ORIGINAL ARTICLE

Anticipatory information sources in elite softball batting: A qualitative approach

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ABSTRACT

Batting performance against high-speed pitches in softball requires effective anticipation skills. While these skills can vary individually, it remains unclear which anticipatory cues players rely on. The aim is to explore the anticipatory information sources and pitch-related cues perceived and considered by elite softball batters. We interviewed eight elite softball players (25 to 50 minutes each), and their responses were transcribed and analysed using an open-coding approach. Subsequently, the responses were thematically organized into higher and lower-order themes. Seven higher-order themes emerged: consciousness, contextual information sources, kinematic information sources, tactical awareness, mentality/confidence, batting technique and strategy, and skill acquisition/training. These themes highlight the various anticipatory information sources players use, as well as the role of kinematic and contextual cues in batting performance. Further analysis revealed detailed lower-order themes within each higher-order theme. A temporal model was developed to illustrate the sequence and interaction of both kinematic and contextual information sources that influence the anticipation skills of expert softball players.

Keywords: Performance analysis, Decision-making, Game performance, Kinematics, Perceptual training, Anticipation, Visual perception.

Cite this article as:
Carboch, J., Praveckova, P., & Joska, M. (2026). Anticipatory information sources in elite softball batting: A qualitative approach. *Journal of Human Sport and Exercise, 21*(1), 38-50. https://doi.org/10.55860/haexdy75

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Submitted for publication May 26, 2025.
Accepted for publication August 06, 2025.
Published October 02, 2025.
Journal of Human Sport and Exercise. ISSN 1988-5202.

doi: https://doi.org/10.55860/haexdy75

INTRODUCTION

Anticipatory skills during hitting play a crucial role in softball. Like other sports, softball is fast game, constantly evolving, and its players are reaching higher levels of individual skills. Hitting is essential for success, and players are continuously pushed to improve due to the high quality of pitchers. The pitching speed imposes limitations on information processing and motor responses. Nevertheless, the best batters are able to consistently hit the ball even against the top pitchers, successfully reaching first base approximately once every three at-bats. Players individually utilize specific advance information, which may influence their behaviour at the plate or their efforts to analyse and successfully hit the upcoming pitch.

Anticipation research often employs partial video occlusions followed by the athlete's response (Williams et al., 2011). These studies typically focus on kinematic information sources for anticipation, such as the opponent's movements or the ball flight (Morris-Binelli et al., 2020; Shim et al., 2006). Müller et al. (2017) investigated the ability of expert and nearly-expert baseball batters to predict the pitch type from six different pitch types and the resulting pitch location—inside or outside—based on video recordings of pitchers. The results showed that the anticipatory skills of professional and semi-professional baseball players did not significantly differ. Their findings indicate that players struggle to anticipate both the type and location of the pitch simultaneously; however, they are significantly more successful when anticipating either the pitch location or type independently.

Previous research consistently shows that expert players outperform beginners in anticipation skills (Abernethy & Russell, 1987; Shim et al., 2005), and that expert players utilize different informational cues (Müller et al., 2009) and employ different visual search strategies (Mann et al., 2019; Murray et al., 2017; Sáenz-Moncaleano et al., 2018). Moore & Müller (2014) demonstrated that expert baseball players are consistently able to use and transfer visual information to anticipate subsequent events. In another study (Müller & Fadde, 2016), it was found that players can distinguish a change-up from a fastball during the pitch release occlusion, suggesting that visual anticipation based on prior information is a key component of batting performance.

Other studies have found that players use not only kinematic information for anticipation but also contextual information such as the match score, weather conditions, and the opponent's position (Vernon et al., 2018). For example, in tennis, during "*big points*" (e.g., break point), the receiving player often anticipates that their opponent will serve their favourite serve type. These contextual factors influence players' anticipation, highlighting the importance of considering players' approach from a broader perspective, rather than focusing solely on kinematic information.

Recently, there has been growing scientific interest in qualitative studies on anticipation research (Carboch et al., 2023; Vernon et al., 2018). These studies offer new perspectives and valuable insights into players' approaches and behaviours. While research on anticipation exists in various sports games (Abernethy & Zawi, 2007; Gabbett et al., 2007; Hopwood et al., 2011; Müller et al., 2006; Williams et al., 2003), including the aforementioned qualitative studies, to the authors' knowledge, no such research has been conducted in softball. Consequently, it remains unclear what cues, information, and approaches players use to anticipate pitches and enhance their batting performance. The aim is to explore the anticipatory information sources and pitch-related cues perceived and considered by elite softball batters.

