BJMB
Brazilian Journal of Motor Behavior

Special issue:
The role of practice in motor learning

It's not the type of practice that matters, it's the attitude: The impact of playful practice on motor skill learning

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https://doi.org/10.20338/bjmb.v16i2.278

ABBREVIATIONS
KR Knowledge of Results

PUBLICATION DATA
Received 13 12 2021
Accepted 28 02 2021
Published 01 06 2026

ABSTRACT
The traditional approach to practice has focused on the physical structure of practice, manipulating parameters like duration, spacing, task variations, practice order, and whether tasks are practiced in parts or as a whole and physically or mentally. The emergence of the deliberate practice framework shifted the focus to the learner's attitude or mindset toward practice. It argues that the most effective practice involves a consciously effortful, workman-like approach to remedying weaknesses in performance. In the current paper, we build on the notion of deliberate play that arose in response to the deliberate practice framework. Rather than view deliberate play as a forerunner to deliberate practice, we argue that a playful approach to practice can benefit the learning process at any stage of learning or skill development. We draw on contemporary research in motor learning and development, in developmental and evolutionary psychology, and in education to highlight the benefits of a playful approach to practice on motor skill learning. We end with practical suggestions for encouraging a playful approach to practice and learning.

KEYWORDS: Deliberate play | Deliberate practice | Goalless learning | Mindfulness | Play

INTRODUCTION

What is the most effective way to organize practice to facilitate motor skill learning? This question has motivated and puzzled researchers and practitioners at least since the origins of the modern field of motor behavior. Theories imported from experimental and developmental psychology, in combination with the practical needs of learners and society, have influenced approaches to answer this question and the volume of research devoted to it. For example, the publication of Hull's (1943) theoretical treatise *Principles of Behavior* [1] spurred considerable interest in the topic of distribution of practice according to Adams (1987), during what Adams referred to as the Middle Period of research on motor learning [2]. Similarly, the publication of Schmidt's (1975) schema theory stimulated substantial interest in the virtues of constant versus variable practice, ultimately leading to a major proliferation of research on the scheduling of variable practice relative to the contextual interference continuum [3]. On the other hand, the exigencies of World War II, which were significantly different from previous conflicts, spurred research on whole versus part-whole practice given the military's need to train personnel quickly to acquire a range of complex skills [2].

These examples – practice distribution, constant versus variable practice, the scheduling of variable practice, and part-whole versus whole practice – relate to the physical structure of practice. Further, these practice variations can be controlled easily by the experimenter or practitioner by manipulating parameters like time, spacing, number of practice variations, the interleaving of practice trials, and the components of tasks. The ease with which these parameters can be varied likely accounts for the large volume of research these practice variations have attracted, particularly during the latter half of the last century. Notably, that volume of research has decreased considerably since the Millennial (see Magill & Anderson, 2021) [4].

Coincident with the decline in interest in how the physical structure of practice influences learning was a surge of research inspired by Anders Ericsson's expert performance approach and its introduction of the concept of *deliberate practice* [5]. The questions raised by the expert performance approach were particularly interesting to scholars and practitioners interested in the identification and development of talent in sport [6]. The deliberate practice idea shifted focus away from the optimal structural parameters of practice toward the attitude or mindset the learner had to practice and the nature of the activities the learner engaged in during each practice session. Although the definition of deliberate practice has shifted since the term was introduced [7], deliberate practice has some defining characteristics. For example, deliberate practice is designed specifically to improve the current level of performance and is often directed to overcoming weaknesses. Practice is adapted as skill improves and it requires focused attention, immediate feedback, repetition, and high levels of effort. Deliberate practice is neither inherently enjoyable nor intrinsically motivating and is often frustrating. In essence, it can be characterized as a workman-like approach to practice [5]. The dour characterization of practice offered by the expert performance approach caused many sport scientists to question whether deliberate practice was the primary way in which learners developed expertise in sport.

Following interviews with athletes, parents, and coaches, which indicated that many athlete's first exposure to sport was fun and playful, Jean Côté introduced the term *deliberate play* [8] as an alternative or complement to deliberate practice. Deliberate play involves activities that are intrinsically motivating, provide immediate gratification, and are designed to maximize enjoyment. However, unlike deliberate practice, which is typically structured and monitored by a teacher, deliberate play is informally regulated by modified rules that are established, enforced and further modified by the participants themselves. Deliberate play became a central feature of Côté and colleagues' Developmental Model of Sport Participation, which argues, among other things, that early exposure to deliberate play prior to later engagement in deliberate practice has a beneficial effect on talent development in sport [9]. We take this idea a step further in the current paper.

