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RUNNING HEAD: IMPLICIT LEARNING IN SPORTS

Implicit learning as a means to intuitive decision making in sports

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Distinctions and dichotomies abound in research on cognitive processes, such as those between automatic and controlled processes (Shiffrin & Schneider, 1977), which are manifest in a number of domains. However, it is not necessarily useful to draw arbitrary distinctions merely for the sake of classification. We should ask ourselves (as researchers) whether such distinctions serve a useful purpose in terms of the theories and models of human behavior that we develop. Supposition of "dual processes" seems to have run its course in some fields, such as social psychology (Chaiken & Trope, 1999), where researchers now have mixed opinions about the need for this *a priori* assumption (Strack, 1999). In other fields, there seems to be a longstanding, pervasive, and (most importantly) empirically-supported tendency to endorse a discrete division—such as that between implicit and explicit learning styles (Stadler & Frensch, 1998).

Recently, there has been renewed interest in applying such a dichotomy to judgment and decision processes; primarily, this results in a distinction between intuitive and deliberate decision making (Sloman, 2002). The current chapter seeks to integrate the learning style and decision process distinctions in a common framework that allows us to explore their usefulness. Specifically, we analyze decisions in sports —a real-world domain for dynamic decision making under time pressure—with an emphasis on how learning style and decision process are related.

The remainder of the chapter is organized as follows. First, we describe what we refer to as a decision protocol (cf. Orasanu, & Connolly, 1993), in order to see exactly what processes may be described as intuitive or deliberate, and how learning impacts subsequent decision making. Second, we briefly review and summarize some relevant literature on the distinction between intuitive and deliberate decision making in sports, and likewise for the distinction between implicit and explicit learning styles. Ultimately, we provide a synthesis of these four (previously independent) concepts in a new model.

A protocol for sports decision-making

What exactly does making a decision entail? There are many phase models of decision making in the literature (Koehler & Harvey, 2004), but we borrow the decision protocol of Orasanu and Connolly (1993) because it includes the execution of decisions that is especially relevant when considering sport decisions. We ~~outline~~ apply what Orasanu and Connolly believe to be the seven key components of a decision to the domain of sports; this will be useful for operational definition in the remaining sections. We note that not every decision situation will be comprised of all seven of these stages. However, these seven stages are particularly relevant for the sports domain that is the focus of this chapter. The sports domain offers a chance to explore real-world decisions, made by motivated and experienced agents, in rich environments under various conditions (e.g., uncertainty, time pressure). We take advantage of this natural opportunity to study decision making that occurs outside of the lab, on the playing field.

The first step in a decision is the *presentation* of the problem. While this may seem to be a trivial or obvious "step," it is actually the focus of a great deal of research in judgment and decision making—such as work on framing effects (e.g., Tversky & Kahneman, 1981). That is, the subsequent steps of a decision are not independent of the manner in which a decision is encountered, or the way it is presented. The next step is the *identification* of the constraints, resources, and goals facing the decision maker. These properties can be specific, such as limited time or information available, or they can be abstract, such as the goal of maximizing expected payoff. Third, the *generation* of possible solutions to the problem, or courses of action, occurs. This step in particular may not be relevant to many laboratory decision-making tasks, where participants are often presented explicitly with the options from which they must choose.

The fourth step of the decision-making protocol, *consideration* of possible solutions, is the one typically regarded as representing the whole of the decision-making process. By this, we imply that the first three stages are often taken for granted—if they are appreciated at all—in much decision-making research. Similarly, the next two stages are rarely dissociated from the output of the consideration phase. *Selection* of a course of action is generally seen as synonymous with identifying the "winner" of the consideration phase; and *initiation* of the selected action is almost always seen as a straightforward extension of a mentally-selected option to a physically-realized one. Finally, the last stage of a decision protocol is the *evaluation* of the decision made, including the appraisal of feedback information, if any exists.

