

BIOMECHANICAL OBSERVATION: VISUALLY ACCESSIBLE VARIABLES

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Many scholars in the field of human movement have emphasized the importance of observation for coaches and teachers (Allison, 1987; Barrett, 1979 and 1983; Biscan & Hoffman, 1976; Brown, 1982; Hudson, 1990; Imwold & Hoffman, 1983; Johansson, 1975; Scully, 1986). After all, the skill of observation is fundamental to 1) monitoring and maintaining a safe environment, 2) verifying that athletes/students are on task, 3) analyzing and evaluating performance for the purpose of assessing skillfulness (and by extension allocating playing time or assigning grades), and 4) modifying performance with the intent of skill development. Of course, success in the first two uses of observation is a precondition to success in the latter two uses of observation.

Much of the research on observation in the teaching environment has been conducted by Barrett (1979 & 1983) and Allison (1987). They have studied the perceptions of people who are more and less experienced with movement in the complex setting of an activity class. Barrett has discussed the need for teachers to plan what they are going to observe and how they are going to observe it. In particular, she focused attention to the identification of "critical features" (i.e., aspects of the movement or the environment that are critical to the outcome of the performance). Allison noted that inexperienced observers did not give attention to movement details and attributed that omission to a difficulty in distinguishing relevant from irrelevant features.

A few researchers have investigated the evaluative aspect of observation (Johansson, 1975; Osborne, 1972; Scully, 1986). In these studies, the environment was simplified by restricting the display of information to a film or videotape of one or two performers. Observers were asked to provide a simple response such as a rating or identification for each sample of movement. Although all observers were able to perceive certain hierarchical features of performance (Johansson), more experienced observers were able to provide more precise and specific information (Scully, 1986).

Hoffman and colleagues (e.g., Imwold & Hoffman, 1983; Biscan & Hoffman, 1976) also conducted a series of studies about the evaluative aspect of observation. They, too, displayed movement in a simplified environment but the focus of observation was biomechanically specific rather than global. The researchers provided a set of plausible descriptions of the movement and asked the subjects to match their observations with the given descriptions. The ability to correctly identify biomechanical components within a movement was found to be a function of experience in observation and familiarity with the skill (Imwold & Hoffman, 1983).

While the preceding studies and others have supplied a foundation from which to build, there are many questions unanswered. For example, in the absence of predetermined descriptions of movement, what choices do observers make in terms of "what, where, and when to observe" (Hudson, 1990)? Do experienced observers make different choices than inexperienced observers? Do inexperienced observers make similar choices but require more iterations in order to perceive? How much of observational ability is a function of experience rather than familiarity with the skill? Accordingly, the purpose of this investigation was to gain insight on these questions.

METHODS

Ten observers participated as subjects in this study. Six of the ten were considered experienced observers as a result of prior coaching and/or activity teaching experience. Four of the observers were considered novices; they were not new to watching sports, but new to observation for skill analysis. None of the novices had any coaching or activity teaching experience.

The task which all of the subjects observed was the lacrosse overhand throw for distance. This was

a relatively maximal, discrete task. It was chosen because it was relatively unfamiliar to all of the observers. The performer of this task was generally athletic, but not trained or proficient at the lacrosse overhand throw.

A videotape of the task was made by filming a sagittal view of the performer as she ran a few steps and then threw the ball. A long lead in before the movement was allowed so that the observers could become oriented before the primary action occurred. A complete follow-through was also included in the recording. The entire movement occurred within the frame. The only object moving out of the frame at any time was the thrown ball.

The subjects were informed that they would be viewing a videotape of a lacrosse skill and that they were to assume the role of a coach or teacher (the choice of which was theirs). As the coach or teacher, their responsibility was to assess the player for the adequacy of her performance in the task. Instructions were given to record what was good/bad, incorrect/correct, or suboptimal/optimal. The subjects were told to explain the importance of each of their observations. All remarks were encouraged, no matter how general or insignificant they may have seemed to the observers. This was done partly to insure that all of the observers (especially the inexperienced ones) were observing with the same purpose as the experienced observers. Although it was not articulated, each observer was expected to plan and implement his/her own observation strategy.

