key characteristic distinguishing experts from non-experts in a professional field.

Acute perceptual ability has long been recognized as a critical skill in the arsenal of experts (Carter, Cushing, Sabers, Stein, & Berliner, 1988; Chase & Simon, 1973). Research supports the claim that experts can efficiently detect cues in the environment and use them to make quick, accurate decisions (Chassy & Gobet, 2011; Gobet & Simon, 1998, 2000). From both theoretical and empirical perspectives, perceptual ability appears to be an important skill in the development of coaching expertise (Nash, Martindale, Collins, & Martindale, 2012). Novices must learn to identify through observations how actual performance departs from a norm or standard (Pinheiro & Simon, 1992).

The study of expertise in teaching began to flourish following the work of Berliner (1986, 1991, 1994) and given the professional task similarities, research into coaching expertise soon followed (Jones, Armour, & Potrac, 2003; Jones, Housner, & Kornspan, 1995; Schempp, Templeton, & Clark, 1998). Instructional research has consistently found that heightened perceptual capacities increases teaching ability. Borko and Livingston (1989), for example, found that acute perceptual abilities helped classroom teachers plan and teach more effectively. Carter and colleagues (1988) concluded that perceptual skills were crucial for optimal instruction. Graham, French, and Woods (1993) discovered that the perceptual capacities of expert physical education teachers allowed them to better verify student understanding and comprehension. Dodds (1994) considered observational skills mandatory for expert teachers of physical activity: "observational (or movement analysis) skills are essential to physical education expertise because a high-priority

teaching goal should be improving students' movement skills One critical characteristic of expert physical educators is their ability to analyze motor skills qualitatively better than novices" (p. 157).

Recognition of the importance of perceptual capacities in coaching is reflected in the growing vibrancy of research on the topic (Mooney et al., 2016; Olusoga, Butt, & Maynard, 2010; Spencer-Ingels & Rhodius, 2016; Tracey & Elcombe, 2015). For example, a study of the perceptual tendencies of swim coaches found that video-based methods were frequently employed by over 70% of studied collegiate coaches. Further, the purpose of the coaches' analyses was qualitative assessments rather than quantitative. That is, the coaches used video to make qualitative judgments regarding their athletes' swim stroke technique (Mooney et al., 2016). In another study, expert basketball coaches were significantly superior in predicting future in-game events based on current game situations than were novices (Spencer-Ingels & Rhodius, 2016).

Two studies focused on coaches' ability to accurately perceive athlete exertion during training. One study determined the relationship between coaches' perceptions of exertion and measures taken by heart rate monitors and accelerometers during the training of 31 elite junior soccer players (Brink, Kersten, & Frencken, 2017). Coaches based their perceptions of exertion on what they expected players will do and what they actually observed them doing on the field. In a study of 24 professional Brazilian male soccer players and their coaches found no statistical differences between the coaches' perceptions and players' perceptions of player exertion during training (Eduardo, Gregorio da Silva, Ricetti, & Dos-Santos, 2017). In both studies, the coaches' perceptions of player training exertion appeared to be accurate when compared to either quantitative exertion measures or players' perceptions of their own exertion.

Cripps, Hopper, and Joyce (2016) explored the relationship between coaches' perceptions of long-term athlete potential and variations in athlete's biological maturity. Talented adolescent male Australian footballers ($n=264$) from nine different teams were recruited to provide basic anthropometric information to estimate biological maturity. Coaches from each team rated their own players' long-term potential. The coaches perceived late maturing athletes to have significantly lower long-term potential than their average and early maturing players. Of the late maturing athletes, 72% were predicted to go no further than adolescent competition. The researchers believed that coaches' perceptions of long-term athlete potential are biased by maturational variation and that such perceptual bias may impact coaches' selection decisions resulting in talented but late maturing athletes missing selection into development pathways. This was the first coaching study to indicate the perceptual capacities are susceptible to bias.

A study similar to the current investigation examined the influences of coaching and playing experience on perceptions of kinematic changes in a tennis serve (Giblin, Farrow, Reid, Ball, & Abernethy, 2016). The participants were 21 coaches averaging 15 years coaching experience and holding or pursuing their country's highest coaching certification, 10 novice coaches (average 5 years experience) and 10 current tennis players. The participants observed a video and point-light displays of a tennis serve and recorded written judgments on whether the serve had changed from one video clip to the next. Three kinematic variables were manipulated: maximum knee flexion, maximum trunk rotation, and ball toss position at zenith. A significant expertise effect showed that expert coaches had superior perceptual capacity when detecting small changes in the skill performance. While caution must be

taken in interpreting a single investigation, their study offers evidence that perceptual skills may be a differentiator between expert and novice coaches, making the case for additional research on the perceptual capacities of expert coaches.

