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How Baseball Players Prepare to Bat: Tactical Knowledge as a Mediator of Expert Performance in Baseball

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Our understanding of the role of tactical knowledge in baseball batting preparation is scarce, thereby limiting training guidelines. We examined the verbal reports of baseball players and nonplayers when told to view different edited video sequences of a half-inning of baseball competition under different task conditions: *to prepare to bat* (problem solve); *recall as much information as possible* (intentional recall); or *prepare to bat,* with an unexpected *recall* (incidental recall). Separate mixed-model ANOVAs (Expertise × Instruction conditions) on verbal report measures indicated that nonplayers used general strategies for recalling baseball events and lacked the tactical skills to use such information for their upcoming times at bat. In contrast, players used baseball-specific strategies to encode and retrieve pertinent game events from long-term memory (LTM) to develop tactics for their upcoming times at bat and to recall as much information as possible. Recommendations for training tactical skills are presented as some players exhibited deficiencies in the LTM structures that mediate batting decisions.

Keywords: memory, problem solving, knowledge structures, verbal protocols, skill

Batting is considered one of the most difficult tasks in baseball. Batting statistics provide coaches and players with only limited interpretations of the ability to select and execute a swing according to the demands of the situation. Researchers have provided information on expertise differences in pitch recognition (Paull & Glencross, 1997) and biomechanics during both actual and simulated batting tasks (e.g., Gray, 2002). Yet there has been little direct examination of the detailed information processing of players when preparing to bat, and factors that influence these processes (e.g., McPherson, 1993). Thus, instructional strategies in batting preparation are limited (see French & McPherson, 2004).

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As Newell (1974) pointed out, a batter facing a pitch must deal with a sensory perceptual challenge as well as a motor response challenge. Because it subserves the motor response, the sensory perceptual challenge component is deemed particularly critical. The task in this situation is for a batter to track the pitch; predict its course; and then, critically, decide to swing or not. Newell also proposed that game and situational variables influence decisions related to batting. In support, Paull and Glencross (1997) found that both expert and novice baseball players improved predictions of ball locations over the plate when provided with hypothetical strategic game information (e.g., number of balls and strikes, runners on base, score). Similarly, Gray (2002) showed that when experienced batters faced a series of virtual pitches where ball speed was randomized, they performed very poorly, barely making contact with the ball. When faced with a series of pitches with only two possible speeds (i.e., fast ball, change up), performance was significantly better with batters changing their swing depending on their expectation.

Newell (1974) categorized factors that influence a batter's decision to swing as objective or subjective. Variables like the score or ball-strike count were considered objective. Subjective factors concerned perceived abilities of self and the pitcher as well as the past history of any contest between them. Newell's emphasis on objective rather than subjective factors stems from the difficulty inherent in measurement, and the fact that batters can make different decisions faced with the same data. A series of studies by McPherson and colleagues (e.g., McPherson, 1994, 1999a, 1999b, 2000; McPherson & Kernodle, 2007; McPherson & Thomas, 1989), however, has developed a method that can be used to assess the influence of these variables and understand how performers learn to use situational information to represent and solve a problem. Moreover, McPherson (1999a) showed how expert performers learn to solve problems in a more sophisticated manner, having developed cognitive structures for this purpose. This theory provides insight into the mechanisms that underlie expert skill and how the skill is developed, which in turn has implications for coaching and instruction (see French & McPherson, 2004; McPherson & Kernodle, 2003).

McPherson (1993) conducted one of the few studies that used verbal report analysis to examine differences in tactical knowledge and skills of collegiate players and nonplayers when preparing to bat. This study was based on earlier work that contrasted recall performances of college students with high and low baseball knowledge on tasks that concerned a script of a half-inning of a baseball game (Chiesi, Spilich, & Voss, 1979; Spilich, Vesonder, Chiesi, & Voss, 1979). Participants listened to the entire script or specific sentences. Measures of accuracy and content (via propositional type analysis) indicated high knowledge groups outperformed low knowledge groups in amount and type of knowledge recalled (e.g., sequences of actions related to the hierarchical goal structure of the game). Yet, this research was not designed to increase our understanding of the development of sport-specific knowledge structures with expertise.

McPherson (1993) developed another methodology for examining the nature of information processing players that engage in when preparing to bat. The task required participants to view video of a baseball competition and report their thoughts anytime and at specific intervals between batters and their simulated time at bat. The video was over 14 min long and included a total of 15 pitches to three batters and 4 pitches to the fourth batter (the role they assumed.). All pitches were delivered by the same pitcher. Verbal data indicated collegiate players in contrast to nonplayers built condition profiles about the pitcher and preceding batters' behaviors as the video progressed. These profiles were used to develop tactics concerning their time at bat. Overall, players unlike nonplayers had access to sport-specific problem representations regarding batting tactics that guided input and retrieval of pertinent information available from the video and long-term memory (LTM).

In summary, McPherson (1993) showed that the objective and subjective variables proposed to influence batting decisions (Newell, 1974) can be measured and that performers learn to access this information when representing the problem situation. Moreover, experts have the ability to adapt their problem representations to the situation at hand by using sophisticated knowledge structures. Specifically, McPherson proposes two types of LTM adaptations (i.e., action plan and current event profiles) as the primary mechanisms responsible for skilled performers' information processing during actual or simulated bouts of competition (McPherson, 1999b). *Action plan profiles* are rule-governed prototypes used to match certain current conditions with appropriate visual and/or motor actions. These profiles include sport-specific strategies to monitor current conditions (e.g., player positions and ball placement, player formations, coordination patterns of opponent) and to monitor the success of the player's own actions. For example, in baseball, a player may direct his hit based on the current location of runners, or he may adjust his position in the batting box in response to a strike. The player in this situation has built and used a profile that drives the choice of action (i.e., action plan profile). *Current event profiles* consist of tactical scripts that guide constant building and modifying of pertinent concepts (past, current, and/or future) to monitor during the competitive event. These profiles are stored as situation prototypes in LTM and are available for activation or updating when deemed necessary. For example, baseball players may develop a profile of a pitcher's tendencies as competition progresses. This pitcher profile can be modified according to game situations and specific batters including their previous times at bat or the pitcher's reputation, among other factors.

Table 1 illustrates the development of these profiles from lower (Level 1) to higher (Level 5) levels of skill, using the example of "diagnosing" a pitcher. Access to and retrieval of critical information is mediated through action plan profiles and current event profiles to facilitate decision making during competition. The added advantage of these mechanisms is that current event and action plan profiles are used to compensate and make adjustments during time-constrained performance. Findings in the previously reviewed baseball batting studies suggest that these knowledge structures (Gray, 2002; Newell, 1974; Paull & Glencross, 1997) develop with expertise as well as over long bouts of competition (McPherson, 1993).