MATERIALS AND METHODS

Participants

Eight (8) softball players participated in our study. All players (age 25,5 ± 3,5 years) were members of the Czech men's national team with experience in softball (18,7 ± 6,4 years of experience). All players have experience from many international tournaments, including European and World softball championships, where they faced the best pitchers in the world. In addition, they have achieved above-average batting statistics in the highest national league for several years. The sample size of expert softball players adequately reflects level of expertise (Müller et al., 2015; Vernon et al., 2018). The study was approved by the Ethics Committee at the Faculty of Physical Education and Sport, Charles University, in accordance with the Declaration of Helsinki.

Procedure

The participants were approached and asked if they would agree to participate in the semi-structured interview that ranged from 25 to 50 minutes, where they considered in detail the key factors anticipating a softball pitch during their careers. A calm place and time without any distractions was arranged to complete the semi-structured interview. Before the interview, each participant reviewed the purpose of the study and provided informed consent. The interviews were recorded on the digital voice recorder application contained in the iPhone XS. Interviews were then transcribed verbatim to be used for analysis.

We used an interview guide and methodology previously developed for tennis research (Vernon et al., 2018), modifying it to suit the context of softball with the help of one expert coach, two elite players and one researcher. The core of the interview guide (relatively unstructured) consisted of the same open questions, aimed at eliciting comprehensive responses from each participant and asking follow-up questions. This approach, characterised by its flexibility, facilitated the exploration of participant responses through probes and follow-up inquiries, thus ensuring a thorough in-depth understanding of their answers and perspectives (Hardy et al., 2017). Table 1 presents the interview guide with the questions. All participants answered the questions based on their own personal experiences with complete freedom in their responses, including the deepest details of the topic discussed.

Table 1. Interview guide for participant interview questions.

1. Can you think of examples of past or present players who are/were good pitchers (hard to hit) and why?
2. When you are going in the batting box, did you consider contextual information to help predict an opponent's pitch? (e.g., match status, number of runners on base, number of outs, spectators, importance of the game, weather, left-handed/right-handed pitcher, etc.)?
3. What role did kinematic information (e.g., pitcher arm movements, refusal gestures, glove position, etc.) play in helping you anticipate or predict the pitch? Was it more important than the contextual information? Why?
Do you try to time your swing to the pitcher if you are in batting circle?
Do you discuss with your teammates about the next pitch type/location?
4. If you utilized such contextual information how did you update it over the course of a match? For example, how many times did a pitcher have to throw the first pitch to the same location or when the same pitch type when you had two strikes count before you considered this a trend and adjusted your response accordingly?
Do you adjust the size of the strike zone according to individual umpires during a game or a batting start?
5. Do you prepare for a match if you know that you will be facing a specific pitcher, what is his dominant pitch/location, batting practice, etc.? Do you watch an unknown pitcher on the video before the match?
6. Based on your experience, what precedes a good hit? In other words, what key factor usually happens before you hit a hard hit? For example, gauging the pitch type, location outside/inside, swing timing, watching the ball at bat (head lock), etc.
7. Do you try to anticipate the next pitch, or do you focus only on the pitch during the ball flight and strive for the maximum level of concentration, to have a so-called empty head, and why?
8. Anything else you would like to add about the pitching and batting and what we have covered today?

Data analysis

Following the methodology outlined by Vernon et al. (2018), we used the open-coding analysis approach (Hendl, 2005; Straus and Corbin, 1998). Three experienced evaluators with research and practical understanding of slang and the specific language performed the analysis. The transcribed interviews were individually coded sentence by sentence by the evaluators separately to draw upon the emerging themes from the participants' responses to the interview questions. During the coding process, the interview sentences were given tags related to the codes that emerged. Based on the tags from each researcher, common themes were included and categorised into higher or lower-order themes. In case of differing themes between the researchers, the findings were discussed until a consensus was reached. For further details regarding the analysis, see Vernon et al. (2018).

RESULTS

A thematic analysis produced seven higher-order themes, which were extracted from the respondents' answers that had previously been identified. They are summed up in the themes and labels below (based on the language of the participants rather than the scientific language). Table 2 shows and summarises each of the themes. A model depicting the use of anticipatory information during softball batting is presented in Figure 1 at the end of this section.