We argue that exposure to *playful practice*, or more specifically a playful attitude toward practice, has intrinsic value regardless of the learner's stage of learning or skill development. From a broad perspective, the various approaches to practice can be organized along a continuum from pure play to deliberate practice. However, there is no obvious reason why more playful approaches to practice need to precede more deliberate approaches to practice, even if this seems to be the case when skill development is viewed ontogenetically and the challenge in the practice context needs to be adapted as skill increases. In the following sections, we briefly outline the key features of play and then discuss how playful practice might enhance motor learning. We end by describing how practitioners might encourage playful practice. Before continuing, we must confess that the ideas expressed in this paper are still embryonic; they require further development. However, we hope this paper will serve as a starting point for debate and discussion on the potential role of playful practice in motor skill learning and development.

CHARACTERISTICS OF PLAY

Play is difficult to define, though scholars often view play as the opposite of work [10]. Extensive research on play in anthropology, psychology and education also indicates that it is an important contributor to learning and socialization throughout life [10], potentially via a "playful" learning mechanism [11,12] and evolutionary processes [13]. Play, which is prevalent in many species, follows an inverted-U development, peaking in the juvenile period when the pressure to perform up to particular standards is low and waning thereafter [13]. All forms of play tend to follow exploration, ontogenetically. For example, infants spend more time exploring than playing and toddler play only begins to displace exploration when the environment is familiar, though infants, toddlers and children explore new objects before playing with them [13]. The structure of play is highly variable and appears to lack immediate purpose, yet play is intrinsically motivating and involves experimentation with objects, the environment, one's own body and motor patterns, and/or with other organisms. The animal's preoccupation during play appears to be driven more by means rather than ends (goals); further, in play, the combinations of motor patterns is greater than in almost any other form of behavior [12].

Scholars consider play adaptive because it increases behavioral variability, which in turn leads to the discovery of novel or innovative action patterns or combinations of behaviors that can be propagated to other individuals via observational learning [11–13]. Play appears to stir the imagination and encourage a sense of adventurousness. One can observe novel behaviors first appearing in play in later goal-directed activity. According to Bruner [11], play provides an excellent opportunity to try combinations of behavior that an animal would never, under functional pressure, attempt. This pressure free context maximizes variability because it minimizes the consequences of one's actions, and therefore risk, and encourages an extension of behavioral limits. Wide variation in behavioral patterns then provides a base upon which selection can operate. Bruner [14] argues that for behavior to be highly flexible play must precede it. The benefits of play are generally realized over the long term, thus if the interest is in short term gains in performance under narrowly constrained contexts, the value of play is less obvious [10].

HOW PLAYFUL PRACTICE MIGHT ENHANCE LEARNING

Given the aforementioned characteristics of play, we now speculate on the potential ways in which playful practice might enhance learning. We build our case by interpreting findings from the motor learning and educational psychology literatures relative to the characteristics of play and, by extension, playful practice.

Enhanced Exploration

As noted earlier, exploration and play are closely connected during ontogenetic development. Exploration features centrally in contemporary theorizing about motor learning and development inspired by the ecological approach to perception and action and the dynamical systems perspective. Gibson made a distinction between movements that are performatory (executive) or exploratory (investigative) [15]. Performatory movements accomplish some behavior in the usual meaning of the term whereas exploratory movements serve to reveal and pick up information. The distinction between these two types of movements led Gibson [16] to claim *"We must perceive in order to move, but we must also move in order to perceive"* (p.223); a claim which highlights the value of exploratory movements prior to and during goal-directed behavior in detecting and utilizing important sources of information for the control and development of action. Bernstein's description of learning and practice as a search for optimal solutions to motor problems further reified exploration as a major contributor to behavioral change [17,18].

Exploratory behavior subsequently became recognized as a critical agent in motor skill development, particularly during infancy [19,20], and motor skill learning [21–23]. Perhaps the most systematically developed description of the role of exploration in behavioral change is Newell and colleagues' characterization of learning and practice as a search for task solutions through the perceptual-motor workspace [22,23]. Drawing on the work of Newell, Gibson, Bernstein, and others, Hacques and colleagues have argued that skill acquisition should focus on how performers can develop exploratory behavior rather than learn a specific movement [21]. They argue practice should lead performers to develop exploratory activity that reveals more reliable information and that it should be undertaken in safe environments where learners can explore even when they are close to or beyond their maximal action boundaries.