A critical component to McPherson's postulates regarding the development of tactical knowledge is the ability of sport experts to adapt their sport-specific problem representations (e.g., type of profiles accessed, line of reasoning) according to their intentions, goals, and/or the demands of the task. Although recall studies show experts' superior recall for structured, domain-specific information (see Chi, 2006; Ericsson, 2006) the task information and portion of the sport-specific knowledge base used to solve the task at hand can vary (see French & McPherson,

Table 1 The Development of Tactical Knowledge and Associated Strategies Concerning the Pitcher When Preparing To Bat in Baseball

Level of Expertise	Conditions About Pitcher	Sport-Specific Strategies
Level 1	Not in problem representation.	No need to monitor pitcher.
Level 2	General or weak analysis.	Occasionally reiterates events about pitcher's behaviors.
Level 3	Previous pitch (in moment).	Monitors pitcher's tendencies; linked to reiteration of events or tactical interpretations of pitch selections according to count, batter characteristics, runners, etc.
Level 4	Pitcher's tendencies (updated on a regular basis; profile emerges; associated with other profiles).	Analyzes pitcher's tendencies to update profile and develop tactics about his upcoming time at bat; linked to other profiles (previous batters, game status, etc.).
Level 5	Style of play and preferences (pitcher profile is embedded in current event profile, e.g., the type of pitch he prefers to hit linked to this pitcher's tendencies).	Same as above; batting tactics are based on pitcher profile and his preferences, or style of play.

Note. Levels 1–5 denote increasing batting expertise.

2004). Since experimental manipulations designed to test the ability of experts to adapt their knowledge structures to task demands are limited in sports, we turned to areas of medical reasoning. This work was influential in developing experimental manipulations and postulates in our study.

Norman, Brooks, and Allen (1989, Experiment 2) examined medical diagnosis and recall performances of seven physicians and six advanced medical students when told to diagnose the patient (problem solve, PS), diagnose the patient and subsequently recall as much clinical information as possible (incidental recall, IcR); and recall as much information as possible (intentional recall, IR). Instruction order was fixed. Six different reports (two per instructions) were equally represented across groups and instructions. Reports contained 20 values judged as more/less critical and more/less abnormal to the problem solution. Experiment 1 established that physicians made more accurate diagnoses than medical students in the PS condition. Therefore, Experiment 2 examined IcR and IR. Both groups indicated that they were capable of memorizing details of a clinical report because they recalled about 10 items during IR. During IcR, physicians recalled 13 items of information whereas medical students recalled only 5 items. In addition, physicians used all laboratory value categories, thereby processing more information to make a diagnosis instead of less (attending to a few critical features) and recalled more higher-order information than did medical students. Thus, physicians were better at recalling clinical data when it was used for diagnostic purposes.

Verkoeijen et al. (2004) randomly assigned participants (N = 48) in three expertise groups to two presentation contexts under IcR instructions: laboratory data only (L) or laboratory data within clinical context (CL). Six different reports were represented equally across groups and contexts; each report contained the same laboratory data for presentation context. Measures included processing time, diagnostic accuracy, and recall content via propositional type analysis. Overall, experts outperformed novices and intermediates in processing time and diagnostic accuracy. Experts with L increased in processing time and recall, and decreased in diagnostic accuracy than with CL. These trends were similar for the other groups (albeit at lower levels), which indicated that presentation context affected all groups. Yet recall performance was similar for all groups in the L condition. The authors suggested this finding was due to experts' poor recall that resulted from their training experiences (e.g., less emphasis on laboratory data). Finally, reviews of studies in medical reasoning (e.g., Chi, 2006; Ericsson, 2006; Norman, Eva, Brooks, & Hamstra, 2006) also note that the superiority of an expert emerges when time is very limited (e.g., 30 s rather than 180 s) and/or when extraction of relevant higher order information is analyzed. Thus, instruction manipulations such as IcR and IR conditions accompanied by propositional type analysis of information should reveal more detail concerning sport knowledge structures as mediating mechanisms in baseball performance.

To date, the tactical reasoning of athletes has been primarily examined in field rather than laboratory settings. Therefore, our aim in this laboratory study was to examine in more detail the development of tactical knowledge and skill regarding batting preparation when players and nonplayers were exposed to manipulations of instructions. Participants viewed three different edited videotapes of a televised baseball game that contained one batter's time at bat. With PS, participants were instructed to prepare to bat before viewing the video and then asked to report their thoughts at the conclusion. With IcR, participants were instructed to prepare to bat before viewing the video and yet at the conclusion of the videotape were instructed to recall as much information as possible about what they saw in the video. Thus, in this condition participants were not told before video viewing that they would be asked to recall as much information as possible and were not asked to report their thoughts regarding batting preparation. With IR, participants were instructed to recall as much information as possible about what they saw in the video before viewing and then asked to do the same at recall. These manipulations were designed to examine general knowledge structures regarding baseball batting preparation and competition. In addition, we randomized the order of instructions and tested this effect. Verbal reports were collected following each videotape, thereby controlling for time between viewing and onset of verbal reports. A model of protocol structure for baseball sport knowledge (McPherson, 1993) was used to examine differences in verbal reports according to expertise and instructions.

We predicted that players' current event and action plan LTM profiles regarding baseball competition in general and batting preparation in particular

(McPherson, 1993) would result in greater information use/recall and more advanced problem representations overall compared with nonplayers. We predicted that all participants would generate the most concepts with IR compared with PS and IcR. With PS we predicted that players would access current event and action plan profiles specific to batting preparation. This was expected to result in fewer condition concepts in this task compared with others due to a narrowing of problem representations and access to fewer profiles to handle the task at hand. Thus, players were expected to generate pertinent conditions, actions, and goals when preparing and planning their time at bat. Nonplayers were also predicted to generate fewer concepts with PS than other instructions and yet do so using weak current event and action plan profiles and less pertinent conditions. Finally, with IcR, we predicted that players would generate fewer concepts once again as a result of their narrowed problem representation as compared with IR. In IcR, we predicted that players would retrieve the contents of their profiles used in planning to bat *as well as* other information used to monitor and update game events in general via current event profiles. Players were predicted to generate more concepts with IcR than PS. In contrast, nonplayers were predicted to generate few concepts on both PS and IcR because they would access weak knowledge structures to perform these tasks.

Method

Participants

NCAA Division I collegiate baseball players (n = 17) and college students (nonplayers, n = 18) volunteered to participate. Participants read and signed the Informed Consent for Human Participants in accordance with the university's regulations before testing. Average age was 19.7 (1.6) years for players and 20 (1.8) years for nonplayers. Players averaged 1.9 (0.9) years of collegiate experience. During a typical baseball season, players reported watching an average of 4.4 (2.1) hr of televised or live baseball competition per week and nonplayers watched an average of 1.9 (1.8) hr of televised baseball competition per week.

Procedure

Participants viewed three edited videos (with no sound) of baseball game situations (Tapes 1, 2, and 3). The tapes were constructed from a half-inning of a televised recording of a collegiate baseball game. Participants had not played against these players and were not familiar with this particular game. Each tape included one batter's time at bat. Batters received pitches from the same pitcher for Tapes 2 and 3 and a different pitcher for Tape 1. All tapes were approximately 2 min long.

Three different task instructions were used. Each task instruction was accompanied by the same video for all participants. Task instructions were PS (Tape 1), which consisted of "prepare to bat" instructions; IcR (Tape 2), which consisted of "prepare to bat" instructions followed by postviewing instructions to "recall as much information as possible"; and IR (Tape 3), which consisted of previewing instructions "to recall as much information as possible."