Table 2. Summary of higher-order themes and their corresponding lower-order themes emerging from the batting anticipation interviews.

Higher order themes	Lower order themes
Consciousness	**Anticipation**: Being aware of contextual and kinematic informational sources. See the ball early off the hand. **Pre-game anticipatory sources**: Gathering information about the opponent through discussions with teammates and coaches before the game, as well as reviewing video footage of the opponent prior to the game. **Anticipation training**: Utilizing anticipatory sources.
Tactical awareness	**Searching and updating information sources**: batter searches for sources during the match, attempting to use them for his own benefit or for the benefit of his team. **Evaluating current game situations**. **Tactics in the box**: Adapting or changing tactics in the box based on kinematic and contextual information based on the current game situation. **Conscious evaluation of anticipatory sources**: Selecting or guessing.
Contextual information sources	**Weather**: Pitch quality and accuracy. **Game situation**: Score, runners on bases, outs. **Observing trends**: The attempt to observe a recurring trend by analysing previous starts in the match. **Catcher's sequence**: Observing the repeating sequence of the catcher in pitch selection. **Signals from teammates**: from the second base runner or a next batter in batting circle. **Pitch count**. **Adjusting the strike zone according to individual umpires**.
Kinematic information sources	**Utilizing kinematic anticipatory sources**. **Pitcher's movements before the pitch**: Body movements, forearm muscles, adjusting the ball in the glove, depth and angle of the pitching hand's insertion in the glove. **Ball flight trajectory**.
Mentality / confidence	**Confidence in batting skills**: As the pitch speed increases, the level of anticipation for the next pitch also increases. **Pitch count**: Balls/strikes.
Batting technique and strategy	**Pitch selection:** specific pitch type the batter wants to hit. **The relationship between pitch speed and setting the batter's strategy for the game.** **Parameters of a hard hit**: The skill of timing the swing.
Skill acquisition / training	**Gaining experience by playing matches**. **Early age anticipation sources training and awareness**: Pitching machine/pitcher.

Consciousness

All participants mentioned that they are aware of several sources of anticipation that they take into account before the match itself and then before every pitch. Before the match itself, the players have several information sources at their disposal, according to which they can set their pre-match strategy and create a plan in their head with which they enter the match. This plan can then change depending on other information sources, such as contextual information sources depending on specific situations, kinematic information sources about the opponent, or information obtained from teammates during the match. Being aware of kinematic information sources, two participants stated that they cannot use kinematic information about the opponent, despite the fact that they consider this information to be very important from the point of view of the success of the batting start. Participant 4 does not use this information purposefully. In contrast, however, all eight batters use pregame anticipatory information about the opponent, such as the pitcher's dominant pitch, frequency of different types of pitch in previous games, and so on. It is also important for the batter to anticipate the type of pitches and whether the batter is right-handed or left-handed, as a right-handed pitcher is unlikely to throw a curve/screwball to a batter standing in the right box. The responses indicate that batters adjust their batting practice depending on which pitcher they will face in the next game, debate with their teammates about what pitches a pitcher is throwing in specific situations, visualise their previous starts against a particular pitcher, and prepare a strategy into the game, such as which pitch they want to primarily hit or what pitches the pitcher might throw them. According to participant 2, there is also a difference between preparing for matches in the Czech league, where he knows all the pitchers, and preparing for foreign pitchers: *"There is also scouting in the national team, where we watch the pitchers on video and try to notice how they throw each type of pitch and what his movement looks like. In America, we have a debate with other teammates who know the pitchers and decide what types of pitch could come to whom and under what conditions. Alternatively, what is the dominant pitch for the pitchers, and which one is worth waiting for before hitting."*

Tactical awareness

All participants confirmed that they evaluate several different sources of information during their start and adjust their tactics in the box to changing game situations such as the number and placement of runners on bases, the number of outs, and the state of the game. If there is a need to get a runner home from third base, players are willing to hit into a forced out at the cost of scoring a run for the team or swing with more control as mentions participant 6. According to proband number six, tactics also change according to the current situation in the field: *"If I have a runner on third base, or if we are down by one point in the end of inning, things change a little at bat, depending on the number of outs, for example. Then, for example, I try to play more confidently, to get the ball into play as it was."* Or participant 2: "*If there are no runners on the bases, I mainly manage the start of the at-bat according to myself so that I feel comfortable in the box, and I go calmly sharply even to the third strike, even though I may be strike out. When someone (runner) is on the base or there is an important match, I try to swing more but not to be strike out. So, I swing with more control."* On the contrary, two participants said that if their team is leading or losing significantly, then they aim for a homerun or a long hard hit to gain personal benefit.