Given what we know about play, it seems ideally suited to developing the types of exploratory activity and competence advocated by skill acquisition researchers. Even though exploration typically precedes play, it does not disappear once play emerges. Rather, exploration and experimentation remain highly visible components of play [11]. The safety afforded by play would seem to encourage the type of limit-testing exploration advocated by Hacques and colleagues [21]. Further, because play is directed toward objects, the environment, the body, and others, it would seem ideally suited to uncovering critical perceptual invariants that characterize the important relations among the task, environment, and learner necessary for learning.

Mindfulness

Play and mindfulness share several characteristics. Mindfulness is a state that can be deployed toward the performance or learning of any activity, yet is rarely explored in the motor learning context. Like play, mindfulness is a difficult concept to define, however, like play, mindfulness also has characteristics that facilitate its recognition. Langer [24] refers to it as *"a flexible state of mind in which we are actively engaged in the present, noticing new things and sensitive to context"* (p. 220). Being in the present moment, being aware, and attending to experiences in a nonjudgmental, nonreactive, and accepting way are the most common characteristics scholars assign to mindfulness [25]. Central to this paper's thesis, Langer [26] notes that whereas work is often accomplished mindlessly, play is almost always mindful. In other words, playful practice might be the most reliable way to encourage the characteristics of mindfulness that are presumed to enhance performance and learning.

The benefits of mindfulness have been studied extensively in educational settings [27] and more recently in elite sport performance [25]. Although scholars have conducted far less research on the effects of mindfulness on motor skill learning, some notable studies suggest a mindful attitude can enhance learning. For example, Kee and Liu [28] showed that learners with a stronger disposition toward mindfulness tended to perform a rollerball task more skillfully. Moreover, mindful individuals used more adaptive learning strategies and reported higher enjoyment during practice. In addition, Zhang et al., [29] showed that learners who were assigned to mindfulness training while they practiced throwing darts for eight weeks showed significantly greater improvement in performance than learners assigned to an attention control group. The performance of the mindfulness group was also significantly higher than that of the control group at post intervention and on a follow up test. Further, the mindfulness group, but not the control group, reported significant improvements in mindfulness, experiential acceptance, and flow at post intervention and follow up.

Langer [24,27] describes several studies in which learners were encouraged to adopt a mindful approach to practice. To foster mindfulness, learners were instructed to be as creative and playful as possible and to vary their approach to practicing the tasks as much as possible. In one skill acquisition study, participants were taught a new sport called "Smack-it-ball." The sport is like squash except that players wear a small racket on each hand like a baseball glove. Half of the participants were instructed in how to use the racket using absolute language and the other half received conditional language. Both groups were shown and told how to hold their hands, however the conditional language group were also told that the demonstrated method was only one possible way to hold their hands. After considerable practice, the researchers surreptitiously changed the weight of the ball. The participants who had learned the game "mindfully" adapted to the changed ball much better than those who had received more traditional instructions. Interestingly, the effect was much greater for females, who appeared to be trapped by their original learning, than for the males.

In summary, a small but growing number of studies suggests a more mindful approach to practice can benefit motor skill learning. Importantly, play, or a playful attitude, appears to encourage aspects of mindfulness that researchers believe are key contributors to an effective learning environment.

De-emphasis on explicit instructions

Learners are rarely exposed to explicit instructions during play. Langer's smack-it-ball study highlights the negative effects explicit instructions can have on motor learning. A number of other studies show that explicit instructions not only degrade the ability to adapt to novel task variations, or changes in context, but also mar the rate of improvement during practice and the level of performance in retention [30–32]. In one of the clearest demonstrations of these negative effects, Wulf and Weigelt [32] showed that learners given explicit instructions about when to apply force to the platform of a ski simulator performed much more poorly during practice compared to participants who received no instructions about how to move. The differences between groups were particularly pronounced on a test in which the participants were stressed by being told an expert ski instructor would evaluate them. Green and Flowers [30] used a very different manipulation to highlight the negative consequences of explicit instructions. They instructed some of their participants to look for specific deviations in the trajectory of a falling object as they learned a computer-based catching task. The participants could use the specific deviations to predict the landing location of the object. Rather than enhance performance and learning, the explicit instructions had the opposite effect, with instructed participants performing substantially worse than non-instructed participants.