The order of task instructions was counterbalanced across participants. A total of six instruction condition orders (i.e., Tapes 1–2–3; Tapes 2–3–1; Tapes 1–3–2; Tapes 3–2–1; Tapes 2–1–3; Tapes 3–1–2) were randomly assigned by block (tape order) to participants in each expertise group. A 5-min rest period for each participant was administered between tapes, following the completion of verbal reports. Participants were tested individually in a quiet room with one researcher present. Each participant was seated and viewed videos on a 32-in. color monitor from a distance of 1 m. Verbal reports were recorded on audio cassettes.

Instructions for Tape 1-PS and Tape 2-IcR were, "Please remember at all times this is not a test. Your responses cannot and will not be graded or used to reflect upon you in any way. Please respond freely and in a natural manner, just as if you were in the actual situation. You will view a video of a collegiate baseball game. You will see one batter. You will assume the role of the next batter in that inning. Remember you are the next batter. At the end of this tape you will be asked what you are thinking about. Remember you are the next batter. There is no minimum or maximum regarding how much you can say. Remember this is not a test. Do you have any questions about the instructions?" Immediately following Tape 1-PS, the experimenter asked, "Now, what are you thinking about?" and probed with "Anything else?" Immediately following Tape 2-IcR, the experimenter stated, "Now recall everything you saw in the video, including as much detail as possible," and again probed with "Anything else?" Instructions for Tape 3-IR were, "You will view a video of a collegiate baseball game. You will see one batter. At the end of the video, you will be asked to recall everything you saw in the video." If applicable, the experimenter also instructed, "You are not the next batter in this situation. Just recall everything in the video." Immediately following the Tape 3-IR, the experimenter stated, "Now recall everything you saw in the video, including as much detail as possible," followed with "Anything else?" A minimum of two "anything else" prompts continued until the participant failed to report any more information and said no.

Analysis

Verbal Report Coding. Verbal reports were transcribed verbatim and coded for concept content and structure according to a model of protocol structure for baseball (McPherson, 1993). This model was deemed valid and reliable for examining adults with and without baseball experience (McPherson, 1993). In recent versions of this model, concepts are typically identified and classified in one of five categories: condition, goal, action, do, or regulatory concepts (e.g., McPherson, 1999a, 2000). In this study, only condition, goal, and action concepts emerged for participants for these particular experimental tasks. Do and regulatory concepts typically emerge when participants' thoughts are collected in actual performance contexts (e.g., McPherson & Kernodle, 2007; McPherson & Vickers, 2004).

Condition concepts may specify a situation or under what circumstances to apply an action to produce goal-related changes in the context of a game situation. Conditions may consist of *explicit cues,* which are concepts available in the game environment ("runners on first and second") or *implicit cues,* which are concepts available through tactical analysis and/or retrieval from LTM ("the pitcher may throw a curve ball if he is down in the count"). *Goal concepts* (e.g., "move the runner over") reflect the goal structure of the task or situation or the purpose of an action or condition. *Action concepts* refer to the action selected, which may produce goal-related changes in the context of a game. Actions may refer to motor responses (e.g., movement in the box or type of hit) or visual responses (e.g., watch the pitcher's release point,).

Condition, goal, and action concepts can be stated in past, current, or future terms. Once major concepts were identified, they were categorized into *subconcept categories* according to participant utterances. Some examples of subconcept categories for each major condition, action, and goal concept are presented in Figure 1. We also coded units of information that reflected specialized anticipation strategies as *probability of pitch statements.* These statements were predictions about a pitcher's type of pitch during the participant's time "at bat." Previous research (e.g., McPherson & Kernodle, 2007) coded similar utterances as condition concepts. For example, in tennis, an utterance predicting an opponent's upcoming return of serve was coded as a condition concept in the sub-subconcept category of previous/future shot in the subconcept category of opponent. However, information on participant statements regarding the probability of pitch allows a comparison with previous work in baseball, and thus we coded these units separately.

Coding rules were also developed to examine the qualitative aspects of conditions and actions and hierarchical aspects of goals. Qualities of condition and action concepts were coded as irrelevant or weak (e.g., a condition about the color of a player's uniform or the size of the crowd in the stands), appropriate without any details, appropriate with one detail, or appropriate with two or more details. Goal subconcepts were classified hierarchically as *skill and himself* (e.g., execution, getting on base, put the ball in play), *himself and teammates* (e.g., keeping the ball away, move baserunners over, avoid the double play), or *win attributes* (e.g., scoring runs, win the game, winning the inning).

Measures of Concept Content and Structure. After concepts were identified, measures of content and structure were applied for the verbal reports. *Concept content* was measured by the frequency total for each participant in terms of *total concepts* regardless of concept category (sum of all condition, action, and goal concepts). Measures of frequency totals within each major concept category were also calculated for *total, variety, and detail (or hierarchy)*. In addition, relative frequency scores were calculated to examine distributions of conditions (e.g., number of pitcher conditions/total number of condition concepts). These categories were broader than those used to determine variety and were as follows: batter (participant's role as batter or in task), pitcher, defense (infield, outfield), offense (base runner, preceding batter), game status, coach/umpire, and environment.

Frequency totals of *connections* and *concepts linked per phrases* examined the structure or organization of concepts. Connections were any word (e.g., *to*, *so*, *when*) or words (e.g., *so that*) that connected two concepts. Connections linking details of a concept were not included in this measure. Concepts linked per phrase were averaged if necessary. For example, if a participant generated three linked concepts in one phrase and two linked concepts in another phrase, then these scores were averaged (i.e., a score of 2.5). A phrase could be one or several

Conditions

Participant's role as batter or in task

- General
- Strength
- Weakness
- Position/status

Pitcher

- General
- Strength
- Weakness
- Prior pitch/tendencies
- Location
- Speed
- Position/status

Base runner(s)

- General
- Strength
- Weakness
- Position/status

Prior batter

- General
- Strength
- Weakness
- Prior hit/attempt/tendencies
- Position/status

Infield

- General
- Strength
- Weakness
- Position/status

Outfield

- General
- Strength
- Weakness
- Position/status

Game status

Environment

- Field
- Weather
- Crowd
- Camera Views

Coach/Umpire

Actions

- Hit
- Position Move
- Visual Move

Goals

- Execution
- Getting on base
- Advance runner
- Avoid double play
- Score runs
- Win game
- Drive runners over to score

Figure 1 — Example subconcept categories for conditions, actions, and goals generated by participants. Major concepts are bolded and subconcept categories are listed by topic for each major concept. Each heading represents a subconcept category; sub-subconcepts are bulleted where applicable.

concepts consisting of a few words to several lines. Phrases were separated by participants' long pauses (>2 s) and/or experimenters' interjections (e.g., "anything else?" probes). Coded verbal reports of Nonplayer (NP) 5 in the PS condition illustrate these measures of concept content and structure. Identified concepts are underlined for this participant's utterances. Parentheses contain the identified major concept, subconcept, and sub-subconcept categories. Categories of sub-subconcepts (in each subconcept category) used to delineate variety in each major concept category are presented in italics.