Missing from this body of research on coaching expertise and perceptual capacities are studies of precisely what expert coaches perceive, why, and what they do with this information. Given the important role perceptual skills play in coaching expertise and the promising results from previous research, a study of the perceptual capacities of sport coaches appears justified. Accordingly, the present study sought to determine differences between the perceptual capacities of expert and novice coaches.

Four questions guided data collection and analysis:

1. How do experts' perceptual capacities differ from novices' in matters of selection, detail and relevance during tennis coaching?
2. Are there perceptual differences between experts' and novices' coaches' inferences, interpretations or evaluations?
3. Do experts and novices differ in their perceptions of meaningful skill patterns, their understanding of observed situations and their anticipation of future events in tennis skill performance and coaching?
4. Do the coaches make a diagnostic analysis or offer a potential solution to perceived problems?

Method

Participants

Four expert and four novice tennis coaches participated in the study. Studies using the expert-novice paradigm involving eight participants have been used in previous research (Lubbers, 1998). As was noted by Müller, Brenton, and Rosalie (2015), the limited availability of an expert population from which to draw a sample often dictates a relatively small sample size compared to studies with a more accessible population. Selection criteria for novice coaches included (a) first year coaching professional, (b) employed full-time as a tennis professional spending a minimum of 15 hours a week coaching tennis on court, and (c) certified professional by either the United States Professional Tennis Association (USPTA) or the Professional Tennis Registry (PTR).

The four novices were referred to as Novice one through four to preserve their anonymity. They were certified and employed as tennis coaches for a minimum of 20 hours per week. Novice one had started coaching a few months prior to data collection. Novice two was a first-year tennis coach. Novice three had been coaching for less than a year and novice four was also a first-year tennis coach.

The second group comprised four expert tennis coaches. The expert selection criteria were adapted from Berliner (1986) and included: (a) a minimum of 10 years of full-time teaching experience, (b) certified professional by either the United States Professional Tennis Association (USPTA) or the Professional Tennis Registry (PTR), (c) had received formal recognition at a regional or national level for the quality of their coaching by either the USPTA or PTR (e.g., Professional of the Year, Alex Gordon Award for Professional of the Year, Steve Wilkinson College Coach of the Year), and (d) had established consistent record of athlete performance at the regional or national level. The experts in the present study averaged over 22 years of coaching experience and were coaching full-time at the Collegiate or elite professional level at the time of the study.

Given their prominent status in the tennis industry, the investigators did not believe it possible to guarantee the confidentiality or anonymity of the experts. Consequently, the experts were informed prior to data collection that their names and institutions could potentially be identified in any publication or presentation of the study. They could, however, withdraw from participating in this study at any time during or after data collection. The University of Georgia Institutional Review Board for the Protection of Human Research Participants approved this decision.

Once identified, phone calls were placed to these individuals and their participation was requested. Upon agreeing to participate, the expert and novice coaches were thoroughly informed of the protocol for this investigation. Prior to data collection, all coaches read and signed an approved Informed Consent Form.

Data Collection

The present study was qualitative in nature. Two data collection methods were used to answer the question: How do expert tennis coaches' perceptual capacities differ from novices? Both a video analysis and a recall test served as data collection methods. The video analysis method was previously used by Graham et al. (1993) in a study of physical education teachers' ability to observe and interpret instructional events at different stages of teaching expertise. This technique has also been previously used in research on coaches' perceptions (Giblin et al., 2016). This technique yielded information regarding "cue acquisition, cue interpretation, and diagnostic decisions" (Pinheiro & Simon, 1992, p. 289). The recall test method was previously used by Carter et al. (1988) to determine differences in expert and novice teachers' perception and processing of visual classroom information.

A pilot study was conducted to test the time demand, efficiency and reliability of each instrument. The investigators were able to gain experience in the use of these techniques and determine the suitability of these methods for providing data that would be serviceable in addressing the research questions. The pilot study was undertaken with tennis coaches who did not participate in the actual study. At the conclusion of the pilot study, minor adjustments were made in the administrative procedures so data could be collected efficiently with no loss in accuracy or thoroughness.