Players are also constantly evaluating several information sources at the same time, and therefore often make decisions about which information source to prioritise, as there are situations when they have multiple information sources at their disposal, and there may be situations where anticipatory sources are mutually exclusive. All participants also choose the degree of reliability and the degree of risk, how much percent they will trust a certain source, and how much they will adjust the tactics in the box based on it. Participant 8 said that if he spots a repeated pitch in a certain situation three times in a row, he has that variation "*in his head*" but does not rely on it 100%. As a pitcher's velocity increases, so does his degree of reliance on a specific

anticipatory source. Participant 1 also works with several anticipatory sources at the same time, and if, for example, the runner from the second base signals him a pitch tip, he takes this information into account but also does not rely on it 100%. He adds that he still must stay as focused as possible, because even if a teammate tips the rise ball correctly, he has to figure out during the flight of the ball how high the rise ball is flying and whether he will try to hit it or not. So, he takes this information as good advice, but as a result he always relies primarily on himself and his batting skills. In his opinion, the correct evaluation of anticipatory information is difficult for younger players who do not have so much experience, as they cannot react in time and effectively if the following event does not correspond to the prediction. According to participant 4, it is necessary to start with the targeted evaluation of (anticipatory) information already in childhood: *"It is something that you have to learn, because you are concentrating on two things at once and chaos can arise in the framework of the division of concentration - what does it show me? Yeah, the rise ball outside… what should I do? And the pitcher is already pitching. So, if it starts from learning from young age, it is great, but it can cause problems for someone if they start later."*

Contextual information sources

The pitch count (ball/strike) is a contextual source reported by all participants. Participant 6 said that if a pitcher is in an unfavourable pitch count, he expects him to improve it with his favourite pitch *'...when he has 3 balls and 1 strike, I expect the fastball, for example.'* This batter also stated that if he hits a hard pitch in a game, he does not get that pitch for the rest of the game again, or only a limited amount, so he primarily focusses on and expects other pitch types in his next bat starts. Batters also look for contextual trends in the game, such as whether a pitcher starts every batter with a strike or a certain type of pitch. By analysing his previous batting starts and the starts of his teammates, he tries to spot some applicable trend, while the minimum number of repetitions of a certain situation to determine the trend is individual. If batters notice a recurring situation, they can adapt their box tactics to this trend. Most participants mentioned trying to decipher the catcher's sequences/algorithm of signals to the pitcher and predict the next pitch. Three of the batters said they try to guess the next pitches based on the catcher's sequences. Participant 8 usually tries to guess pitches based on the catcher's sequence and how well the particular catcher knows him. The participant tries to guess the pitch type if he feels that the catcher is showing the same signals as to previous batters. But if he feels that the catcher has changed the sequence, he does not try anything and is ready for anything.

Players also adapt their tactics in the box according to specific referees. Five of the eight batters confirmed that they change the size of the strike zone according to the particular umpire. If it rains during a game, players are cautious and watch to see if the pitcher's control over pitch placement is impaired by wetness or humidity. Participants can rely on signals from the runner at second base, who can see the catcher's signals and also has a better view of the pitcher's glove (to see the ball grip). All participants use these signal possibilities in their teams for specific pitch types or location in their teams to gain additional information about the next pitch. Batters are provided information about catcher position change from of the dugout or teammates.

Kinematic information sources

The movements of the pitcher, which the batter either consciously or unconsciously associates with specific types of pitches and then anticipates the following type of pitch based on them. All participants agree that this type of information is very valuable and that this skill is associated with a hitter's success. The use of this skill is counterproductive for three of the participants, as they have to split their attention on multiple factors, and the resulting batting performance is then worse than if they had only focused on their performance, and therefore one proband does not attempt to obtain this information at all. However, five participants say that

they use this skill to their advantage. The entire team, including coaches and scouts, participates in obtaining this type of information by specifically watching the pitcher during pitching in previous games, or by analysing video footage. If a batter can successfully predict the types of pitches from the forward movements of the pitcher, it is a vital weapon that can significantly help the batter hit successfully. The participants mentioned specific cues: the angle and depth of immersion of the pitching hand in the glove and the movements of the forearm that accompany setting the ball in the correct position in the glove. Two participants mentioned, that thy could recognize the pitch type form the forearm muscles, however the pitchers wear a long sleeves now to hide this cue.