Hodges and Lee [31] note several potential explanations for the detrimental effects of explicit instructions on performance and learning. First, explicit instructions may lead to a narrow focus of attention on specific aspects of the task rather than the whole task. Relatedly, explicit instructions may discourage exploration, thus limiting exposure to the task dynamics and important sources of intrinsic information available for the regulation of performance. Explicit information may also impede learning about task dynamics and critical sources of intrinsic information by increasing the information processing load and the demands on attention. Finally, explicit instructions may force the learner to concentrate only on finding the correct solution to the motor problem, leading to a stereotyped repetition of the process used to solve the problem and increasing the chances the learner will get stuck in an attractor.

De-emphasis on goals

The aforementioned discussion of the potential negative side effects associated with explicit instructions leads naturally into a discussion about the potential negative side effects of focusing on goal attainment given the focus on means rather than ends during play. A surprisingly large body of literature has focused on the negative effects of providing learners with specific goals, although most of that literature is in educational and experimental psychology. Nevertheless, one can interpret some classic phenomena in motor learning relative to the potential drawbacks of providing specific goals. Most obvious is the *implicit learning* phenomenon [33], which is also closely related to *incidental learning* [34]. Both phenomena highlight that a large degree of what we learn and remember is learned without conscious awareness or as a side effect of pursuing explicit goals. The negative effects of frequent Knowledge of Results (KR) on motor learning is another example of the potential downside of focusing too intently on goal accomplishment, if we acknowledge that KR provides a constant reminder of the learning goal. Researchers have attributed the negative effects of frequent KR to the learner's failure to process the critical sources of intrinsic feedback needed to sustain performance in the absence of KR [35]. Thus, the learning processes subverted by frequent KR are similar to those subverted when instructors provide learners with explicit instructions about how to move.

The most extensive evidence that a focus on specific goals can hurt learning is in the educational psychology literature. This is particularly true in the literature on mathematical learning, where scholars generally classify mathematics-related problems as transformational problems, with an initial state, a goal state, and legal problem-solving operators. Sweller [36] has argued convincingly that some forms of problem solving encouraged by specific goals interfere with learning because they interfere with development of the schemas presumed to support problem solving [36]. He questions the common assumption that practice on a large number of conventional problems is the best way to acquire schemas and develop problem-solving skill. Sweller [36] bases his conclusions on numerous experiments in which he gave participants a variety of problems that they could solve either by means-ends analysis or by inducing a rule based on the problem structure. One can characterize means-ends analysis as trial and error learning, in which the learner attempts to solve the problem by generating multiple solutions until they find a successful solution. Sweller [36] found that while participants had little trouble solving the problems using a trial and error approach, they usually did not induce the relevant rules. Essentially, conventional, goal-directed search heuristics like means-ends analysis typically prevented problem solvers from learning essential aspects of the problem's structure [36].

In contrast to the negative effects of goal-directed means-ends analysis on learning, Sweller [36] found nonspecific goals led to rapid learning of essential characteristics of the problem structure. He attributes the detrimental effects of specific goals and the beneficial effects of nonspecific goals to the related mechanisms of selective attention and limited information processing capacity. First, he reasons that solving a problem and acquiring schemas require largely unrelated cognitive processes. That is, to solve a problem by means-ends analysis, a problem solver must attend to differences between the current problem state and the goal state but can ignore previously used problem-solving operators and relations between problem states, except to prevent retracing steps during solution. In contrast, schema acquisition requires recognizing a problem state as belonging to a particular category of problems that require particular moves. Thus, attention to previously visited problem states and moves associated with those states is important for schema acquisition. Second, means-ends problem solving strategies can impose a high cognitive load during complex problem solving because the learner must keep so many pieces of information in mind, including the goal state, the current problem state, the relationship between the goal and current state, and relations between problem-solving operators. Consequently, this high cognitive load may leave limited processing capacity available for schema acquisition even if the learner solves the problem.

A series of experiments by Sweller and Levine [37] highlight the logic behind Sweller's ideas. The authors gave participants learning maze puzzles to solve and tracked the speed at which the solution was achieved and the participants' understanding of the rules leading to the problem solution. They gave one group of participants an explicit goal and another group of participants a non-specific goal. For example, in one experiment, participants had to trace their way out of a maze while blindfolded. In the specific goal group, they placed one of the participant's hands on the start location and the other hand on the goal location, while participants in the non-specific goal group had one hand placed on the start location and were simply told them to find the end location. Intriguingly, participants in the non-specific goal group solved the problem in fewer moves and were much more likely to report the rule underlying the solution to the problem, which actually required moving away from the goal location before moving toward it. Participants in the specific goal group frequently followed paths toward the goal location, i.e., paths that minimized the distance between the current location and the goal location and encountered dead ends. One can imagine how difficult it would be to avoid such a strategy as a member of the specific goal group; that is, proximity to the goal must have been extremely alluring.