We offer a brief sports example to illustrate each of these seven stages. Imagine a forward in soccer who is dribbling towards the goal and is approached by a defender. At this point, the decision problem has *presented* itself: what action to take in response to the approaching defender. The forward *identifies* the constraints on his behavior (e.g. he cannot pass offside) and prioritizes his goals (e.g. above all retain possession, but score if possible). In light of these, he *generates* possible options that he may undertake, such as shooting at the goal, passing to a wing player, or dribbling away from the defender. He *considers* these courses of action, perhaps by ranking them according to their likelihood of achieving his top goal (retaining possession).

Then, he *selects* an action; this is likely to be the one with the highest rank. He *initiates* the action by physically performing so as to bring about the action he selected (e.g., physically dribbling the ball to the right). In doing so, he buys time for the wing player to streak towards the goal, where he passes the ball and assists in a score—resulting in positive *evaluation* of his decision.

Intuitive and deliberate processing in sports

To begin our discussion of intuitive and deliberate processes, we must be careful to employ a particular operational definition. Intuitive processes are generally assumed to be automatic activations of (semantic) networks (Anderson, 1983). We follow suit in defining intuitive (as opposed to deliberate) decisions as fast decisions that are based on a perceived pattern of information that is often linked automatically to a specific action or sets of actions (see Hogarth, 2001). However, we want to stress that routine behavior is not the same as intuitive processes. Rather, the latter may serve as a basis for the former, especially in the absence of creative or emotional aspects not in line with an automatic information processing perspective (Schönpflug, 1994, but see Lieberman, 2000). Therefore the link between intuitive processes when deciding and the preference to use these (as opposed to deliberative) processes is derived through tacit information accumulated over long-term experience (see Epstein, this Volume).

We prefer to view decision-making style as a continuum, rather than as a dichotomy (cf. Hammond, 1996). That is, rather than classifying behavior as intuitive or deliberate, it may be more fruitful to consider a spectrum of decision-making *processes*, with these two extremes. Because decision-making processes cannot be directly observed, they are often operationalized by measures such as deliberation time or susceptibility to dual task interference (e.g., deliberate processes are slower and more susceptible; Kahneman & Frederik, 2002). In this context, we only have ordinal relations to claim one process is “more intuitive” than another, or we must introduce some threshold or criterion for determining, e.g., how quickly a process must occur to be considered “intuitive.” With this continuous nature in mind, we can now describe what “more deliberate” or “more intuitive” decision making suggests for the relevant stages of our protocol.

Intuitive and deliberate processes in the decision protocol

We can precisely localize the influence of intuitive vs. deliberate processes by utilizing the seven-stage schematic developed in the previous section. That is, we can now see exactly where and how intuitive decisions may differ from deliberate ones. When one speaks of intuitive and deliberate decision making, it does not necessarily mean that the entire protocol is performed intuitively, or deliberately. Rather, we should independently consider each phase of the decision protocol. For example, the *presentation* and *identification* of information for the aforementioned soccer player may foster intuitive processes only if a coach constructs situations of high time-pressure. Indeed, we conceptualize the distinction between these two processes primarily in the third and fourth stages (generation and consideration)—the key internally-active segments of the decision-making protocol. Traditionally, these two stages have not been considered together in decision-making research. There has been relatively little research on how options are generated—because they are often explicitly presented in experiments—and even less relating option generation to subsequent consideration and selection (for notable exceptions, see Johnson & Raab, 2003; Klein, Wolf, Militello, & Zsambok, 1995). Nevertheless, we can employ concepts and results from previous research in determining which decision-making process may result.

Option generation can be performed deliberately, where rules may dictate how to develop viable solutions to a problem (Sloman, 2002). In contrast, option generation may be akin to spreading activation in a representation network, proceeding with little conscious effort or direction (Johnson & Raab, 2003). For example, suppose the first option generated by the soccer forward in the example above is a pass to the right wing player. Depending on the organization of the forward's internal corpus of options, spreading activation would suggest that options that are most similar to this first option would be generated next (Johnson & Raab, 2003; Klein, et al., 1995). If similarity is based on the spatial attributes of options, then perhaps the next generations may be passing to the right fullback, dribbling to the right, shooting to the right of the goal, or lobbing to the right corner. In contrast, deliberate option generation suggests more formal rules for determining the order of generated options. Perhaps training has taught the forward to always generate passing options prior to shooting options, which would change the order of generated options (and the options themselves) in our example.