Video analysis. A videotape of the first 10 minutes of a tennis practice session was shown to the participants. The videotape was made by the researchers and depicted a typical group tennis practice session taught by an experienced, certified tennis coach who was not a participant in this study. Prior to viewing the tape, the researcher overviewed the procedures of the study with each participant. The researchers read and followed the typed protocol adapted from Graham et al. (1993) which stated:

For the next 10 minutes, you will be watching a videotape of a tennis practice session. The purpose is to have you describe what you observe. You should find it helpful to take notes while you observe the tape. After viewing the tape you will be given another 20 minutes to write down your perceptions and evaluation. Please try to provide as full a description as possible of what you observed.

Recall test. The expert and novice coaches participated in individual sessions of a memory recall test during which they viewed a series of 10 slides depicting a variety of tennis players performing fundamental tennis strokes (e.g., forehand, backhand, volleys, serves) as well as tennis coaching related activities. The coaches viewed each slide for five seconds. After the slide was removed, the

coaches were told to "Recall as much as possible from the slide." The participants were given unrestricted time between the slides to provide as much information as they could recall. The coaches were then shown the next slide. The participants' comments were audio taped and the tapes later transcribed and analyzed.

Data Analysis

Data collected from the two procedures were analyzed to identify distinctive themes that differentiated expert from novice perceptual capacities. The completed written accounts from the video analysis and the recall test audiotape yielded 105 pages of transcripts which served as the primary data for this study. The researchers looked for recurring themes and categories using the generic qualitative study technique recommended by Merriam (2009). That is, each transcript was read and consistent concepts underlying the participants' perspectives were identified both within the data set for each participant as well as the data sets between each participant. The data analysis process of the video analysis written accounts and the transcripts from the recall tests also involved the development of a meta-matrix (Graham et al., 1993). This meta-matrix displayed information extracted from both data sources relating to participants' perceptual capacities. The matrix was divided into expert and novice groups.

The use of the constant comparative method (Glaser & Strauss, 1967) was used throughout the data analysis. This required that incidents reported or descriptions offered by the participants be compared with previous incidents included in the category. As more incidents were analyzed and included, the categories were redefined to better fit the included data. As the category structure began to take shape, references were made to previous work on perception and perceptual capacities in order to better substantiate and define each category and identify the relationships among the categories. As the relationships between the categories became clearer, the categories were reorganized into a "systematic substantive theory" (Glaser & Strauss, 1967, p. 113) that explained the differences between expert and novice coaches' perceptual capacities.

Data Credibility and Trustworthiness

For confidence to be gained in the findings, it is critical in a qualitative study to undertake procedures to enhance the credibility and trustworthiness of the gathered data and subsequent analysis. Lincoln and Guba (1985) proposed several strategies that have become an accepted standard for confirming the trustworthiness of qualitative data. Strategies chosen for incorporation into the design of this study to help ensure that the results were dependable included: (a) data triangulation, (b) a key informant and (c) member checks.

Triangulation. As themes emerged from a particular data set, it was checked against the other data source and a key informant for consistency. That is, if there appeared a trend in the video data, the recall test was reviewed for consistency with the emerging theme, and the key informant was also consulted to see if he interpreted the data in the same way. If there appeared contradictory data in one of the secondary sources, the emerging trend was either abandoned as non-supportable, or redefined so as to be supportable for the other data sources. This strategy allowed the emergent themes to be confirmed at multiple points in the analytic process and reduced the possibility of inconsistencies or misinterpretations in the results. Beginning this technique early in the data collection helped insure that investigators would not place significant weight on initial

impressions until impressions could be confirmed through another source of data.

Key informant. The researchers invited Butch Staples as key informant in the study. Butch Staples holds three college degrees; two in Physical Education and Sport Science (Bachelor's of Physical Education and Master of Science). Butch also served as the Chairman of Tennis Canada Coaching and Development Instructors' Committee. At the time of this study, he had over 25 years of professional coaching experience. He is a PTR Master Professional, a United States Professional Tennis Association Professional 1 and a Tennis Canada certified coach. He was twice the recipient of the prestigious National Trainer of the Year award by the United States Tennis Association. The Professional Tennis Registry (PTR) named him both Clinician of the Year and Pro of the Year. Staples was awarded the 2009 United States Olympic Committee (USOC) "Doc" Counsilman Science Award. In 2012, he received the prestigious Tennis Hall of Fame Educational Merit Award for his contribution to teaching and coaching. As such, the investigators determined that he possessed the competence, knowledge and experience of an expert tennis coach and would serve competently in the role of key informant.