Gathering pitcher kinematic information is primarily obtained by watching the pitcher from the dugout, from the stands, or by watching and analysing video footage. They (players and coaches) are looking for a specific movement that is connected to the subsequent action. This information is shared within the team. Participants number six states that the batter's box is the place where the application of the acquired kinematic information already takes place: *"The batter must already have information about the pitcher's movement before the pitch when he goes to the box. You already have to know what it does and then apply it in that box or try to apply it. The moment you don't see what you saw from the dugout, or what someone else tells you, then you need to get rid of it."*

The answers show that some batters can read the swing pitch from the pitcher's kinematics during the pitch, when the pitcher swings his torso to the side from the straightforward direction of the pitch. Some batters can recognize a change up when the pitcher slows down his movement before releasing the ball. The answers also show that the more starts a batter has against a particular pitcher, the easier it is for him to anticipate from kinematic information, because he knows the pitcher's movement, knows what to focus on and subconsciously knows whether the pitcher is slowing down the movement or will throw a technical pitch, whether it's a screw, curve, drop or a rise ball. Participant 5 said: *"I am using my catcher experience. I am often catching to best Czech pitchers, I'm able to recognize the change up from the movement when we hit. When they start the movement, I subconsciously see what they are going to throw, because I have seen the movement so many times that I can recognize it and react to it."* This information is supported by participant 3: *"I perceive the pitcher subconsciously, if I have watched (studied) a specific pitcher many times, then I know that he will throw a screw/curveball."* Participant 6 claims that the evaluation of information in this phase of the movement occurs automatically without the batter's voluntary effort: *"I do not purposefully follow the kinematics of the pitcher during the movement. I can kind of subconsciously know if the pitcher does something different, like slows down the change up or leans to the side at the point, the body reacts to that, but it's not something I have to focus on."*

Mentality/confidence

All participants revealed they never rely on information sources about the next pitch on 100%, and the final decision on whether to swing or not to swing depends on evaluating the pitch characteristics (spin, speed, direction). Even if the batter has advanced information about the type of the next pitch, i.e. its spin or location (height, inside/outside) before the ball release, he must consider the pitch variability since the pitcher is not a machine and every pitch is unique. However, as most participants said, in most cases, batters have incomplete, minimal or no information. The batter must primarily rely on his batting skills, and that is why self-confidence and mental toughness are essential, especially in critical moments of the match, when it is necessary to move runners on the bases by batting. Participant 1 said that if he has a form, he does not take contextual information into account or change anything in the box; however, if his form stagnates, he returns to controlled batting at important moments. In the batting box, batters try to be as concentrated as possible and not succumb to pressure from the environment, such as pressure to perform or the presence of

spectators. One participant admitted that many spectators' presence negatively affects his batting performance, as he tends to be nervous. Another participant said that the large number of spectators affects him emotionally, but he cannot specify whether it is positive or negative. Batters can also be nervous when they are expected to bat or when it is a crucial match moment. Participant 7 stated: *"I take it as a huge drag on my performance, thinking that I must send home three runners now because we have to win. However, I know that I could not remember what I was thinking of (solving) if I had a strong or important hit. Suddenly, it was such a flow when I did not solve anything, and it went on its own."*

Some batters try to the pitcher under pressure. For example, if pitchers have three balls without a strike, they make it clear that they will not hit the next pitch, for example, by indicating a bunt. Participant 2 said: *"I will signal a bunt to the pitcher, and no matter what pitch type he throws, I will not attempt to hit it".* Another participant mentioned that if a pitcher refuses catcher's signals (for a pitch type), he takes time (time-out) to make the pitcher uncomfortable.

Batting technique and strategy

All eight participants agree that going into the batting box with a strategy against high-quality pitchers is important. Batters decide in advance which pitch type they want to hit and do not attempt to hit other pitches. For example, one of the batters always tries to hit a change-up if he knows the pitcher will throw it. Participant 1 concentrates on the dominant pitch: *"If the pitcher throws drop ball in 80% of the pitches, I only try to hit drop balls, nothing else"*.