Consideration of the generated options occurs independently from the generation process—intuitively generated options may be considered deliberately, for example. A great deal of research has examined intuitive vs. deliberate processes of consideration, to which we cannot devote a great deal of discussion here (see chapters in this book for an overview). Intuitive consideration may involve little or no actual "consideration" at all: favor what is most salient, or most readily comes to mind; see if each option, in turn, is sufficient on all attributes; do what one did the last time; etc. A deliberate process may involve relatively simple rules or heuristics (e.g., Gigerenzer, Todd, & The ABC Research Group, 1999), or more cognitively intensive algorithms such as weighted summation.

Evidence for intuitive and deliberate processes in sports

In keeping with the focus of this chapter, we will provide some examples of intuitive and deliberate processes from the sports domain in particular, rather than an extended general review. It seems plausible that different types of decisions in sports may be conducive to differential processing. For example, a coach may use deliberate and careful analysis of countless statistics to decide which pitcher to use in late relief of a baseball game. In contrast, a streaking basketball player on a “fast break” may need to trust her intuitions on whether to pass or shoot. In sports, verification for suppositions such as these has just started to develop. This evidence is primarily the result of an effort to show that intuitive decision making can be at least as successful as more deliberate strategies.

The *presentation* of information to athletes, and their subsequent *identification* of the situation, are often varied by the amount and type of instruction or feedback a coach employs. For instance, setting up a tactical game-like situation or scrimmage without much instruction may result in generally intuitive processes, compared to guided-discovery instruction of an if-then rule associated with specific attack training (Smeeton, Williams, Hodges, & Ward, 2005). In sports, such rule-based instructions are widespread and commonly used to produce deliberative processes when deciding. For instance, educational concepts such as Teaching Games for Understanding (McMorris, 1998) provide learners with explicit knowledge and encourage deliberative thinking about tactics before training such skills.

A recent study on option generation and resulting choices provides evidence for the presence—and perhaps the superiority—of intuitive option *generation* in sports. Johnson and Raab (2003) demonstrated that intuitive option-generation results in better choices than deliberate and prolonged option generation in experienced handball players. Their Take-The-First heuristic describes how people generate options in a given situation and choose among them. The heuristic consists of an information search rule (i.e. *generation*) and a decision rule (i.e. *consideration*). The search rule suggests that the stimuli trigger the first option generated, which then serves as a point from which option generation proceeds (see also Klein, et al., 1995). Subsequent generation is characterized as spreading activation driven by the (dis-)similarity between options (represented in a semantic network) as well as the strength of the option and the stimuli presented.

In the research reported by Johnson and Raab (2003), participants with different levels of handball expertise performed a video decision task, where they were shown an attack situation that was “frozen” when a particular attacker received the ball. Participants were asked to assume the role of this player and to (a) immediately speak the option that “intuitively” came first to mind, then (b) generate as many options they thought would be appropriate, and finally (c) pick the best option for this situation, from all options that were generated. In support of the heuristic’s proposed intuitive generation process, initial options were reported immediately upon the onset of each trial, and subsequently generated options could be classified by their similarity to the initial option.

Johnson and Raab (2003) also provide support for intuitive processes in choosing (i.e. *selection*) among the generated options. Specifically, chosen options were often among the first generated, suggesting that participants trusted their instincts, electing to “Take the First” rather than perform an algorithmic comparison among options. Furthermore, this quick process seemed to produce better decisions than longer, more deliberate consideration of the options. Further evidence for the benefits of intuitive consideration come from Halberstadt and Levine (1999), who used a framework of Wilson and Schooler (1991) that distinguishes between “intuitive” and “reflective” (deliberate) processes. They asked self-described basketball experts before actual basketball games to predict the outcome. Half of the spectators were asked to analyze and list reasons for their predictions, while the other half were instructed *not* to analyze their reason but predict intuitively. The results indicate that deliberate reasoning results in fewer correct predictions.