In summary, a large body of literature supports the counterintuitive assertion that providing more information about the problem structure by introducing specific goals can subvert learning about the remainder of the problem space. Learners' preoccupation with accomplishing the goal appears to interfere with important processes underlying the development of advanced problem solving capacities. Sweller has described the potential downsides of specific goals in a particularly lucid and convincing way. Interestingly, one cannot help but notice how similar his findings are to those of Tolman [38] many decades earlier. Tolman coined the term *latent learning* to refer to the learning acquired by rats allowed to roam freely within mazes without specific goals to pursue. Relative to the focus of this paper, it is interesting to note that Bruner [14] has referred to play as latent learning. The detrimental effects of specific goals on attentional processes is also curiously similar to the inattentional blindness phenomenon reported in the literature, wherein the tracking of an explicit goal interferes with the detection of salient information in the environment [39].

Repetition without repetition

The previous discussion has interesting implications for Bernstein's [17] idea of practice and learning as a form of *repetition without repetition*. Bernstein's ideas about practice popularized the notion that learning was a form of problem solving characterized by a search through the problem space. Bernstein stated, *"The process of practice toward the achievement of new motor habits essentially consists in the gradual success of a search for optimal motor solutions to the appropriate problems"* (p. 362) [17]. With respect to the idea of repetition without repetition, he explained, *"Repetitions of a movement or action are necessary in order to solve a motor problem many times (better and better) and to find the best ways of solving it"* (p. 176) [17]. According to Bernstein, *what learners repeat during practice is not specific solutions to the motor problem but the process of solving the problem again and again and discovering better and better solutions*, hence inspiring the contemporary description of skill acquisition as exploration, discovery and selection.

The discussion so far has implications for Bernstein's ideas for a least two reasons. First, the idea of practice and learning as a search for solutions to task problems conveys the notion that learning is about acquiring something already in existence. But as Pachecho et al. [23], have noted, skill acquisition is less an "acquisition" of something that can be selected and more a "transformation" of the learner's ability to solve the problem. Secondly, Sweller's [36] analysis of the downsides of specific goals reveals that learning and problem solving are not necessarily the same thing. The learner might solve the problem successfully but learn nothing useful about the problem structure in the process. This is far more likely to occur if the learner uses a trial and error approach to generating the "correct" solution to the problem and therefore does not learn the rules by which they can generate solutions. A deeper understanding of the problem space and the rules underlying it can lead to the generation of appropriate solutions not only to the current problem but also to problems with a similar structure, thus providing a basis for transfer of learning (see for example Harlow's 1949 notion of *learning to learn* [40]). As Langer [27] notes, from a mindful perspective, a person's response to a particular problem is not an attempt to make the best choice from among existing options, that is to take an available heuristic that seems to work best, but to create options. An understanding of rules, especially rules linking causes and effects, seems far more likely to promote the capacity to create options, to shift the learner from a trial and error learner to one who adapts to problems via hypothesis and insight [40].

We do not intend to imply Bernstein's ideas about practice and learning are misguided. Quite the opposite. We want to highlight the need to evaluate Bernstein's ideas relative to the broader literature on learning and problem solving. One encounters the phrase *repetition without repetition* frequently in the motor learning literature, however its meaning seems to vary from author to author. From our perspective, and consistent with the broader literature on learning and problem solving, learning can be viewed as a search for solutions to motor problems if the type of search the learner engages in reveals the structure of the problem space and the rules that bind its elements together. *In other words, not all types of search are equal and some searches may actually compromise learning*. A goal-directed search that encourages a trial and error approach to solving problems may be far less effective than a more playful search that leads to broader discoveries about the problem space.