> "couldn't believe that the third baseman didn't catch the ball how he just, (condition-infield-*weakness*; quality = appropriate one detail) it was a ground ball inside (condition-prior batter-*prior hit/attempt*; quality = appropriate with 2 details) **and** it just fell out of his glove or it hit the side of his glove (condition-infield-*weakness*; quality = appropriate one detail) **and** he didn't throw with accuracy, it was a poor throw (condition-infield-*weakness*; quality = appropriate one detail) **and** it could have been an out (condition-infield-*position/status*; quality appropriate one detail).

The following are frequency totals (**in bold**) for measures of concept content for this participant: **5** *total concepts*; **3** *total conditions*; **3** *variety of conditions*. Quality of conditions were **0** inappropriate or irrelevant, **0** appropriate no details, **4** appropriate with one detail, **1** appropriate with two or more details. Measures of relative frequency of conditions were **20%** (1/5) for conditions about offense and **80%** (4/5) for conditions about defense. In addition, quality of conditions coded as appropriate with one detail and appropriate with two or more details were summed for statistical purposes (in our example, the total would be 5). Frequency totals for concept structure were **3** *connections* and **5** *concepts linked per phrase*. All other measures of concept content received a **0** (e.g., total actions = 0, variety of actions = 0, goals = 0).

Reliability of the Verbal Report Coding. Coding rules and coder reliability on the instrument were initially obtained on a pilot study. The pilot study ($N = 6$) was conducted on collegiate baseball players and nonplayers at a small private college. Procedures were the same as those presented previously except that instruction order was held constant. Coding rules were refined by the first author and a researcher who was a former NCAA Division 1 collegiate baseball player and a current collegiate baseball coach of a small private school (different from the one the participants attended). All transcripts were coded individually by the first author and the baseball coach to obtain interrater and intrarater reliability (all transcripts were coded again 1 week later). Reliability was estimated by: Number of agreements / (# of agreements + disagreements) $\times$ 100 = reliability percentage. Interrater reliability was .94 or higher for all concept categories and .92 or higher for intrarater reliability.

Two male coders were trained on the verbal report coding instrument, using sample protocols from the *pilot study*. To obtain reliability, each coder scored the same six randomly selected participants; three from the player group and three from the nonplayer groups. Both coders were blinded to group membership. For reliability purposes, measures of coded responses were collapsed across instruction conditions for these participants. Each coder scored these same six transcripts again (10–14 days later) to obtain intrarater reliability. Interrater reliability was obtained from the first coding session. Interrater and intrarater mean reliabilities were .85 or higher for all concept categories. The remaining protocols were scored by one of these coders.

Statistical Techniques. Verbal report measures for players and nonplayers for each instruction condition were screened for normality assumptions for statistical purposes. Statistical tests were conducted on measures that met data assumptions for univariate and multivariate techniques. Separate 2 (expertise level) $\times$ 3 (instruction conditions) ANOVAs with repeated measures (RM) on the last factor were conducted on mean frequency scores for total concepts, total conditions, variety of conditions, conditions with one or more details, total connections, concepts linked per phases, and relative frequency scores for conditions about the pitcher. Differences among instruction conditions were examined via RM ANOVA on *mean frequency* scores for *irrelevant conditions* as multifactor assumptions were not met. Several concepts (total, variety, and detailed actions and total goals) were not generated during IcR. Thus, separate mixed-model ANOVAs (2 nonplayer, player $\times$ 2 PS, IcR) were conducted on mean frequency scores for these measures. Expertise differences during the PS condition were examined via ANOVA on *probability of pitch statements*. Alpha was set at .05 for all statistical tests; Bonferonni corrections are noted. Effect sizes (η^2) and Greenhouse–Geisser corrections are reported where appropriate. A few remaining measures were examined via descriptive data because data assumptions were not met. Finally, sample verbal reports were examined qualitatively. Originally, a between-subject effect for *order of instructions* was included in the previously mentioned mixed-model ANOVAs. This effect was not significant, $F(5, 23) = 0.59$, $p > .70$, and respective interactions were not significant ($p > .10$) for all previously mentioned measures. Thus, this effect was removed from the design.

Results

Table 2 presents mean frequency scores for main effects of expertise, $F(1, 33)$, and instructions, $F(2, 66)$, on measures of *total concepts*, *total conditions*, *variety of conditions*, *conditions with one or more details*, *total connections,* and *concepts linked per phrase*. Main effects for expertise were significant on measures of *total conditions, total connections,* and *concepts linked per phrase*. Players generated more condition concepts and associated networks of concepts than players regardless of instructions. As predicted, significant main effects (see Table 2) were noted for instructions on measures of *total concepts*, *total conditions*, *variety of conditions*, and *conditions with one or more details.* Mean frequency scores increased across PS, IcR, and IR conditions, respectively, for measures of *total concepts*, *total conditions*, *variety of conditions*, and *irrelevant conditions*. The only exceptions regarding instruction effects were measures of concept structure, which did not reach significance. Trends indicated more *connections* between concepts were generated during the PS and IcR than IR instructions. In addition, *concepts linked per phrase* increased across PS, IcR, and IR instructions, respectively. Post hoc tests for instructions (see Table 2) demonstrated significant effects for all contrasts for measures of *total and variety of conditions.* These measures increased across

Table 2 Descriptive Data and Statistics for Main Effects of Expertise and Instruction Conditions for Measures of Concept Content and Structure

Variables	**Expertise Level[a]**			**Instruction Conditions[b] Post Hoc Tests**						
Content Measures	Nonplayer	Player	η^2	Problem Solve	Incidental Recall	Intentional Recall	η^2	PS vs. IcR	PS vs. IR	IcR vs. IR
Total Concepts[b**]	7.7 (3.8)	9.5 (4.0)	.09	7.2 (4.2)	8.8 (3.5)	9.8 (3.8)	.16	ns	**s**	ns
Condition Concepts										
Total Conditions[a*b***]	6.6 (3.8)	8.3 (3.9)	.11	4.8 (2.8)	7.8 (3.6)	9.8 (3.8)	.45	**s**	**s**	**s**
Variety of Conditions[b***]	4.3 (2.4)	5.3 (2.4)	.10	3.1 (1.7)	4.7 (2.9)	6.5 (2.4)	.51	**s**	**s**	**s**
Detailed Conditions[b***]	4.6 (2.9)	5.9 (2.9)	.09	3.9 (2.7)	6.2 (3.3)	5.8 (2.6)	.21	**s**	**s**	**s**
Irrelevant Conditions[b***]	4.6 (4.4)	4.5 (3.4)	—	0.4 (0.7)	1.0 (1.5)	3.2 (3.0)	.40	ns	**s**	**s**
Structure Measures										
Total Connections[a*]	2.4 (1.7)	3.6 (2.2)	.18	3.3 (2.3)	3.0 (2.0)	2.5 (1.7)	.06	—	—	—
Concepts linked per phrase[a***]	4.4 (1.9)	7.5 (2.8)	.31	5.2 (2.5)	5.9 (4.0)	6.7 (4.5)	.06	—	—	—

Note. PS = problem solve; IcR = incidental recall; IR = intentional recall. Total concepts = sum of all conditions, actions, and goals. Standard deviations are in parentheses. *$p < .05$, **$p < .01$, and ***$p < .0001$ for significant main effects of expertise[a] F (1, 33) or instruction condition[b] F (2, 66). Irrelevant conditions were examined via RM ANOVA for instructions only F(1.3, 45.4). s = significant if $p \leq .017$; ns = not significant if $p > .017$.