Finally, evidence for intuitive and deliberative decision making is quite marginal in the last two stages the protocol (initiation and evaluation). For instance, in ice hockey defensive tactics, both the initiation of eye-fixations to important parts of the ice and the resulting defense movements are fast and intuitive by elite players but slower and more deliberative by non-elite players (Martell & Vickers, 2004). Furthermore, there is some evidence that giving batters in baseball minimal feedback for evaluation of their decisions enhances batting skills in transfer and retention; however, full feedback for decision evaluation enhances batting skills during acquisition (Vickers, Livingston, Umeris-Bohnert, & Holden, 1999).

Both intuitive and deliberate processes seem to be used to differing degrees in the various stages of the decision-making process in sports. It is important to consider what factors might determine whether any given situation will be processed more deliberately or more intuitively. We propose that the learning style of the decision maker is a key factor, and therefore turn now to an introduction of learning styles in sports.

Implicit and explicit learning styles

A very common distinction in learning is the level of how much explicit information is given to the learner (i.e., implicit vs. explicit learning dimension; see Stadler, & Frensch, 1998, for an overview). The concepts of implicit and explicit learning may be best explained by looking at the learning situation itself. Situations in which actions are incidental in nature engender implicit learning, whereas situations in which actions are intentional in nature engender explicit learning.

Incidental learning (Perrig, 1996; Thorndike, & Rock, 1934, p. 1) is learning in a situation without the intention to learn, or without explicit knowledge about the underlying rule structure of the situation. For instance, in language comprehension and production, native speakers learn through immersion, naturally picking up cues and proper syntax, grammar, semantics, etc. In contrast, learning a language from foreign language textbooks or courses often results in more explicit study of linguistic structures, rules, and exceptions.

In sports, tactical decisions learned through playing "pick-up games" may result in good but non-verbalizable individual decisions. For example, the acquisition of if–then rules, whereby a learner performs in specific situations (if) with specific actions (then), relies mainly on implicit learning (McPherson, & Thomas, 1989). Yet, there also exists the possibility of explicit learning of rules and strategies. If a player is introduced to an attack situation by a coach using a blackboard demonstration and skill-like training, repeating the same movement in one context, then she will likely produce verbalizable knowledge of these rules and rely more on explicit learning.

Implicit and explicit learning are generally still treated as dichotomous, even though both can occur for any one decision. However, recently the adoption of a continuum and interactions between these learning styles has become more prominent (Rossetti, & Rovunsou, 2000; Sun, Slusarz, & Terry, 2005). We, too, advocate the viewpoint that these two learning styles, much like intuitive and deliberative processing of the previous section, exist on a graded continuum. Therefore, as in the previous section, we can examine ordinal relations (e.g., more implicit) within the framework of our decision protocol.

Implicit and explicit learning in the decision protocol

Implicit and explicit learning processes can be mapped to a continuum describing the nature of feedback. For instance, complete lack of instruction about task goals, cue importance, cue utilization, and ideal performance would be characteristic of feedback fostering completely implicit learning. In contrast, extensive training in the desirable outcomes of a task, as well as what cues to use and how to use them in achieving the outcome, describe explicit learning. In reality, many situations may provide a moderate degree of feedback. This may be in the form of only some explicit instruction (e.g., which cues to use, but not how to integrate them), or explicit feedback only some of the time (e.g., partial reinforcement). We now explore exactly where these forms of feedback occur in—and how they subsequently influence—the decision protocol.

Distinctions between implicit and explicit learning play a key role in the first two stages of the decision protocol. First, a decision situation may be *presented* in a manner that highlights either an implicit or explicit goal or knowledge structure. Performance on objectively identical experimental tasks can vary greatly depending on the domain frame, the instructional set (Reber, 1967) or "cover story" (Ceci, & Liker, 1986). For example, even if implicit, non-verbalizable rules are successful in one situation, such as handicapping horse races, these may not transfer to more abstract situations that rely on explicit application of the same rules (Barnett & Ceci, 2002).

Second, the type of learning in a task can affect the *identification* stage of subsequent encounters. We restrict ourselves here to just a couple illustrative examples of identification processes —goal identification and identification of relevant information. In determining the appropriate goal(s) in a situation, explicit learning provides specific, relatively stable goals in well-defined tasks. In contrast, purely implicit learning involves tasks that are more ill-defined, without precise goals or performance metrics. Explicit learning, in many cases, includes detailed and specific tenets for information search and importance—e.g., first determine if the defense is zone or man-to-man, then count the number of linebackers, and so on. Information handling is not precisely governed when implicit learning is involved, but rather a quarterback perhaps scans the downfield defense and notices something that "sticks out," such as single coverage on a star receiver.