Most participants agreed that the faster the pitcher's velocity is, the more they stick to the batting strategy, and improvisation disappears. On the other hand, with decreasing pitch velocity, batters enter the box with an empty head, as the time that elapses between the release of the ball by the pitcher and the contact of the ball with the bat is enough for them to recognize the pitch speed, type and location in time. If the pitch's high velocity does not allow this option, batters split the strike zone into two halves and only swing pitches that fly to that one half or attempt to hit only one pitch type. Participant 8 revealed: *"It depends on how fast the pitcher is and how pleasant he is to me. It is actually about my feeling. Sometimes I do it this way, and sometimes I do it that way. I have not set it beforehand, but the pitch speed is probably the most important factor. If I cannot keep up, I tell myself something and act accordingly."*

Five participants see the swing timing as a key factor in hard hits. Seven participants try to get the timing right in the warm-up circle, where they perform practice swings. Other factors used by batters as key to hitting hard were evaluating the type or location of the pitch. If a player can only perceive and use a minimum of context or kinematic information sources during a match, he must rely on his batting strategy based on pre-match scouting and setting his plan. Participant 5 stated on the batting strategy: *"It occurs to me that after a certain level in softball, the see the ball, hit the ball rule does not apply. Yeah, it just does not work (for the minor leagues, it works, but definitely not for the international level). Then I have to go into the batting box with a plan and think about what they are pitching, for sure, and you cannot make any progress without that in world softball, how fast the pitchers throw."*

Skill acquisition/training

Three participants mentioned that the younger generation of batters, who practice perceiving and evaluating anticipatory sources from a young age in junior categories, are more successful in this anticipation/batting area. Participant 4 comments regarding the pitcher's kinematic information: *"I think this skill can be learned like other techniques in hitting. For example, Bred Rona from New Zeeland claimed that before the pitch is*

released, he knows in 90% of cases what the incoming pitch will be. Either he reads it from the box, or someone from his teammates advises him, but mostly he reads it from the box".

Most participants agreed that the swing timing skill can be practised by facing pitches. Facing a pitching machine has the disadvantage that the machine is always pitching velocity, and the batter does not have to adjust the swing timing for each pitch. Batting in the cage from the front toss has the advantage that pitches can be easily placed on any part of the strike zone, and hundreds of balls can be pitched this way without higher demands on the pitcher's condition or technical equipment. However, pitches made with this style are relatively slow. In the batting cage practice, it is impossible to achieve sufficient development of this batting skill (timing) since the distance at which the ball is pitched, and the speed of the pitch do not imitate match conditions. Three participants agreed that match experience and training with live starts are most valuable for a batter. According to participant 3, players who play all year-round, without a winter break, such as Latin American nations, have the greatest advantage while having the opportunity to gain more experience from real match starts against pitchers, as well as players who regularly bat against fast pitchers. Participant 1 stated, *"You definitely cannot be a top batter based only on (batting) cage practice. The key element is to see live pitches regularly, even in practice."*