PS, IcR, and IR, respectively. In addition, significantly *more detailed conditions* were generated during IcR than IR instructions. In addition, significantly more *total concepts* were generated during the IR than PS instruction conditions. Finally, significantly more *irrelevant conditions* were generated during IR than IcR or PS instructions, which were not significantly different from each other. The remaining contrasts were not significant.

Mean scores for interaction effects (see Figure 2) were not significant as several measures indicated players generated higher yet similar patterns of findings across instructions compared with nonplayers. For example, patterns of mean scores for both groups indicated increases in measures of total concepts and total, variety, and detail for conditions across PS, IcR, and IR, respectively. In addition, mean scores for both groups indicated more irrelevant conditions were generated during IR than PS and IcR. In addition, different patterns of findings are illustrated in Figure 2 for measures of concept structure. Nonplayers generated few connections regardless of instructions, whereas players generated more connections during PS and IcR than IR. Players generated similar amounts of concepts linked per phrase regardless of instructions, whereas nonplayers exhibited larger amounts of concepts linked per phrase during IR compared with IcR and PS.

As Figure 3 illustrates, measures of percentages of conditions about the *pitcher* indicated a significant main effect for instructions $F(2, 66) = 10.5$, $p < .0001$, $\eta^2 = .24$. Post hoc tests indicated that PS ($M = 52\%$, $SD = 42\%$) and IcR ($M = 50\%$, $SD = 27\%$) were significantly different ($p < .001$) from IR ($M = 28\%$, $SD = 17\%$). A significant effect for expertise $F(1, 33) = 19.9$, $p < .0001$, $\eta^2 = .38$, indicated that players (M = 57%, $SD = 26\%$) generated conditions about the

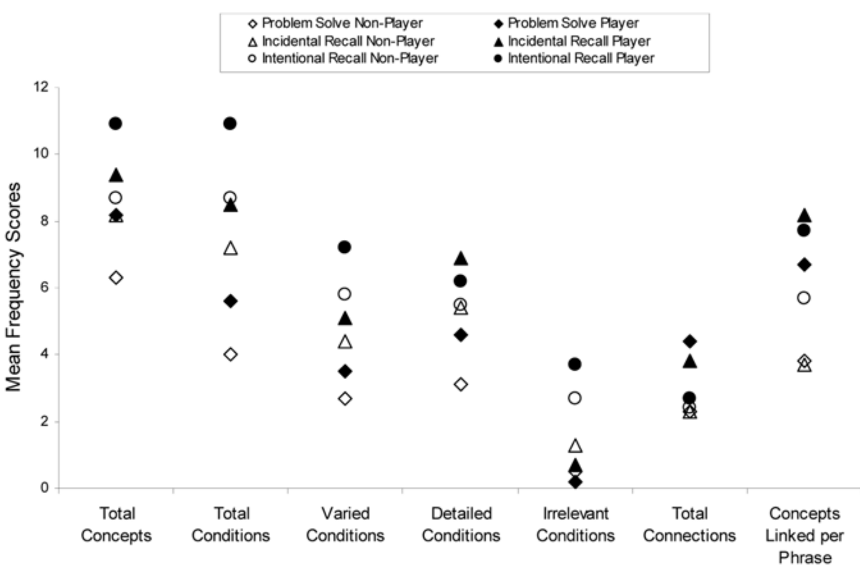

Figure 2 — Mean frequency scores for the expertise by instruction effects for measures of overall content and structure and specific measures of conditions.

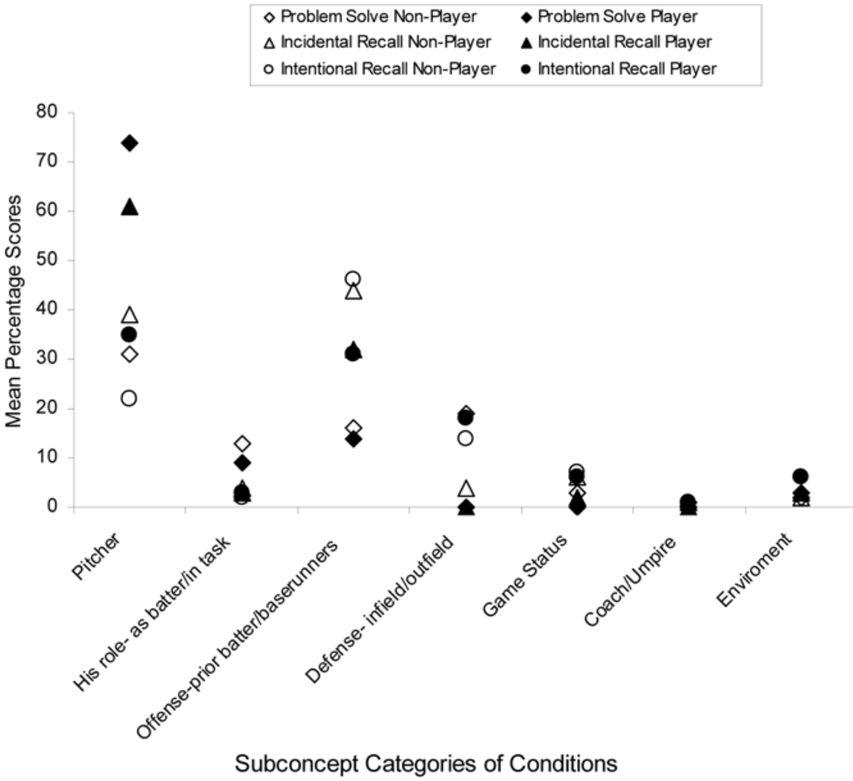

Figure 3 — Mean percentage scores for the expertise by instruction effects for measures of subconcept categories of conditions. *Note.* Mean percentage scores were computed for each participant for each subconcept category of conditions (i.e., total concepts generated in a particular condition subconcept category / overall total condition concepts).

pitcher more often than nonplayers (M = 31%, SD = 31%). The interaction was significant $F(2, 66) = 3.8$, $p < .027$, $\eta^2 = .10$, because players generated higher percentages of conditions about the *pitcher* overall than nonplayers, especially in PS and IcR. Figure 3 illustrates that players only reported conditions about the *defense* during the IR instructions. In contrast, nonplayers reported conditions about the *defense* across all instructions and especially during PS. In comparison, nonplayers reported conditions about the *offense* more often than players, and both groups reported more conditions about the offense more often during IcR and IR than PS. Further, conditions about their *role as the batter* were reported more often with PS than IR and IcR.