EVALUATING THE EFFECTS OF PLAYFUL PRACTICE

Earlier in this paper, we noted the benefits of play are generally realized over the long term; the value of play is less obvious if the interest is in short-term gains in performance under narrowly constrained contexts [10]. The long-term effects of play and the preceding discussion have clear implications for evaluating the effects of playful practice. The most obvious implication is that the benefits of playful practice are unlikely to reveal themselves after limited amounts of practice or on immediate tests of learning. Moreover, the benefits are far less likely to reveal themselves on retention tests than a test of transfer. This premise is consistent with the general benefits associated with discovery learning, which show up more frequently after large amounts of practice and when learners are tested with novel tasks or in novel contexts [41,1]. Task complexity should moderate the effects of playful practice on learning, such that the learning benefits will appear after a much longer delay for complex tasks than for simple tasks.

Motor learning research has a preoccupation with documenting learning outcomes rather than the process by which learners achieve those outcomes [42]. This preoccupation with outcomes would clearly impede an understanding of the effects of playful practice on learning given the learner's focus on exploration and experimentation with novel movements and routines during play. Consequently, we recommend that researchers include process measures such as behavioral strategies, movement kinematics and kinetics, and gaze data in addition to outcome data when evaluating the effects of playful practice on learning. Creativity (the generation of novel behavior for unique problems) would be another useful dimension to evaluate given the centrality of novelty during play. Creativity has received limited attention in the motor learning literature, with the exception of the analysis of the development of tactical creativity in team ball sports (e.g., Memmert [43]), and deserves closer scrutiny.

Researchers should also consider learners' experiences and affective states when they engage in different types of practice because learners' experiences and affective states have a major bearing on their willingness to engage in further practice. Dimensions of experience to potentially evaluate include fun, enjoyment, gratification, anxiety, frustration, satisfaction and motivation, among others. It would also be useful to evaluate learners' mindset to ascertain the extent to which they adopt an attitude that is conducive to learning.

ENCOURAGING PLAYFUL PRACTICE

[1] We do not intend to equate playful practice with discovery learning, as will become apparent in the final section of the paper, however, the similarities in the delayed effects of play and discovery learning are an interesting side note.

As evident from the introduction to this paper, there are many different ways to physically structure practice and many different types of practice, although deliberate practice and deliberate play have received the most attention in the literature. Our analysis suggests that instructors should consider adding playful practice, which shares many characteristics with deliberate play, to their instructional repertoires. Curiously, play and playful practice do not feature in Mosston and Ashworth's [44] widely utilized teaching strategies, perhaps because playful practice connotes an attitude toward practice that can be applied to any instructional approach along the continuum from pure play to deliberate practice. Whereas play naturally occurs more easily during childhood, playful practice can be used in adulthood and at any stage of learning, as is quite clear from the way in which researchers have used play to cultivate a mindful approach to learning [24,27]. Bouts of playful practice might be particularly important to break up the monotony associated with more deliberate forms of practice and increase motivation and adherence.

One of the most obvious ways to set the conditions for playful practice based on the preceding analysis is to deemphasize goals. Goals and goal-directed problem solving feature prominently in learning theory and contemporary instruction in education even though, as noted already, learning and problem solving are not equivalent concepts. Teachers and students have a preoccupation with moving quickly from problem to solution and getting the correct answer. This mindset is not without merit and it often leads to success on the task. However, it can be problematic if learners engage in the type of trial and error problem solving that leads to limited insights into the structure of the problem for which a solution is sought and poor understanding of the causal relations between solutions and problems. A focus on finding correct solutions to problems can also induce anxiety, especially via fear of evaluation, further depleting attentional capacity. This may be another reason why goal-directed problem solving limits understanding of cause and effect within the perceptual-motor workspace.

When the goal of the task is difficult to deemphasize, an alternative approach is to reframe the goal of the task (for example the goal might be to produce errors/mistakes) or redirect attention to sub-goals that highlight critical relations within the task space. Miller, Lehman, and Koedinger [45] found the latter worked well when students had to play a computerized electric field hockey game to learn about the properties of electric fields and charged particles. Miller and colleagues [45] created three groups to evaluate the effects of goal pecificity on learning. They instructed the "standard-goal" group to position and adjust charged particles so that the "puck" (a charged particle) would avoid obstacles and slide into a hockey net. They gave the same instructions to the "specific-path" group, however, participants in this group were also asked to focus on learning an idealized trajectory of the puck as it moved from its starting position toward the net. In essence, the specific-path group had to learn how to produce a trajectory of the puck rather than how to score goals. Finally, they removed the net and obstacles for the "no-goal" group, who they told would ultimately be given a situation with an obstacle and a net but who, in the meantime, should experiment with the relationships between the charged particles in any way they saw fit to understand the game's properties. Analysis of the post-test scores out of 100, where all groups performed the task with obstacles and a net, highlighted the superiority of the no-goal group, who achieved a score of 77, which was better than the specific-path group's score (70) and considerably better than the standard-goal group's score (52). Moreover, the no-goal group achieved considerably higher scores on a declarative knowledge test about relations between charged particles and on specific problems that required knowledge about relations between charged particles.