The distinction of implicit and explicit *generation* and *consideration* of options is widely present in sports. For instance, in the last twenty or so years a number of sport associations development handbooks to describe how to verbalize the kind of options that should be generated and considered in a specific situation. These so called situation-method references are still used in different sports such as golf, softball, tennis, badminton, and many more (Griffin, Mitchell, & Oslin, 1997). We believe that implicit or explicit *selection* and *initiation* is mainly influenced by the preceding stages, although relevant empirical evidence is quite scarce.

The role of learning is manifest most overtly in the seventh stage of the decision-making protocol. Specifically, learning involves *evaluation* of the decision outcome and incorporation of feedback for the purpose of adapting future behavior. That is, learning describes how the evaluation of previous decisions affects (primarily) identification and consideration in subsequent decisions. Feedback itself can be characterized as more implicit or more explicit. If successful performance is clearly defined and/or rewarded, it is possible to distinguish the behavior giving rise to this performance in an explicit manner. If, on the other hand, performance is more difficult to assess, then reinforcement of the causal behaviors is more subtle or implicit.

Evidence for implicit and explicit learning in sports

Whereas the implicit versus explicit learning distinction is well-known in cognitive psychology, this distinction has been rarely used in sports psychology (see Masters, 2000; McMorris, 1998; and Raab, 2003 for exceptions). Furthermore, the advantage of one learning style over the other in sports decision making (see Raab, 2003, for an overview) is rarely empirically investigated. We briefly review research from sports psychology that supports our theoretical discussion of the influence of learning style, including work that compares performance between learning styles.

The influence of implicit and explicit learning on the presentation and identification in sports tasks was discussed recently in a review indicating that the amount and kind of instruction as well as the organization of training situations lead to different (re)presentations of tactical knowledge and amount of transferability between different situations (Raab, in press). For instance, the instruction of the coach or the situational characteristics of training determine the learning style of if-then rules for mapping situational factors to choices. Furthermore, different instruction techniques influence the identification of constraints and goals, which in turn affect transfer of this tactical knowledge across sports or situations. Unfortunately, influences of learning styles on *generation* are not empirically investigated in sports to the best of our knowledge.

The *consideration* and *selection* processes are also impacted by learning style. In a series of experiments (Raab, 2003), novices were trained either implicitly (observational training) or explicitly ("if-then rules") to learn tactical decisions in sports situations of varying complexity. Directly after training and four weeks later, they were required to make allocation decisions in a retention test. The results suggest that implicit learning of tactical situations results in nonverbalizable, intuitive decision making—when implicit learners were asked to recall or recognize the rules underlying the situations, they were unable to do so. When prompted or required to learn implicitly, gleaning situation structure and responding correctly are often naturally salient, and explicit information interferes with this automatic encoding. This conjecture is also supported by differences in performance, as measured by choice quality and decision time, based on learning condition.

In terms of performance, implicit learners outperformed explicit learners in low-complexity situations (manipulated by perceptual similarity or the number of if-then rules). However, in highly complex situations, explicit learners surpassed implicit learners, benefiting from instructions to focus on specific "information-rich" elements of the situation. This basic finding was replicated in different sports such as basketball, handball, and volleyball (Raab, 2003)—all sports in which allocation decisions had to be made quickly.

The *initiation* and *evaluation* processes of movements are influenced by implicit and explicit learning styles as well. For instance, initiation of movements are mainly implicit by default and research of this initiation process is reviewed in sports quite often (see Jackson & Farrow, 2005, for a recent overview). Self-evaluation based on explicit learning is present in sport concepts such as Teaching Games For Understanding (Griffin, Mitchell, & Oslin, 1997), where athletes are asked after their movements to evaluate and explain their choices. Contrary self-evaluation is also implicitly learned through active comparisons of the anticipated consequences and the real consequences of an intended movement. These comparisons can be learned implicitly and need not be verbalized by the athlete (Hoffmann, 1995).