Measures of *actions* and *goals* were not generated in IR (except for one player and nonplayer that generated one action). Thus, 2 (nonplayer, player) × 2 (PS, IcR) mixed-model ANOVAs were conducted on measures of actions and goals. Results for *total actions* indicated a significant effect for instructions $F(1, 33)$ =

12.3, $p < .001$, $\eta^2 = .27$, as more actions were generated during PS ($M = 1.5$, $SD = 1.6$) than IcR ($M = 0.60$, $SD = 0.9$). Results for *variety of actions* indicated a significant effect for instructions $F(1, 33) = 13.8$, $p < .001$, $\eta^2 = .30$, as more varied actions were generated during PS ($M = 0.9$, $SD = 0.9$) than IcR (M = 0.5, $SD = 0.7$). A significant interaction $F(1, 33) = 8.0$, $p < .008$, $\eta^2 = .20$, indicated players generated more varied actions during PS than IcR compared with nonplayers who performed similarly under both instructions. Results for *detailed actions* were significant for instruction, $F(1, 33) = 7.7$, $p < .009$, $\eta^2 = .20$, as more detailed actions were generated during PS ($M = 0.9$, $SD = 1.2$) than IcR ($M = 0.3$, $SD = 0.7$). Results for *total goals* indicated a borderline effect for expertise, $F(1, 33) = 3.4$, $p < .07$, $\eta^2 = .09$, as nonplayers generated goals more often than players ($M = 0.6$, $SD = 0.8$; $M = 0.2$, $SD = 0.3$, respectively). Descriptive data indicated that nonplayers generated more goals than players with PS instructions and that few goals were generated with IcR. Results for *variety of goals* were significant for instruction, $F(1, 33) = 5.4$, $p < .03$, $\eta^2 = .11$, as a greater variety of goals were generated during PS than IcR ($M = 0.5$, $SD = 0.7$; $M = 0.2$, $SD = 0.4$, respectively). In addition, descriptive data indicated that players generated goals at one hierarchical level (*himself and teammates*) whereas nonplayers generated goals at all levels.

Verbal data regarding actions and goals indicated that both groups attempted to prepare to bat during PS and IcR. Likewise, the finding that these concepts diminished with intention to recall suggests that both groups altered their intentions during this task. In addition, although frequency scores were low, these data are meaningful given that few actions and goals were predicted for both groups.

The measure of *probability of pitch statements* was significant for expertise, $F(1, 33) = 17.2$, $p < .001$, $\eta^2 = .34$, as players predicted the pitch more frequently ($M = 1.0$, $SD = 0.9$) for their time at bat than nonplayers ($M = 0.1$, $SD = 0.2$). Only one nonplayer (NP6) developed a rudimentary statement related to the probability of the upcoming pitch (in the PS condition). His following statement was based on a weak diagnosis of pitcher tendencies: ". . . pitcher would probably throw it to batter's right end or to my right end if I was the batter, considering he threw it the majority of the time to the right end of the base except on the last throw." Likewise, in IcR, NP6 also planned a rudimentary action based on a weak analysis of the pitcher without developing a probability of pitch statement. His utterances were as follows: "No . . . if I was batter, I'd probably, next batter I would probably uh hit it; I'd look for a hole to hit down, wherever there was no one, there to uh alleviate the pitcher from throwing continuously throwing junk." NP18's statement—"I was just thinking about making contact with the ball and trying to get on base"—illustrates that there was an overall failure in the nonplayer group to develop an explicit probability of pitch statement for time at bat. In addition, the verbal report of NP5 (see methods section) provides an excellent example of how several nonplayers processed game events but did not necessarily relate them to batting preparation.

In contrast, 13 out of 17 players generated probability of pitch statements in PS. These players' predictions about the pitch during their time at bat were derived from their tactical analysis of a variety of conditions about the pitcher as well as other pertinent conditions. All but one of these players predicted a fast ball on the first pitch and most predicted it would be thrown to the outside corner of the plate.

Their concepts indicated extensive profiles of this pitcher. These profiles were developed while viewing the video that contained various ball-strike counts along with predicted pitches and how they would handle such pitches in these situations. To illustrate, P2 developed four probability of pitch statements (e.g., fastball first pitch) and several visual search strategies (e.g., do not look for an inside pitch).

> . . . I'd be looking fastball first pitch and if I happened to take it, I'd assume he would bring it again on the outside corner like the last guy, but the third pitch he threw a wasted fastball, I'd be looking off speed like he threw the fourth pitch, but I'd be looking at the third pitch, outside about give 4 or 5 inches off and then a wasted pitch with a one, two, count [Anything else?] if he got me 2 strikes there's a two one count and he worked two strikes on the outside corner, I'd be looking for a fastball probably, maybe inside high and in trying to waste a pitch high and in, but I wouldn't look for anything down the middle, especially because he was a fastball pitcher, it's gonna be his best pitch, he's gonna work it away and inside, but the off-speed I'm gonna look for away change up maybe down, then a fast ball high and in or high and away nothing down the middle [player P2, PS]

Depth of processing in players is shown in that several also noted the typical flight path of the pitcher's pitches, and that all of his pitches came over the top or that he would use his fastball when ahead in the count and use his curveball when behind in the count. Furthermore, some players noted his fastball was thrown hard and estimated it was around 96 mph. This type of information was used by P6, for example, to develop an action plan to step back in the box, and by P11, who planned to hit fastballs even if they were hard. P11 selected this plan to avoid chasing off-speed pitches similar to what the preceding batter he observed had done. Not only did 13 players generate probability of pitch statements, but also 5 players generated concepts exclusively about the pitcher (i.e., P4, P11, P13, P14, and P18), showing how important the pitcher is to this group. Other measures of concept content and structure (mentioned previously) indicated players' pitch predictions for each count situation (e.g., 2 balls, 1 strike) were based on a variety of situation profiles related to batting. These profiles were updated and modified as the video progressed. The following protocol by P9 provides an excellent example.

> I was watching him and he threw 2 strike fastballs on the outside corner, he only threw one curve ball so I'm thinking first pitch is gonna be a fastball because he's gonna try to get on top and it's gonna be outside, well since the guy is on first base, I'm gonna try to drive it to right field so I can move the runner around, so if he throws me the fastball it's gonna be on the outside cause that's where he's throwing it, he ain't tried to bust anybody on the inside yet and I'm gonna try em take him to right field [Anything else?] If he doesn't throw that fastball, if he throws his curve ball, I'm gonna lay off of it because he hasn't thrown it for a strike yet, so the next pitch should be a fastball cause he's gonna still want to get back on top and he's gonna throw it outside and I'm gonna try and grab it to right field [player P9, PS condition]

In addition to probability of pitch statements, the player group continued to show a depth of processing in developing tactics. For example, P3, the only player with 4 years of collegiate experience, developed extensive tactical profiles about the pitchers' strengths (best pitches) and pitch types (fastball or change up) under various ball-strike counts for both the PS and IcR conditions. He showed integration and synthesis of the information that he accumulated. His hitting tactics were derived from his condition and situation profiles as well as condition profiles about his role as batter (his strengths). The player indicates what to do as a batter in specific game situations.