The videotape of the throw was shown on a 19-inch color TV monitor. Repeated viewing was given for the observers. After each of the first three viewings the subjects were given as much time as necessary to note their observations. This was done to insure that all of the subjects were available to watch the next viewing. At the end of the first three viewings the subjects were directed to mark where their notes ended. This was done so that what was observed in the first viewings could be distinguished from what was seen in later viewings. Then, the videotape was shown continuously until all observers were satisfied that they had completed their observations.

The data were categorized by using the constant comparison and typological methods described by Goetz & LeCompte (1981). Recognizing individual variations in format, the data were reduced by organizing each observer's notes into distinct responses about the performer and the performance. Caution was exercised in terms of changing the meaning or inferring too much or too little meaning from the notes. Following the examination of "what" was observed, the "when" and "where" of observation were examined with the temporal (i.e., preliminary, propulsive, post-propulsive) and spatial (i.e., somatic, sectional, segmental) categories given by Hudson (1990). Frequency of response for each category was then used to compare between the groups.

RESULTS AND DISCUSSION

The format of the responses varied from subject to subject. For example, some observers tabulated brief notes under headings such as "incorrect;" others listed a series of short paragraphs. For the purpose of analysis, some compound sentences were separated into separate, though related, variables. In other cases, consecutive sentences were counted as a single variable if the information appeared to be redundant or elaborated.

Overall, a total of 29 distinct responses about the performance were noted. Members of the experienced group reported an average of 12 variables. Novice observers listed an average of 8 variables. Within the first three viewings of the sample tape, the experienced observers noted about 8 variables and the novices reported about 5 variables. Thus, experienced observers could perceive, on the average, as many variables in 3 viewings as the novice observers could perceive in unlimited viewings.

Not only did the experienced observers make more comments about the movement than the novices, the comments were more specific as well. For example, members of the experienced group expressed the concept of coordination with terms such as "simultaneous", and "moving at the appropriate time". In contrast, novices denoted coordination with terms such as "slight hesitation", or "[she] ran, she stopped, and then threw".

In addition to observations about the performance, there were also non-observations about the performance. In other words, a few of the experienced observers remarked about features which they were unable to see (due to the component being blocked by the body in some way). None of the novice observers made such comments. Perhaps,

some of the experienced observers had formulated a plan of observing that was partially incompatible with the information available.

Another contrast between the experienced and novice observers related to responses about the performer rather than the performance. That is, no comments were made by the experienced observers as to the skill level of the performer. The novices, however, made notes such as "lots of promise", or "needs confidence level improved". These remarks may indicate that the novice observers were using kinematic information to draw inferences about the performer rather than the performance.

In summary, both experienced and inexperienced observers were able to perceive several features of the performance. However, in keeping with the work of Scully (1986), the experienced observers were able to report more observations as well as more precise and specific information. Also, the experienced observers were able to perceive the variables they needed to analyze the performance more quickly than the novices. The reports of irrelevant details by the novices (i.e., comments about the performer rather than the performance) and unobservable features by the experienced observers (i.e., notes about obscured components of the body) lend credence to Allison's (1987) contention that inexperienced observers have difficulty distinguishing irrelevant features from relevant ones. In as much as the recognition of specifics of performance is a function of experience in observation and familiarity with the skill (Imwold & Hoffman, 1983), the differences in number and specificity of observation between the groups of this study could not be attributed to familiarity with the skill.

For the purpose of examining the "what, where, and when" of observation, the irrelevant, unobservable variables (see discussion above) were excluded. The most frequently noted observations about the performance are given in Table 1. The dimension of range of motion (ROM) was the most consistently identified variable by both the experienced and novice observers. Nine of the ten subjects identified ROM, and they all identified this variable early in their observations. Half of the subjects mentioned this variable more than one time. As follow through was mentioned often and early by several subjects, this variable may have been perceived by both groups as an important characteristic of the movement.

TABLE 1.
Responses with highest frequencies

NOVICE (at least 3 responses)	EXPERIENCED (at least 4 responses)
1. range of motion (3 responses)	1. range of motion (6 responses)
2. velocity loss/weight transfer (3)	2. balance (6)
3. angle of projection (3)	3. step length (5)
4. axis of rotation (3)	4. axis of rotation (4)
	5. trunk involvement (4)
	6. approach speed (4)
	7. angle of projection (4)
	8. velocity loss/weight transfer (4)
	9. grip (4)
	10. stick extension at release (4)

Axis of rotation, an adjunctive concept to ROM, was also identified by 9 of the 10 observers, although not necessarily early in the listings. Perhaps, the frequent mention of this variable was due to the vigorous rotation of the various segments of the upper body in throwing the ball. The dimension of balance included both the balance of the body as well as the balance of the ball in the netting of the stick. This dimension was noted by

all of the experienced observers but only two of the novice observers.