The re-direction of attention away from specific goal accomplishment is a central feature of some of the most well-known complementary and alternative approaches to movement education [46]. For example, the Alexander Technique encourages students to inhibit their desire to accomplish a task objective mindlessly, but instead to focus on alternative and less effortful ways to accomplish the objective. Alexander teachers encourage students to take a playful and exploratory approach to discovering new ways to perform everyday tasks. Similarly, the Feldenkrais method encourages playful exploration of the sensations associated with novel movements performed in the absence of specific task goals. The variations in movement patterns encouraged by the Feldenkrais method are similar in some respects to the movement variations encouraged by those who advocate for *differential learning* [47], however, a primary difference between the two approaches is the explicit focus on accomplishing the task goal in the differential learning approach [48]. Complementary and alternative approaches to movement education potentially have much to teach motor learning scholars and practitioners [46].

Consistent with the range of individual difference characteristics that influence motor learning [42], the attitude required for playful practice or induced by playful practice might come more easily to some learners than to others. Given the focus on process rather than goal accomplishment during play, a playful attitude might be induced much more easily in individuals with a task orientation than those with an ego orientation. The same might be true for those with a growth mindset compared to those with a fixed mindset. Similarly, individuals who score higher on openness and lower on conscientiousness on the Big-5 personality test might be more naturally inclined to adopt a playful attitude toward practice and learning. Finally, those with a disposition toward mindfulness [28] might find it easier to adopt a playful attitude toward practice than those with a disposition toward mindlessness. Quite possibly, play and mindfulness are reciprocally related, such that play encourages mindfulness and mindfulness encourages a playful attitude.

The relation between play and mindfulness raises two final ideas worth considering. First, if play and mindfulness are reciprocally related then it is not clear whether the learning benefits that researchers have attributed to play should really be attributed to mindfulness and vice versa. Second, the relationship highlights the importance of the attitude the learner takes into and embraces during practice and the potential ease with which practitioners can manipulate attitude, regardless of any other characteristics of the practice context. We end by reinforcing the idea that one can consider playful practice its own type of practice or as an overlay to other types of practice. We have a tendency to dichotomize different types of practice, which is notoriously apparent in the volumes of discussion on the benefits of direct instruction versus discovery learning [41]. Recent analyses highlight that these two types of practice are not antithetical to one another; rather, they are two complementary approaches to practice and learning that practitioners often combine to great effect [50]. In the same vein, playful practice might be profitably combined with other types of practice to enhance learning.

CONCLUSION

Interest in understanding how the physical structure of practice influences performance and learning has waned since the Millennial. Stimulated by the concepts of deliberate practice and deliberate play, the waning of interest in the physical structure of practice has coincided with an increased interest in understanding how the learner's attitude toward practice influences performance and learning. We build on the concept of deliberate play in the current paper and argue that exposure to playful practice can benefit skill acquisition regardless of the learner's stage of learning or skill development. Playful practice might enhance learning because it encourages exploration and mindfulness, deemphasizes explicit instruction and goal attainment, and encourages the type repetition without repetition during practice that generates insights into the structure of motor problems. We hope the ideas raised in this paper will encourage further discussion of the potential benefits of playful practice on motor skill learning.