> OK, well first of all, anytime you're, you're on deck you always try to always try to think of the situation in the game, how many outs there are if we have runners on base, what the score is, so that, you know, lets you know what you need to do, if you need to move a runner over, or uh or find a way to get on base or start a rally, whatever, but uh I noticed from the tape the pitcher he came right at you the first 2 pitches—the fastball's out over the plate—as a hitter you gotta know what your strength is first of all, personally, my strength is pitch out over middle plate or a pitch away and so I would look for that the first two pitches and if I got the pitch try to take advantage of it and drive it, if not I thought his best pitch was his breaking ball, so if I were to get in the hole, I would concentrate on staying back and you know in that situation you have to be a little more defensive and can't be quite as aggressive early in the count [player, P3, PS]

> okay, well first of all the situation you had runners on first and second and 2 outs so in that situation as a hitter you would be looking for a pitch that you can really drive and take a good aggressive swing and try driving that run, basically the pitcher from what I saw had two pitches basically he threw a fastball and a change up, he likes to throw his change up, I think he started that out first two pitches and uh threw one threw the first pitch over for a strike then missed outside with the next pitch then he came in high and tight with a fastball then he showed the change up again several times and ended up walking the batter so as a hitter you know that his best pitch is probably his change up since he likes to throw it that much so, so when he's you know, if you get in the hole two strikes you gotta really concentrate on staying back and waiting on that pitch and driving it, putting the ball in play [player P3, IcR]

These statements reflect the use of *sport-specific or metacognitive strategies,* wherein the player uses information such as the current game situation, his team's current needs and goals, his strengths and weaknesses as a batter, and how to handle this type of pitcher when he is at bat. The player calls upon a variety of specialized processes such as encoding, retrieval, updating, and monitoring of current events (past, present, and future) that are embedded in his sport-specific knowledge (i.e., condition profiles in LTM) to develop his batting tactics. Moreover, some players stated they would have liked to view more video or to actually be in the game to gain more information. Thus, they knew their current event profiles were not complete. Several also expressed that they would have liked to hit against this pitcher to ensure their tactics were complete. Finally, several players monitored their memory for game events and interrupted their thoughts to correct their account of events to ensure profiles were accurate. Nonplayers did not show any metacognitive strategies, or express the need to test tactics or gain more information.

We also examined players' probability of pitch statements and metacognitive strategies across instructions. Probability of pitch statements were developed by three players in the IcR condition (i.e., P6, P12, P19). Overall, most players in IcR seemed to solve two tasks. One was to reveal information processed that was pertinent to preparing to bat and the other was to recall as much information as possible about game-related events in the video. For example, the following verbal report of P9 indicates that he was preparing to bat when unexpectedly asked to recall, with as much detail as possible, everything he saw in the video.

> Alright uh he threw uh he threw one, one curveball breaking ball it didn't go for a strike, the second breaking ball didn't go for a strike, no, the second pitch he tried to throw it and it was kind of like an off-slider and he threw it up and at the bat wide off the plate, the third pitch he threw a breaking ball outside, and didn't didn't wasn't called for a strike, uh, then the pitcher he got it back and then he threw one outside again, and he walked the guy, no first man then, then he uh the guy popped one up and it went foul, and then on the last pitch he walked the guy, now as he runs . . . the batter runs down on first base cause he got walked and man here I'm thinking he hasn't thrown for a strike yet, or his breaking pitches aren't working, he's he's kind of wild, his fast ball is not working, it's kind of outside, so I'm thinking I'm gonna take the first pitch if he throws the ball and I'm gonna keep taking it till he throws me a strike and if he does throw me a strike, I'm gonna try to hit it to right again, to move the runner over [player P9, IcR]

In contrast, in IR, P9 was not acting as a player preparing to bat, but rather processed information that was pertinent (pitcher's pitch types) to game events, but also information that was less pertinent (batter stepping out of box). Although his verbal reports indicated he monitored game events with good accuracy, his tactical reasoning was limited and unlike his verbal reports in other instruction conditions.

> Okay, first pitch was up and in, the catcher tried to frame it but he couldn't, he couldn't get it in the strike zone, the batter stepped out, looked at his bat, turned it twice, got back in and the pitcher was fixing the ball, cause he was gonna throw another fast ball, threw it, it was up and in again, uh the catcher tried to frame it, couldn't get it, threw it back, ok pitcher fixes the ball again, then he threw a curve ball, it missed uh no, he threw it for a strike uh, then he threw it back, at the end threw a straight fast ball, when the first uh then the uh batter stepped out again, fixed his bat turned it twice, got back up, he threw uh a fast fastball right down the gut, the guy hit it uh up the middle, the catcher tried to, I mean the pitcher tried to grab it uh . . . the second baseman came over, threw it in the dirt, first baseman picked it up for the out [player P9,IR]

Four players (P6, P7, P8, and P16) failed to generate an explicit probability of pitch statement during the PS condition. At the time of data collection, three of these players were in their first year of collegiate competition and one was in his third year of collegiate competition. However, these players did develop profiles about the pitcher as well as other relevant conditions concerning batting preparation. Thus, certain aspects of their problem representations were less tactical than their peers. In addition, some players failed to process information related to other aspects of their upcoming bat, like conditions about their strengths and weaknesses concerning their pitch preferences. The verbal report by P8 was the weakest among these players and provides an excellent illustration of differences between players:

> well since there's a guy on first now with that area you're thinking about moving him over whether it be bunting or hitting the opposite way, uh when you're up you get up you're looking at the pitcher where he's throwing the other guys', his control, which is a little bit, little bit wild I guess uh how he's pitcher uh who's different pitchers and so on [player P8, PS]

These individual differences among players indicate that specific practice regarding batting preparation might enhance all players' tactical skills.

Discussion

We examined how expert baseball players learn to bat, what information is used in preparing to bat, and the impact of instructions and goals. Participants were asked to view three edited videotapes of a baseball competition under PS, IcR, and IR instructions. Comparisons between nonplayers and players provided insight into the acquisition of this skill and mediating structures in LTM.

Instruction effects indicated significant increases in total concepts and conditions (total, variety, details) across PS, IcR, and IR, respectively. Thus, as predicted, more information was recalled during IR than IcR and PS, respectively. However, more irrelevant conditions were generated during IR than IcR or PS, which generated more conditions about the pitcher. Actions and goals were absent in IR and generated more often during PS than IcR. These findings showing the influence of instructions on amount and relevance of knowledge recalled were as predicted.

Significant expertise effects showed players' more tactical problem representations regarding baseball competition in general and bating preparation in particular. Players generated more total conditions, conditions about the pitcher (including pitch predictions), total connections, and concept linkages per phrase than nonplayers regardless of instruction condition. Thus, players exhibited a more cohesive and extensive network of conditions regarding baseball competition, with an emphasis on conditions concerning the pitcher.

Overall, players generated more concepts in IR than IcR and more concepts with IcR than with PS. As predicted, however, PS instructions elicited more relevant information for the task of preparing to bat, especially for players.