Taken together, the results presented so far have strong implications for the relationship between (implicit/explicit) learning style and (intuitive/deliberate) processing. Specifically, the results of Raab's (1993) study suggest a disposition for more intuitive processing in implicitly-learned situations, as evidenced by dependent measures (e.g., response time) and self-report. Motivated by the state of the current research, we turn now to a formal elaboration of the relationship between learning style and intuitive/deliberative processing. To anticipate our main hypothesis, we believe there is a strong coupling between implicit (explicit) learning, and intuitive (deliberate) decision-making processes.

Synthesis of learning and processing styles in decision making

In the previous two sections we localized within the decision protocol of Orasanu and Connolly (a) the source of distinction between intuitive and deliberate decision making, and (b) the differential effects of implicit and explicit learning. In this principal section, we tie these points together to make general propositions about the relation between learning and processing styles in decision making (Figure 1).

INSERT FIGURE 1 ABOUT HERE

Figure 1 demonstrates the simple relationship between learning style (solid lines) and decision-making processes (dashed lines), within the protocol introduced in this chapter. Note that Figure 1 has been simplified in that intuitive processes are tied to implicit learning and deliberative processes are tied to explicit learning. However we are aware that intuition may not be only a result of implicit learning but can be also learned explicitly and by experience becomes automatic. Furthermore, we should reiterate that we adopt the viewpoint that both learning and processing style exist on continua, rather than as discrete types (although Figure 1 is simplified in this respect as well). We now detail the relationship between learning and processing style and across decision-making stages.

First, we propose that learning style exerts the strongest influence on the presentation and identification stages, as discussed earlier; this is illustrated by the solid lines traversing these stages in Figure 1. For example, explicit learning is more likely to include direct instruction (presentation) and promote identification of particular goals or attributes. In contrast, implicit learning by definition does not include formal instruction, and relies on the decision maker to identify appropriate task-relevant information, constraints, goals, etc.

Second, based on the presentation and identification characteristics, in conjunction with the learning history, subsequent processing proceeds either more intuitively or more deliberately (dashed lines in Figure 1). Assume that a decision agent is faced with a task on numerous occasions. Sometimes task features provide the means for executing explicit strategies, but otherwise behavior is more “trial-and-error.” The former results in explicit learning of the appropriate associations (which options to consider, and how to do so), whereas the latter results in subjective updating of which options are appropriate. That is, implicit learning (and its associated task features) is more likely to produce intuitive decisions, while explicit learning characteristics will tend to initiate deliberate decision making.

In cases where a strategy is explicitly learned, and validated through feedback evaluation, those options conforming to the explicit rule are deliberately retrieved (generated). Continued application of the prescribed rule dictates subsequent deliberate consideration. In contrast, when implicit learning is necessary, option generation is less precise because it is based on variable reinforcement strengthened only through successful experience. Then, there also exists no rule for formally considering the generated options, and "intuition" prevails (e.g., perhaps in the form of some inherently-favored heuristic). The selection and initiation of options is then influenced by the processing of the previous stages.

Finally, feedback (evaluation) is the criterion primarily used to classify learning as implicit or explicit; this is shown by solid lines at the bottom of Figure 1. In other words, it is the nature of feedback that we use as an operational definition for learning style. This, in turn, determines the corresponding features of task presentation and identification that begin the decision protocol anew.

Consider the following concrete example of an attack situation in sports. In hopes that his players will adopt a particular strategy, a coach uses a blackboard to diagram an upcoming play. The coach then describes the intended outcome of the play (e.g., an uncontested shot), and identifies which members of the opposing team should be taken most seriously. These support a subset of distinct strategies (e.g., sequences of ball movements) the coach approves, depending on physical position of the key defenders. The players are told which options are better under which circumstances, and what criteria to use in deciding whether to select an action (e.g., defender distances). During an ensuing timeout, the coach discusses with his players their performance, to assist in future use of the same play.