While he was familiar with the study, Butch was not a participant and did not discuss this study with the participants during any phase of the investigation. As a key informant, Butch's insights were sought for two purposes: to validate initial themes derived by the investigators, and provide clarification and elaboration on the potential themes. The key informant was given open access to all data and encouraged to form an independent interpretation. The written data did not reveal the names of the participants, therefore Butch could not differentiate the experts from the novices during data analysis. The investigators and key informant met on a continual basis during both data collection and analysis for the purpose of discussing participant responses, data collection, emerging themes, and the trustworthiness of the findings.

Member checks. In the video analysis, participants were encouraged to review their written responses and suggest changes they believed would either correct, improve or clarify their statements. In the recall technique, participants were asked to review the transcripts of their recorded responses for accuracy. Finally, the themes drawn from data were shared with the participants who were available at the time data analysis was completed. The participants believed the findings of this study to be accurate representations of their responses to the study protocol.

Results

Results were organized into six themes: (a) quantity of cues perceived, (b) attention to critical features, (c) analytic depth, (d) recognizing meaningful patterns, (e) anticipating the future, and (f) from description to prescription.

Quantity of Perceived Cues

Surprisingly, experts and novices identified a similar number of environmental cues. The 332 total cues perceived by novices in this study slightly exceeded the 313 total cues perceived by the expert coaches (see Table 1). A cue was defined as a noun or phrase used to identify or describe an event, action or object in the environment recalled from the slides and video observed by the coaches. For example, if the coach recalled "The player was left handed, 'left handed' would be considered a cue. There was less than a

Table 1 Quantity of Perceived Cues

Coaches	Total Cues	Average	Relevant Cues	Average #	Percent Relevant
		# Per Coach		Relevant Per Coach	
Experts	313	78.5	311	77.8	99%
Novices	332	83.0	240	60.0	72%

10% difference in the total number of cues perceived by the novice and expert coaches from both the video and recall tests.

Attention to Critical Features

While there was little difference in the quantity of cues perceived by the novice and expert coaches, there appeared a large difference between the two groups in terms of the relevance of those cues to player performance and coaching. The findings suggested that the experts attended to a greater number of "critical features" than did the novice coaches. According to Knudson (2000), "critical features are the most invariant technique points of a movement: they determine whether a movement is effective, efficient, and safe" (p. 20). Experts focused their attention on a multitude of critical features notably arm, back swing and preparation, back and body position, point of contact, balance and weight transfer, elbow, eyes, footwork, grip, hand, head, legs, movement, positioning on the court and towards the ball, racquet, timing, and wrist. The novice data combined did not include as many critical features as one single expert transcript. Experts' technical comments added up to 578 (99%) words, while the novices had less than half as many with a total of 251 (72%) words (Figure 1). On average, the novices perceived approximately three critical features per slide, substantially less than the experts who averaged close to 10 technical comments per slide. For example, in Figure 1, Novice 1 shows two relevant comments namely "backhand, and low backhand volley" while the expert had 8 relevant comments on the same slide "racquet head low, knee bent, step across, foot at an angle, balance, body position, right hand, wrist not dropped".

Further, there was greater consistency among experts' critical analysis and diagnosis of motor skill. For example, Expert 1 examined 30 different critical features (hand, wrists, body position, head, legs, grip, etc . . .) while the four novices collectively examined a total of 19 features. The rest of their focus was targeted to environmental factors such as player apparel, gender, equipment on sidelines, shrubs and trees, etc. In both the slide recall and video analysis data, experts were more selective and focused tightly on the critical features of player and coach performance. For example, in analyzing a slide of a player hitting a backhand, Expert 2's perceptions were exclusively targeted to the player's critical skill features.

That's somebody hitting a backhand groundstroke. Their elbows are very high in on the body. I don't like that position too much. She's actually stepping across. So, with her feet she has to reach to the ball but with her hand she's very jammed. So I think her footwork and elbows and hands should be a lot different. That was about it. (slide 4)

In contrast, novices' perceptions were more random than focused. They commented on a variety of topics ranging from technique to age, clothing, surrounding area and weather conditions.