Specifically, players reported increasingly more conditions about the pitcher across IR, IcR, and PS instructions, respectively. Players also generated fewer yet more specific and pertinent conditions, actions, and goals when preparing and planning their time at bat. Taken together, when preparing to bat, players narrow their problem representations, as we predicted. In comparison, nonplayers generated fewer concepts with PS than the other instructions not necessarily due to narrowing their search but rather because actions and goals were based on less pertinent conditions. Similarly, although we expected nonplayers would generate similar patterns of concepts during IcR and PS as compared with IR, this was not the case. Instead, nonplayers were able to report more information with IcR than PS, again, simply because their knowledge structures contained information (albeit weak) about baseball competition in general. For example, nonplayers reported few conditions about the pitcher and most during IcR, rather than PS or IR. Importantly, nonplayers reported less information in PS due to their lack of knowledge rather than their ability to adapt their knowledge structures to perform the task at hand. Thus, taken together, the pattern of differences between players and nonplayers in these data echo the Chiesi, Spilich and Voss (1979) findings, wherein high knowledge individuals made use of the context and acquired strategies in recalling information related to their domain of expertise. These trends also reflect patterns of findings in medical reasoning, as physicians were more accurate in recalling relevant higher order information than medical and psychology students regardless of instructions (e.g., Norman et al., 1989) or presentation contexts (e.g., Verkoeijen et al., 2004).

Verbal reports indicate that both player and nonplayer groups attempted to attend to information relevant to batting preparation to perform the experimental tasks. More specifically, the data indicate that players used more tactical reasoning during these tasks. These findings generally coincide with Newell's (1974) proposed model of batter decision making. The data go beyond, however, and support the position that players develop complex LTM constructs and networks of condition and situation profiles related to batting performance in baseball. This is how they learn to bat. Referring back to Table 1, the condition profiles of nonplayers showed analysis and development at Level 2 and at best approaching Level 3. The problem representations of players were characteristic of Levels 3 and 4 more often than Level 5. These data are an instantiation of the different performance levels described by Starkes, Cullen, and MacMahon's (2004) model of the development of perceptual-motor skill. In this model, perceptual-cognitive skill is seen to develop from a collection of "if-then-do" statements (McPherson & Thomas, 1989), to simplified mental models, to game scripts that incorporate context, probabilities, and knowledge of one's own skill. Ericsson (2003) argues that expert performers are those who are able to overcome automation and arrested development by developing complex mental representations. Our data suggest that not only do they create complex representations and game scripts (Starkes et al., 2004), but they also develop the ability to monitor their use of these representations, evaluate their completeness, and compensate and create contingencies for missing information.

In addition, this study shows that manipulating goals and instructions impacts on the knowledge that is selected, retrieved from memory, and reported. The results provide two important overall findings. First, we found that experts were able to adapt to instructions and modified their problem representations according to the demands of the task. This is in line with the predictions of French and McPherson (2004) and McPherson and Kernodle (2003) who propose that sport performers with increasing sport-specific tactical knowledge demonstrate increasing flexibility in its use. Adaptable problem representations are thus a characteristic of sport experts who have automated processes, leaving greater capacity for higher level processing and flexibility (Starkes, Cullen, & MacMahon, 2004). Specifically, players' cognitive flexibility and relative "ease of processing" was shown during IcR because this task did not interfere with processing for batting preparation.

The effects of task instructions are particularly important with regards to the development of tactical knowledge in sport. That is, several nonplayers demonstrated the ability to recall information (even pertinent information) but did not use it for batting preparation. Thus, the ability to recall information does not necessarily equate with the ability to process such information for tactical purposes. Although this might be a necessary step (see McPherson & Kernodle, 2003), we believe players should be taught as soon as possible and appropriate to develop and use tactical knowledge and skill during practices and competition. This topic is currently being explored in a variety of sports and programs for all ages and levels of competition. So far, researchers in sport science and related areas agree that tactical skills (much like motor skills) require practice and instruction (e.g., French & McPherson, 2004). As a result, research examining how to train tactical skills is becoming more prevalent. Given this push, we now turn specifically to this topic.

As our experiment suggests, not all players have well-developed knowledge bases concerning batting preparation. This is especially the case at the lower levels of experience. As noted, some players failed to generate an explicit probability of pitch statement during PS. Although these players developed profiles about the pitcher, as well as other relevant conditions concerning batting preparation, they did not arrive at a prediction. Given the extreme time constraints in baseball batting and that decision time is enhanced by movement predictions, it is important to move players toward this ability to enhance performance.

The problem-solving task used in these experiments can be used as an instructional tool for coaches and players. For example, coaches or support personnel can easily construct a 2-min video of competition instructing players to view the video as the next batter and process their thoughts aloud or retrospectively on digital recorders. This process can take place in a large group setting or in pairs. A pair may consist of a player and a coach, or a less experienced player with a more experienced mentor-player. This allows individuals to examine the nature of their tactics concerning batting preparation and learn more about how to develop appropriate batting tactics (e.g., what did my partner think about that I didn't?). Similar to this study, evaluation of tactics will reveal the type of information processed (e.g., pitcher's tendencies), planning (e.g., including any probability of pitch information), and the suitability of plans according to chosen factors such as the individual player's abilities, the game situation, and any team rules or styles of play. At the higher levels of performance, this approach may be particularly useful for players moving from one team to another where style of play and tactics may vary.

These sorts of instructional strategies can be modified using developmentally appropriate tactics according to level of play (see French & McPherson, 2004; McPherson & Kernodle, 2003; McPherson, 2008). For example, at the professional level, as players and coaches learn how to identify tactical knowledge and skills (e.g., whether a profile about a pitcher is complete), they can begin to use such information in the dugout and during competition. Major league baseball teams already incorporate hand held devices to review videos of the pitcher during competition. Diagnoses overlaid with player comments about what they noticed, predicted, and adjustments they made during an at bat can be used to enhance players' and hitting coaches' tactics.

As we pointed out earlier, if sport scientists and coaches are aware of what information experts process and how they process it, we can facilitate and improve the acquisition of these skills. It is even possible that training tactics will promote its acquisition for players who may not have developed tactical skills otherwise, falling in to a state of arrested development (Ericsson, 2003). Although we have provided a great deal of detail on this matter, there is still a need for additional information concerning the types of feedback and instruction that support knowledge and tactical development.

It should also be noted, however, that ideally the problem-solving task used in this study would be not only modified, but also combined with other methods to examine the interplay between cognitive and motor skills. This sort of multidimensional approach has been used successfully in tennis and volleyball (e.g., McPherson & Vickers, 2004). We also advocate the use of verbal reports as a means of understanding knowledge base development in other areas of perceptual skill training and instruction (see Vickers, 2007). So far, players' thought processes during task performances have been absent from much of this research. Only in rare cases are verbal reports examined along with other performance measures. Of course, we concede that the verbal report process is labor and resource intensive, but with advances in recording and coding software we hope to see more of it incorporated in research and practice. In the meantime, on a practical level we believe coaches and players can use this approach for diagnostic and training purposes to begin a dialogue about tactics and to explore other ways to develop and reinforce such skills (see McPherson, 2008).

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