In the above example, the coach was hoping for explicit learning of a deliberate decision schema, so he *presented* the problem formally on a blackboard. He *identified* the important information and the goal of the situation, as well as how to use this information. The players, as a result, were afforded the ability to use deliberate processes during the play: first, to *generate* a specific subset of successful actions; then, to use a rule about defender distances in *considering* which action to perform; then to *select* the appropriate option and to *initiate* it. The feedback from the coach during the timeout allows players to *evaluate* their performance, and allows the coach to tailor his instruction in future instances based on the players' errors (or lack thereof).

It is important that we stress a few qualifications about our model as shown in Figure 1. First, we maintain that processing occurs independently of learning style, but suggest that there is a high degree of correlation between them. That is, although they are distinguished by line type, there are tendencies to see the cycles indicated that pair one type of processing and learning. However, we do not suggest that behavior proceeds deterministically according to our depiction. There are certainly cases where more implicit learning can give rise to deliberate processes and vice versa. For example, over time, a strategy that is acquired through explicit learning—such as the coach's diagrammed play above—may become automatic as a result of continued use that then elicits more intuitive processing; or behavior learned implicitly may be verbalizable as an explicit strategy by think-aloud protocols and therefore promotes deliberative processing. Keep in mind also that the concepts of deliberate and intuitive processing are poles of a continuum, not discrete operating modes.

Situational factors, although not shown in the model, are also of vital importance in decision making. The situation or environment influences the exogenous characteristics such as the presentation (e.g. instruction, format, etc.), identification (e.g. attention, importance weighting, etc.) and feedback (e.g. correct/incorrect) that affect the endogenous stages of generation and consideration. It remains to be seen the extent to which these situational factors correlate to each learning type. That is, as discussed earlier, certain task features would certainly be more conducive to each learning style. This presents a challenge, however, in determining the unique (independent) effects of situational factors that are not mediated by the role of learning style.

Conclusions and future directions

Two lines of research were merged: one favoring the distinction between intuitive and deliberate decisions, the other contrasting implicit and explicit learning of decision making. The benefit of this simple framework is to formally define the coupling of implicit learning to intuitive decision making, and of explicit learning to deliberate decision making. Furthermore, we have couched this model within specific stages of the decision-making process. Each of these key advances is open to future empirical investigation.

Note that we do not claim that either type of learning or processing is globally superior; rather, depending on the situation and/or the individual, one way of deciding or using experiences may result in better choices than another. Based on the findings cited herein, for example, it seems that implicit learning may help in less complex situations and explicit learning in more complex situations. Furthermore, intuitive decisions may result in good decisions in experts but not necessarily in novices because they lack representative sampling due to their relative paucity of experience. The wide variety of task/context effects and individual differences that interact with learning style and intuitive/deliberative processing to affect performance should benefit from future research; as we see it, many key questions remain. What are the situations and individual differences that determine whether intuitive or deliberative processing may be more successful? To what extent is implicit learning the basis of intuitive processing?

Finally, theoretical and practical implications can be derived from our framework. Theoretically, implicitly-learned intuitive decisions reflect an opposition to rational models of decision making that claim that more information and careful deliberation reign supreme. However, we do not know exactly what mechanisms drive the implicit acquisition of structure from the environment that helps to discover principles and develop strategies for improving decision techniques. Practically, it is useful to develop decision training programs in sports as well as in other contexts that appreciate when intuitive versus deliberate thinking helps to make good decisions (Klein, 2003; Raab, 2003). A recent review of training programs revealed that these can be placed along the implicit/explicit learning continuum (Raab, in press). Furthermore, some training programs widely used in school and club settings in Canada, France, Germany, UK, and USA promote a sport-specific perspective (i.e., becoming an expert in soccer requires only soccer training). Other approaches endorse a general perspective that a wide experience in different sports and training of abilities will transfer later to specific performance as well. We do not know yet how much the dimensions of learning style and specificity influence the effectiveness of intuitive and deliberative decision making in sports. However, the current state of the art suggests that if most situations in the target sport reveal high need for fast decisions, then intuitive processes may provide the desired quickness and (especially through experience) accuracy.