The guy had blue shorts on, a white hat, a white shirt; he had on a watch with a bright band . . . a little bit of foliage back

Sample Perception Patterns of Novice and Expert Teachers



Figure 1 — Sample perception patterns of novice and expert teachers.

there. I think she had a white blouse on. She had reddish-blond hair, I think brown eyes . . . Two cars in the background, I don't remember if I said he had dark glasses on . . . The device you drag the court with was on the court . . ." (Novice 1, video)

It isn't that the experts see only critical features, but rather they attend only to these features in their observations. When asked why he didn't mention anything regarding the background (e.g., cars, foliage) or the student's hair color and clothes, expert Expert 4 explained:

I don't think that's relevant nor has any bearing on their technique or stroke mechanics or anything to do with tennis, coaching or observing. I don't think that makes any difference at all. Because I feel like as somebody critiquing the game of tennis the things to observe are mechanics, positioning, strategy, teaching technique. Now if the tennis coach had been dressed poorly, I would have mentioned it or if the players had improper equipment for the surfacing, that would be relevant. (Expert 4, video)

The key informant also recognized a qualitative and quantitative difference between the experts' and novices' tennis related feedback in the video analysis data.

These data here show half a dozen technical related comments. There are six or seven points in the experts' data and only one or two points are tennis related in the novices' data. (Key Informant)

The comparison between expert and novice data revealed a detectable difference in the amount of irrelevant comments made by both groups (Table 1). Experts' data reported attending to only

4 irrelevant comments: "Do you want environment things like windscreens and backgrounds? There was a windscreen missing right behind him." (Expert 2). In contrast, a total of 94 irrelevant comments appeared in the novices' data: "She had on blue shorts, tennis shoes, pink shirt . . . There were flowers/trees behind the fence" (Novice 2, slide 2).

Analytic Depth

While both experts and novices' perceptions demonstrated the use of evaluation, experts consistently supported their evaluations with precise examples and detailed explanations. This became evident when the key informant inquired about the video analysis and recall test protocols. He asked if there was a difference in the interpretation of the word "describe" among the participants. He found that the experts in the study went beyond simple description to interpretive judgment and critique. "It's not just a description of what they see as much as it is an analysis" (Key Informant). In other words, the experts' 'descriptions' included analytic insights that assessed the significance of what they perceived. As an example, Expert 4 had this response when viewing the videotaped tennis practice: "Overall so far, I would say that he's feeding the ball pretty well; he's vocal and verbal which is good; he does know their name and that's good . . . He is good with kids. The kids seem to like him. He has a good personality for coaching." Similarly, the technical evaluation was also very specific: "Still too much racquet movement, too much swinging, too much loose wrists, instead of keeping a short compact swing with the volley" (Expert 1).

In contrast, novices' evaluations were characterized as non-analytical descriptions. "The player hit a good volley and the coach explained that it was good" (Novice 2). "The guy, whoever is

hitting a back-hand volley just looks gorgeous—pretty form on that” (Novice 3).

When reviewing the data, the key informant confirmed the theme that experts were more critical and judgmental and the novices’ more descriptive. He was able to follow what experts and novices were watching and recognize the source of their descriptions.

Recognizing Meaningful Patterns

The fourth theme identified was the recognition of meaningful patterns in the coaches’ perceptions. This theme appeared to be solely in the domain of the experts, and consequently another differentiator between novice and expert coaches. The researchers anticipated that experts’ perceptions would follow specific technical patterns with a sequence of stance, grip, preparation, footwork, point of contact and follow through (van der Meer, 1999). Experts clearly and consistently perceived the critical cues or performance factors in the observed events. Focusing on skill patterns kept the experts’ attention on the critical performance factors, while the novices, in contrast, seemed almost oblivious to the technique patterns defining a player’s performance quality.

Previous research indicated that experts can only perceive patterns that are meaningful and not random (Chase & Simon, 1973; deGroot, 1965). Therefore, a slide was added to the recall procedure that was out of the ordinary in tennis coaching. Slide nine depicted a physical education instructor at the beginning of a tennis class of approximately 30 college students. The instructor did not have a racquet in his hand and the students were all standing behind the baseline. This slide was chosen because it was related to tennis and tennis coaching yet it was out of a traditional context and assumed to be peculiar to the expert eye. The experts had trouble making sense of this situation. Because meaningful patterns could not be discerned, their responses were more descriptive than analytical. Their thoughts were not as structured, lacked selection of critical features and contained few inferences or anticipatory comments of future events.