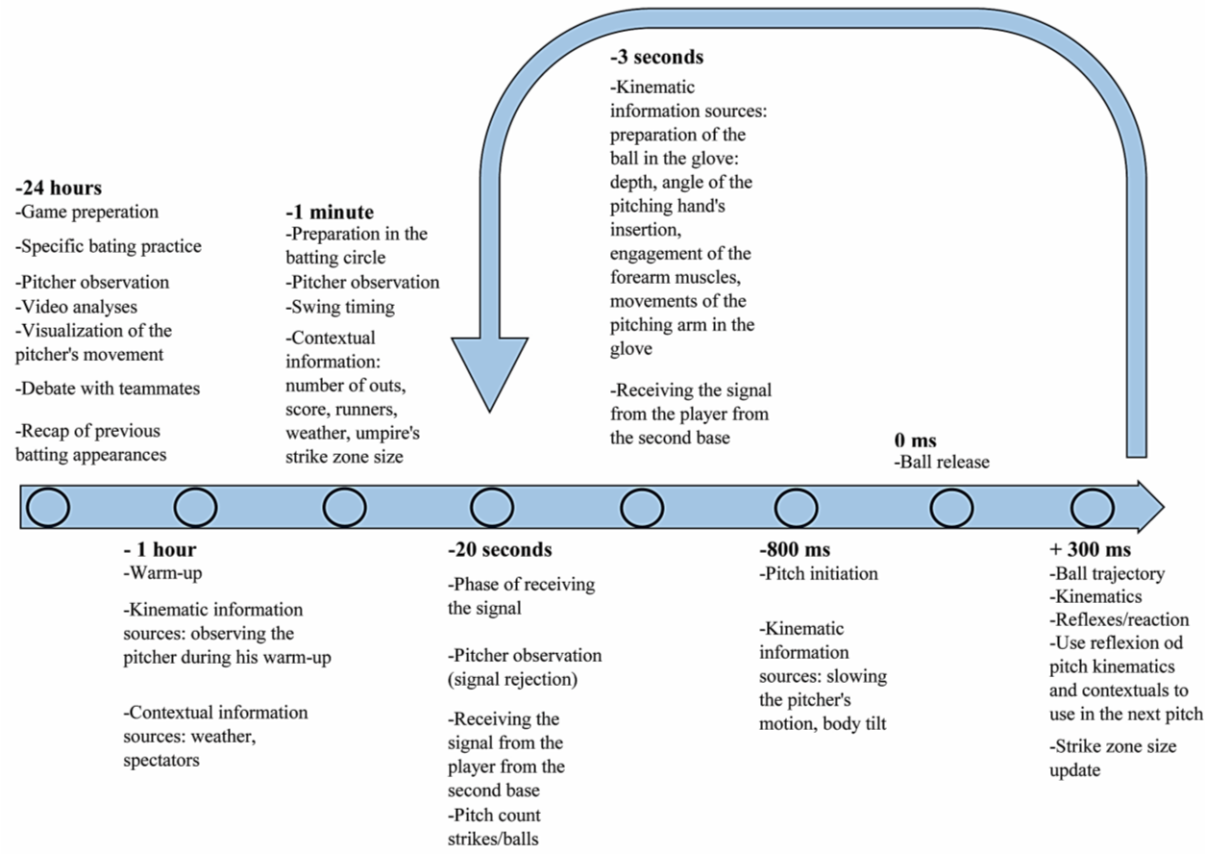

Figure 1. Temporal model illustrating how anticipatory information is utilized during softball batting.

DISCUSSION

The interviews revealed several common ideas, players' approaches, and hitting strategies that were agreed upon by several or most of the interviewed batters, independently of each other. However, some of

the insights shared were unique and original, highlighting the ambition and effort of batters to read the opponent pitcher and predict their intentions. Some batters went further in their reasoning than others. However, all participants anticipate and sometimes rely on advance information to predict the next pitch.

Batters use various anticipatory sources to anticipate pitches. Typically, they start by preparing for the game based on the pitcher they will face, often through pre-game scouting, which includes direct observation or video analysis. Once they have this information, batters prepare during batting practice for the types of pitches they expect to see in the upcoming game, or they visualize the pitcher's pitches. Familiarity with a pitcher's video footage helps batters understand their movements and identify the types of pitches the pitcher uses, similar to how a tennis player anticipates an opponent's favourite serves during critical points (Vernon et al., 2018). In tennis, players face many serves and update their information based on the opponent's movements. This helps them predict the type of serve after observing 10 to 30 serves, which could make up a third of the match. In softball, however, each batter faces only a few pitches per game, meaning there's less opportunity to update kinematic information from personal experience, but each batting start helps.

The responses revealed that the use of anticipation increases with the speed of the pitches. The faster the pitches, the harder it is to react solely based on visual information about the ball's trajectory, prompting batters to predict the type or location of the pitch. To do this, they rely on visual or contextual anticipatory cues, as well as information from pre-game scouting. However, most participants agreed that the better the pitcher, the more difficult it becomes to observe anything in the pitcher's kinematics—either before or during the pitch—that could help the batter anticipate the upcoming pitch. As a result, this informational resource becomes less useful when facing top pitchers, and batters (according to the responses) might divide the strike zone into two halves or attempt to hit only one type of pitch. In such cases, anticipation turns into more of a guessing game.