The question of "when" was addressed by partitioning the discrete responses into those that occurred in the preliminary, propulsive, and post-propulsive phases (Hudson, 1990). Many observations could not be classified as referring to a single phase of the movement. For example, observations about range of motion could have referred to one, two, or three of the time intervals. Given that many observers made separate notations about follow through, it is probable that comments about "range of motion" were based on the ambiguous interval including aspects of preparation as well as propulsion. In total, almost one third of the observations could have been based on vague time intervals. The use of these vague intervals was more prominent in the experienced group: All six experienced observers but only two novices reported at least one variable with an ambiguous time base.

Combining the responses from distinct and ambiguous intervals, it appears that more observations were initiated in the preliminary interval than either the propulsive or post-propulsive interval. However, many of the observations which were initiated in the preliminary phase were continued into the propulsive phase, and, in some cases, into the post-propulsive phase. The importance of the preliminary phase to the observation process is substantiated also by the finding that all 10 subjects commented on events occurring in the preliminary phase.

Three of the expert observers commented on the release of the ball from the stick. These notations, represented the only cases of observation which could be construed as referring to a very brief instant of time. Overall, most observations could be conveniently classified in regard to the temporal intervals of preliminary, propulsive, and post-propulsive movement. However, there were 10 times as many observations which were based on larger instead of smaller intervals of time. This suggests that observers, both experienced and inexperienced, choose to use relatively diffuse rather than focused temporal intervals.

The question of "where" was addressed by classifying the discrete responses according to apparent spatial focus: somatic, sectional, and segmental (Hudson, 1990). The distribution of comments was 16% somatic, 63% sectional, and 21% segmental for the experienced observers and 31% somatic, 54% sectional, and 15% segmental. Thus, for both experienced and novice observers the dominant type of focus was sectional. The secondary choice of focus was relatively microscopic (i.e., segmental) for the experienced observers and telescopic (i.e., somatic) for the novice observers.

Within the somatic category, the most common observations concerned the speed of approach of the body and the sense of balance exhibited by the body. When the sectional focus was used, more responses concerned the upper body rather than the lower body. This is not surprising since the lacrosse throw is primarily an upper body movement. However, the lower body does make an important contribution toward the resultant ball velocity. The experienced observers seemed to recognize the importance of the lower body because most of their analyses included observations about step length (see Table 1). Only one novice observer commented on step length. Within the segmental category, the most common response was about the trunk. This could be due to the perceived importance of the trunk, the relatively slow movement of the trunk, or the large size of the trunk. Only one comment was made about a distal segment.

A summary of the what, where, and when of observing the lacrosse throw is given in Figure 1. The vertical axis of this continuum has the frequency of notation for each variable, and the horizontal axis has the time sequence for the movement divided by phases. The majority of the variables occur or can be identified by the end of the preparatory phase; less of the variables occur in other phases of the movement. It is possible, however, to identify some of the variables which first occur in the preparatory phase in a later phase of the movement. For example, the step length can first be identified in the preparatory phase of the movement, but can be assessed during the beginning of the propulsive phase if the observer finds it advantageous.