Inferences and Anticipation of Future Events

Based on recognized patterns in the perceived cues, the experts demonstrated an ability to make logical inferences and deduce future events and consequences. With the lack of pattern identification, it was not surprising that none of the novices’ data revealed inferences or the anticipation of future events. Their difficulty in making sense of the present situation did not allow to see beyond the present to the past or future.

Often inferences or the anticipation of future events would follow the experts’ description, diagnosis and prescription pattern; but not always. Experts’ understanding of drill patterns, as well as technical analysis and past experience, were also factors influencing their ability to infer likely outcomes. Drill patterns observed in the video were especially helpful in providing the experts with cues as to what was likely to come next. The experts were able to discern these patterns and infer future events even in the still pictures. “The coach was in the back in the center initiating with the other two players on the other side and . . . then the two on his side were reacting to their ball and probably playing the point out from there and re-setting after that” (Expert 4, slide 8).

Inferences and the anticipations of future events were sometimes linked to observations or technical analysis. From a still picture, Expert 4 inferred the following based on his perceptions of

critical performance features: “He flips the follow through over his shoulder which means he probably hits a top spin but he probably hits pretty well short of the court.” The key informant agreed that when an expert “sees something in terms of an action or a movement even before it happens, they can infer what came before or anticipate what’s going to occur next because they’ve seen it so many times.”

As can be seen in the following description, the experts’ perceptual capacities had a refined, natural flow that transitioned from description to diagnosis to prescription and then anticipated outcome.

Backhand ground stroke [description]. She was very off balance [diagnosis] because she was only on one foot [description] and was on the weight off her right foot which would be correct [diagnosis] but probably leaning way too much forward [inference] and therefore her back foot came off the ground [diagnosis] so her body was moving a lot forward or to the side which is more than should be [diagnosis] and if she would keep her back foot down and not take such large steps to the ball [prescription] – it would probably help her to take smaller steps [anticipated outcome] – and be on balance more [anticipated outcome] and to keep her back foot down as she hits through the stroke [anticipated outcome]. (Expert 4, slide 4)

The theme ‘inferences and anticipation of future events’ appears to be a differentiator between expert and novice coaches as no such patterns or accounts were found in the novice data.

From Description to Prescription

While the novice recall represented primarily descriptive recall, the experts perceived the descriptive details in critical features, provided an assessment and then followed this with implications and suggestions for player and coach improvement based on their perceptions. That is, their perceptual process focused on: (a) factors that would influence performance outcome (i.e., critical features), (b) assessing the quality of the demonstrated critical features, and (c) features that if changed would improve player performance outcome.

The experts’ cognitive processing from description to prescription of the coaching video began the moment they perceived a critical performance feature, but it did not always follow each step in order.

First off, he should know their names before they start [prescription]. He should tell them what they’re going to do before he tells them to get over there [prescription]. No technique at all [diagnosis]. He should demonstrate the drill before you start it with himself and maybe one more kid on each side [prescription]. That would have helped them at the start [anticipated outcome]. He had to stop and start over a lot [description]. He should have had all that stuff ready before he even started [prescription]. So far, I would say it’s very disorganized [prescription]. He’s going too fast for this level [diagnosis]—he should probably slow his feed down a little [prescription]. Also, technique is thrown out the window [diagnosis]. (Expert 4, video)

Thus, Expert 4 initiated his critical analysis without any type of orienting description or introduction. His analysis was chronological, suggesting he responded analytically as the critical features in the order he perceived them.

Novice perceptions spanned a variety of topics from hair styles to facial expression. Yet, unlike the experts, there appeared to be little consistency or pattern to their observations. Examples of novice perceptions included: “It looks like it’s staged for the picture there . . . it’s just a little too perfect. There’s not a hair mussed. I don’t think he actually hit the ball. It’s just my suspicion” (Novice 3). “They’re burning plenty of calories out there – whether it’s because they’re on film, it’s hard to say” (Novice 3). “He had confidence on his face like he’d hit a winner” (Novice 1). In short, while descriptive, there was a noticeable absence of diagnosis and prescriptions in the novices’ perceptions—even in perceptions of critical performance features.