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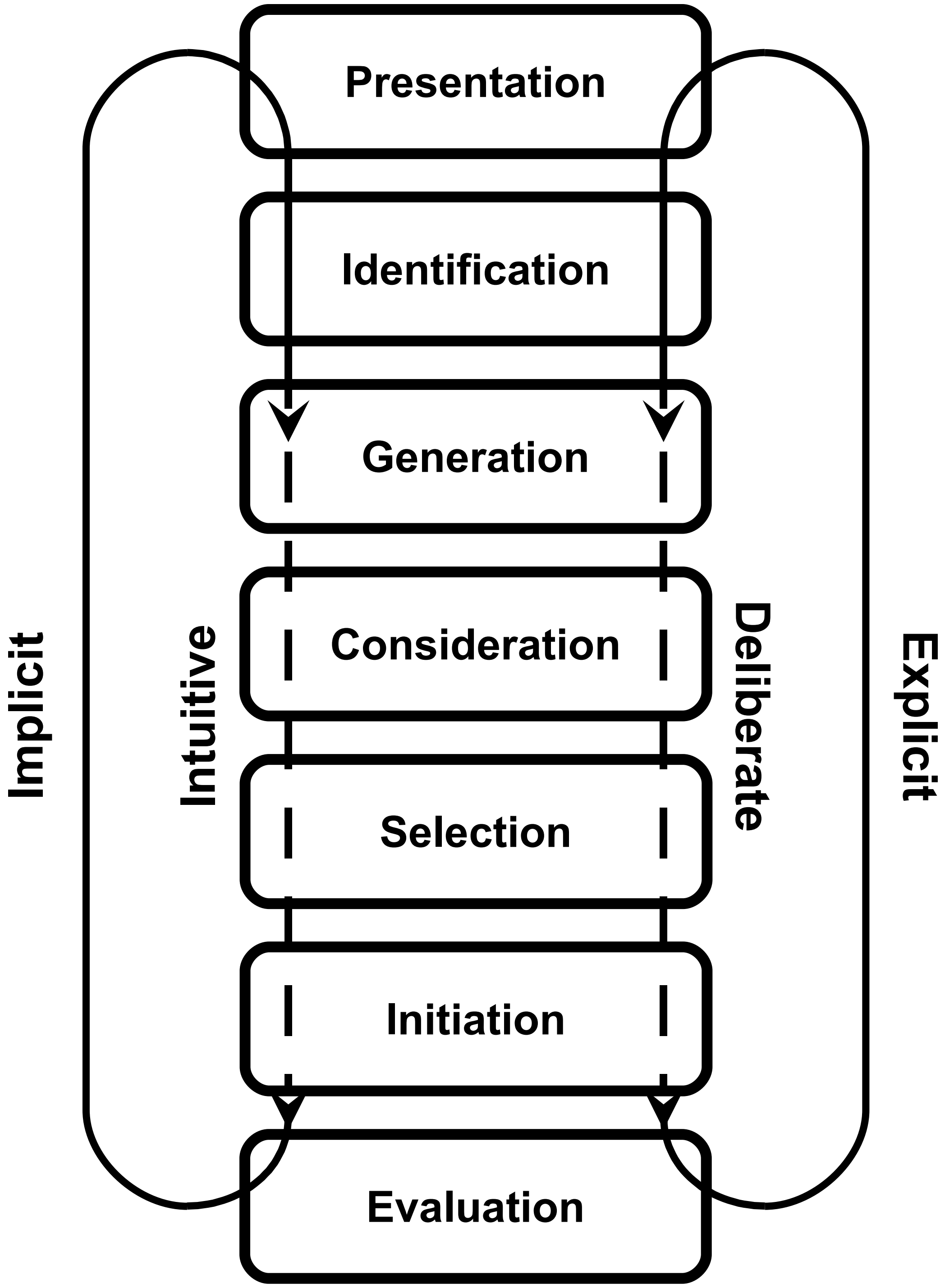
Figure Caption

Figure 1. Simple model relating learning and processing styles, within a general theoretical decision-making protocol. Learning styles are solid lines and decision-making processes are dashed lines. Note that Figure 1 has been simplified in that intuitive processes are tied to implicit learning and deliberative processes are tied to explicit learning.


Presentation
Identification
Generation
Consideration
Selection
Initiation
Evaluation
Implicit
Intuitive
Deliberate
Explicit