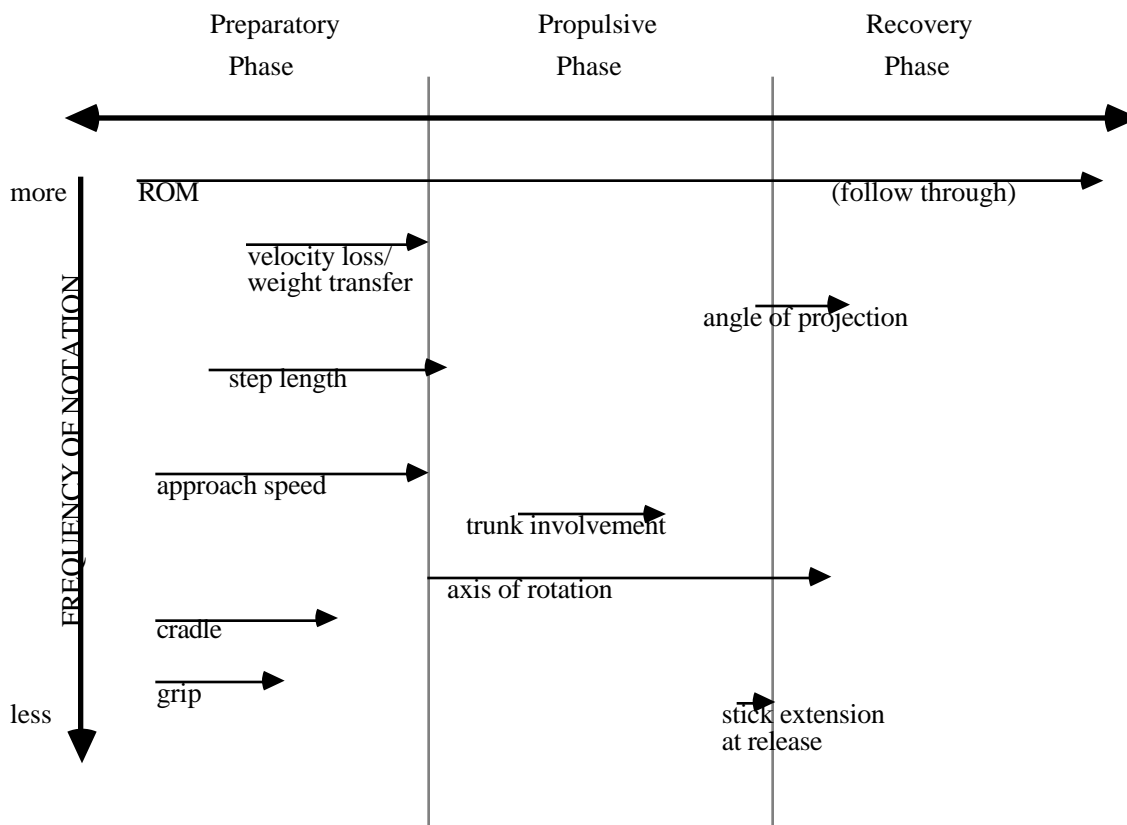


Figure 1. Continuum of Observation Responses. In this figure the length of the arrows represent the relative amount of time each of these variables could be assessed in this performance.

Several trends also seem evident from the analysis of the continuum. One is that components of the movement that happened at a slower rate were reported earlier in the observations of the subjects. This is not to say that these components occurred earlier in the movement, only that they occurred at a slower rate. Another trend is that although the observers tended to concentrate on the preparation phase of the movement more than the propulsion and follow-through phases, there was no tendency to report these components earlier in the comments.

Considering that a person may not be able to perceive something unless it is believed to be relevant, it is likely that the experienced observers reported more variables because they were aware of more critical features of the movement. From what knowledge base did this awareness of critical features come? In this study, the knowledge base was not familiarity with the skill as the task was a relatively novel skill for all observers. Given that all subjects, both experienced and inexperienced, were able to make observations about the movement, it is probable that most people can operate from an inherent knowledge base about skillful movement. Items that are relevant to the lacrosse throw which may be part of this knowledge base are listed in the novice column of Table 1. From the comments of the experienced observers it appears that they augmented this inherent knowledge base with a type of conceptual or qualitative biomechanics. Although many of these experienced observers had taken a class in biomechanics, it is unknown whether their conceptual base was instructed or self-constructed.

Beyond the issue of the content and source of the knowledge that undergirds observation, there are other questions which need to be addressed: Are the critical features that arise from the knowledge base useful in terms of modifying movement? What are the most important types of critical features to impart to observers? How can observers be effectively instructed about critical features and how to observe them? Is instruction about critical features dependent on the intellectual maturation of the observer? Do observers accurately perceive the features that they believe to be relevant? Are certain types of features more accurately perceived than others?

To answer these questions and others, a concerted effort will be necessary to link biomechanical knowledge with observational abilities. By clarifying this relationship we will help the coaches and teachers that rely on their observational skills to develop simple and effective plans to analyze the movements of their performers.

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