When reviewing the data, the key informant confirmed the theme that experts were more critical and judgmental and the novices’ more descriptive. He could follow along with what experts and novices were watching. Yet in some instances, he could not tell if the novices and experts were viewing the same videotape due to their perceptual intentions. “How is this the same tape? These people are watching the same tape? It’s unbelievable. Are you sure? (laugh).”

Discussion

The purpose of the present study was to identify differences between the perceptual capacities of expert and novice coaches. One of the first noticeable findings was there appeared little difference between the novice and expert coaches in the amount or quantity of environmental cues or information perceived. This finding stands in stark contrast with previous research. For example, in research on the perceptual capacities of expert and novice X-ray technicians, experts saw a significantly greater number of secondary and subtle cues than did the novices (Lesgold et al., 1988). Chess masters also perceived a significantly greater number of cues (Charness, 1981; Connors, Burns, & Campitelli, 2011), as did expert weather forecasters (Hoffman, Trafton, & Roebber, 2006) and teachers (Sabers, Cushing, & Berliner, 1991). This contradictory finding clearly suggests the need for additional study of the quantity and scope of perception by expert and novice coaches before a reliable conclusion can be drawn.

While this investigation found little difference between the amount of information gleaned from perceptions of novice and expert coaches, in matters of selection, detail, and relevance to coaching, the present results reinforced findings from previous research (Wolff, Jarodzka, van den Bogert, & Boshuizen, 2016). As was found in earlier research, these expert coaches demonstrated the ability to perceive more cues relevant to coaching and player performance, make better sense of a situation and respond constructively to a multitude of stimuli (Alberdi et al., 2001; Carter et al., 1988; Graham et al., 1993; Wolff et al., 2016). Similar to expert teachers in a study by Cushing, Sabers, and Berliner (1992), the perceptions of the expert coaches focused tightly on player performance and coaching concerns.

A key finding that led to the recommendations for practical applications was the randomness of the novice perceptions. Such randomness made it difficult for them to identify or act upon the primary factors leading to improved athlete skill performance or a well-orchestrated practice. This finding supports Goldstone, Schyns, and Medin’s (1997) theory that perception involves attention weighting. In other words, the expert coaches’ attention was almost exclusively weighted on perceptual cues relevant to coaching and athlete performance, while novices weighed more attention to perceptual cues less-relevant to coaching or player performance.

The current investigation found a difference in the analytic depth of novice and expert perceptions. Similarly, research with chess masters revealed a greater maximal perceptual search depth by the experts, with no loss to analytic speed (Connors et al., 2011). It may also be speculated that due to a heavy focus on critical features, the experts in the present study recognized the significance of what they perceived and consequently provided greater analytic depth in order to connect this new information to their rich knowledge stores and thus make greater meaning of what they perceived. If so, this would support previous studies of experts in clinical pathology (Jaarsma, Jarodzka, & Nap, 2015), chess (Gobet & Simon, 2000), and X-ray technicians (Lesgold et al., 1988).

Research has long recognized experts’ superior skills in critical analysis and perception of important information (Berliner, 1986; French & Housner, 1994; Pinheiro & Simon, 1992; Schempp, 2006). In other words, experts’ perceptions are analytical as opposed to simply descriptive. In the present study, experts identified considerably more critical features (i.e., features related to player or coaching performance outcome) than did novices. The analytic depth led the expert tennis coaches to recognizing meaningful patterns that resulted in the anticipation and prediction of future events.

Indeed, the present study discovered that expert coaches recognized meaningful patterns in the perceived environment cues, while the novices saw no such patterns. Previous research also discovered that experts focused on appraisals of the key elements of player skill patterns (Connors et al., 2011). But this pattern recognition only occurs when the patterns are meaningful to the outcome of the observed event. Prior research also found that experts can only perceive patterns that are meaningful and not random (Chase & Simon, 1973; deGroot, 1965). Because the environmental cues did not allow expert coaches to construct meaningful patterns in what they saw, the expert responses were similar to those of the novice coaches.