For a successful hit, the key factor is the proper timing of the swing, which means the point where the bat's flight phase intersects with the ball's flight phase (Katsumata, 2007). According to Joska (2019), batters are able to time their swing relative to the changing speed of the different phases of the swing and the varying time allocations for each phase. From a training perspective, it is essential to simulate the timing requirements of a real game. This means the training must match both the game's pitching distance and the pitch speed. This can only be achieved with live pitching or by using a pitching machine. However, when hitting off a pitching machine, the length of the stride and swing tend to increase (Aubrecht, 2017; Carboch et al., 2022). Therefore, the best training for batting skills—specifically timing—consists of simulated batting starts during practice or actual game situations.

The interviews indicate that all the participants consider kinematic informational sources from the pitcher both in and outside the batter's box. For a batter to use these advance information directly in the box, they must already know in advance what to look for in the pitcher's kinematics. This is why players or coaches observe the pitcher's movements before the game during warm-ups, as well as during the game from the dugout or batter's circle. Some participants, after the pitcher starts their motion, are unable to extract anything from their movements and focus solely on themselves. Meanwhile, other batters can detect shifts or slowing of the pitcher's movements and anticipate a technical pitch or change-up. This skill can correlate with how familiar the batter is with the specific pitcher and also highlights differences in anticipatory skills among high-level players.

The participants reported minimal exposure to targeted anticipation training, which suggests potential areas

for improvement in training for batting performance. Perceptual training (Brenton et al., 2019; Gabbett et al., 2007; Hopwood et al., 2011), which involves watching occluded video clips and predicting the next action, could be valuable for enhancing these skills. This approach could be recommended for coaching practice. Among the players who have the most opportunity to observe pitchers are catchers, which helps them better read the pitcher's movements. However, it was not confirmed that catchers are better batters than players in other positions (Klein, 2015). This may be because catchers, after pitchers, are the most physically active players, performing several squats and throws during each inning. As a result, they enter the batter's box more physically fatigued than players in other positions. Fatigue in the lower limbs can also cause slower sprints to first base, leading to lower success in batting statistics. Additionally, catchers must focus on every pitch, which can lead not only to physical fatigue but also mental fatigue, potentially reducing reaction times compared to players in other positions who are not as heavily involved during the game. In training, catchers often catch pitches for pitchers, which can limit their opportunities to practice hitting.

The interviewed batters reached a consensus regarding the adjustment of the strike zone size according to the individual umpire and the batter's situation. Specifically, five batters adjust the size of the strike zone based on who the home plate umpire is during the game. They are prepared to swing at pitches they personally wouldn't consider strikes but believe the umpire would call a strike. On the other hand, six participants expand the strike zone when they have two strikes. Interestingly, according to a study by Huang & Hsu (2020), professional baseball umpires tend to shrink the strike zone when there are two strikes, while they expand it when there are three balls.

One limitation of the research was the extensive responses from the players, which often strayed from the original question. While these off-topic responses provided interesting insights, sometimes players did not answer the questions in detail, which should be addressed in future research. Further studies should focus on surveying professional and semi-professional softball players from other countries.

CONCLUSION

Anticipation plays a crucial role in softball high-level hitting, and as the speed of the pitches increases, the level of anticipation rises. The anticipation informational sources batters consider include the pitcher's kinematics, information about the opponent (such as the pitcher's dominant pitch and preferred locations), analysis of previous matchups against the specific pitcher, and the catcher's sequence. However, the interviews revealed that batters do not always have access to these pieces of information due to the pitcher's unreadable movements. In these cases, guessing comes into play, where batters, for example, divide the strike zone into two halves and only swing at pitches in one of those halves. Players also adjust their strategy in the batter's box based on contextual information such as the number of outs, runners on base, or the presence of a particular umpire. Better performance in anticipation in batting box is facilitated by prior knowledge of the pitcher. According to the players, the greatest benefit for developing anticipatory skills comes from facing top pitchers in actual games, as such conditions are difficult to replicate in training. Therefore, for improved batting performance in softball, it is essential for as many players as possible to regularly participate in international tournaments where they can gain experience against foreign pitchers.

AUTHOR CONTRIBUTIONS

Jan Carboch and Petra Praveckova conceived and designed the investigation, analysed and interpreted the data, drafted the manuscript, and approved the final version submitted. Marek Joska collected and interpreted the data.

SUPPORTING AGENCIES

This study was supported by: Charles University Cooperatio Sports Sciences, Biomedical & Rehabilitation Medicine.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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