The expert tennis coaches demonstrated not only the ability to perceive factors associated with improving coaching and athlete performance, but identified meaningful patterns in observed events, understood the circumstances accounting for the situation, anticipated forthcoming events and predicted future results. This finding suggests that experts and novices may ‘see’ the same events and even identify the same number of cues in a coaching environment, but they differ in how they make sense of what they see and the significance of the cues detected (Schempp, 2006). Further, unlike novices, experts extrapolated on the cues and patterns they perceived to explain how the situation came to be, assess the potential for positive or negative outcomes from the present circumstances, and offer courses of action that would likely lead to successful outcomes (Alberdi et al., 2001; Siedentop & Eldar, 1989). While novices only perceive problems on the surface, experts appeared to excel at perceiving, analyzing and solving problems (Graham et al., 1993; Jaarsma et al., 2015). Detection of meaningful patterns, however, only occurred when the patterns made sense to the experts. As was found in previous research, the expert and novice data were similar for the slide that depicted a contrived situation rather than actual occurrence in a game or practice (Connors et al., 2011).

An expert’s ability to perceive critical features allowing them to accurately anticipate and predict subsequent and future events is not a finding unique to the present study (Abernethy, Wood, & Parks, 1999; Abernethy & Zawi, 2007; Müller & Abernethy, 2012; Müller, McLaren, Appleby, & Rosalie, 2015). The expert tennis coaches’ inferences pertained to technique, drill patterns and coaching. In doing so, the experts appeared to have the ability to perceive, evaluate and interpret aspects of the coaching

environment in such a way as to deduce both the past and future of the observed event with a high degree of accuracy. In addition, it appeared that the experts' knowledge allowed them to perceive critical performance factors, interpret events, compare the present to past experiences and process the information to maximize coaching effectiveness (Wolff et al., 2016).

The findings of the present study confirm Tan's (1997) belief that acute perceptual capacities are a distinguishing characteristic of expert coaches. Empirical evidence also suggests that superior perceptual capacities are an important characteristic of expertise (Abernethy, Wood, & Parks, 1999; Carter et al., 1988; Thomso, Önkal, Avcioglu, & Goodwin, 2004). Having perceptual capacities to recognize meaningful cues and patterns in what they observe, match that information to their knowledge stores, and predict the success of potential decisions appear, therefore, to be a characteristic linked to superior coaching performance (deGroot & Gobet, 1996; Graham et al., 1993). The findings of the present study, supported by contemporary theory and research on expertise, strongly indicated that the acute perceptual capacities are a present and potent force in the arsenal of experts (Ericsson et al., 2006).

Future Research

Do expert coaches see more than novices? While the findings of the present study suggest they do not, research in other domains (Lesgold et al., 1988) suggest experts do indeed perceive more critical features and more interrelationships among the features than novices in familiar environments. Research in this area should attempt to discern whether expert/novice perceptual differences are in the quantity of information perceived or the relevance of the perceptions to professional tasks (e.g., coaching, player development, performance). Perhaps using a different protocol, such as different tasks, challenges, or procedures, as well as coaches from other sports in future research would continue to clarify true differences between expert and novice perceptual capacities.

The field of coaching would benefit from studies that examine connections between perceptual capacities and other expert characteristics such as extensive knowledge, superior memory, automaticity of behavior or experience. It would also be constructive if studies examined coaches in other sports, particularly team and individual sports. Such research would not only provide a comprehensive understanding of the related characteristics of expert coaches, but should these characteristics be detectable across sports our understanding of coaching expertise would be more robust.

The findings of the present study suggest that expert coaches have superior perceptual capacities due to their recognition of critical cues, analytic abilities, pattern recognition, diagnosis, and anticipatory skills. Further, these abilities appear to combine in a repeatable, consistent pattern of perception. Further research is needed to understand the links between these perceptual capacities and the knowledge and experience contributing to the development of these capacities. It would also benefit those aspiring to become expert coaches, or those designing coach education programs, to understand how these skills are learned and how that learning curve may be shortened.

Author Biographies

Paul G. Schempp is a professor in the Department of Kinesiology and the director, Sport Instruction Research Laboratory at the University of Georgia. A senior Fulbright Research Scholar and named a Distinguished Scholar by the International Center for Performance Excellence at West

Virginia University, he conducts research on the development and characteristics of expert coaches and sport instructors.

Sophie Woorons is the owner of the Brookstone Meadows Tennis Club in Anderson, SC, who holds a Ph.D. in Sport Pedagogy from the University of Georgia. She was an All-American and ACC Tennis Player of the Year at Clemson University. Still competitive, she is an 8-time age-group National Champion. In 2015 she was named the USPTA Southern Professional of the Year.

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