REFERENCES

1. Hull CL. Principles of behavior. New York: Appleton-Century; 1943.
2. Adams JA. Historical review and appraisal of research on the learning, retention, and transfer of human motor skills. *Psychol Bull*. 1987;101:41–74. doi.org/10.1037/0033-2909.101.1.41
3. Schmidt RA. A schema theory of discrete motor skill learning. *Psychol Rev*. 1975;82(4):225–60. doi.org/10.1037/h0076770
4. Magill RA, Anderson DI. Motor learning and control: Concepts and applications. 12th ed. New York: McGraw Hill; 2021.
5. Ericsson KA, Krampe RT, Tesch-Römer C. The role of deliberate practice in the acquisition of expert performance. *Psychol Rev*. 1993;100:363–406. doi.org/10.1037/0033-295X.100.3.363
6. Baker J, Young B. 20 years later: deliberate practice and the development of expertise in sport. *Int Rev Sport Exerc Psychol*. 2014;7(135–157). doi.org/10.1080/1750984X.2014.896024
7. Hambrick DZ, Macnamara BN, Oswald FL. Is the deliberate practice view defensible? A review of evidence and discussion of issues. *Front Psychol*. 2020;11:1134. doi.org/10.3389/fpsyg.2020.01134
8. Côté J. The influence of the family in the development of talent in sports. *Sport Psychol*.1999;13(4):395–417. doi.org/10.1123/tsp.13.4.395
9. Côté J, Murphy-Mills J, Abernethy B. The development of skill in sport. In: Hodges NJ, Williams AM, editors. *Skill acquisition in sport: Research, theory and practice*. 2nd ed. New York: Routledge; 2012. p. 269–86.
10. Rieber LP. Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educ Technol Res Dev*. 1996;44(2):43–58. doi.org/10.1007/BF02300540
11. Bruner JS. Nature and uses of immaturity. *Am Psychol*. 1972;August:687–708. doi.org/10.1037/h0033144

12. Fagan R. Selective and evolutionary aspects of animal play. *Am Nat*. 1974;108(964):850–8. doi.org/10.1086/282960
13. Pellegrini AD, Dupuis D, Smith PK. Play in evolution and development. *Dev Rev*. 2007;27(2):261–76. doi.org/10.1016/j.dr.2006.09.001
14. Bruner JS. Organization of early skilled action. *Child Dev*. 1973;44:1–11. doi.org/10.2307/1127671
15. Gibson JJ. The senses considered as perceptual systems. Boston: Houghton Mifflin; 1966.
16. Gibson JJ. The ecological approach to visual perception. New York: Taylor and Francis Ltd.; 1979.
17. Bernstein NA. The co-ordination and regulation of movements. New York: Pergamon; 1967.
18. Bernstein NA. On dexterity and its development. In: Latash ML, Turvey MT, editors. *Dexterity and its development*. Marwah: Lawrence Erlbaum; 1996. p. 3–244.
19. Gibson EJ. Exploratory behavior in the development of perceiving, acting, and the acquiring of knowledge. *Annu Rev Psychol*. 1988;1–42. doi.org/10.1146/annurev.ps.39.020188.000245
20. Thelen E, Smith LB. A dynamic systems approach to the development of cognition and action. Cambridge: MIT Press; 1994.
21. Hacques G, Komar J, Dicks M, Seifert L. Exploring to learn and learning to explore. *Psychol Res*. 2020;85:1367–79. doi.org/10.1007/s00426-020-01352-x
22. Newell KM, Kugler PN, van Emmerik REA, McDonald PV. Search strategies and the acquisition of coordination. In: Wallace SA, editor. *Perspectives on the coordination of movement*. North Holland: Elsevier; 1989. p. 85–122.
23. Pacheco MM, Lafe CW, Newell KM. Search Strategies in the Perceptual-Motor Workspace and the Acquisition of Coordination, Control, and Skill. *Front Psychol*. 2019;10(1874). doi.org/10.3389/fpsyg.2019.01874
24. Langer EJ. Mindful learning. *Curr Dir Psychol Sci*. 2000;9(6):220–3. doi.org/10.1111/1467-8721.00099
25. Gardner FL, Moore ZE. Mindfulness in sport contexts. In: Tenenbaum G, Eklund RC, editors. *Handbook of Sport Psychology*. 4th ed. John Wiley & Sons; 2020. p. 738–50.
26. Langer EJ. Mindfulness: 25th anniversary edition. Boston: Da Capo Press; 2014.
27. Langer EJ. (2016). The power of mindful learning. Boston, MA: Da Capo Press. Boston; 2016.
28. Kee YH, Liu YT. Effects of dispositional mindfulness on the self-controlled learning of a novel motor task. *Learn Individ Differ*. 2011;21(4):468–71. doi.org/10.1016/j.lindif.2011.01.009
29. Zhang C-Q, Si G, Duan Y, Lyu Y, Keatley DA, Chan DKC. The effects of mindfulness training on beginners' skill acquisition in dart throwing: A randomized controlled trial. *Psychol Sport Exerc*. 2016;22:279–85. doi.org/10.1016/j.psychsport.2015.09.005

30. Green TD, Flowers JH. Implicit versus explicit learning processes in a probabilistic, continuous fine-motor catching task. *J Mot Behav*. 1991;23:293–300. doi.org/10.1080/00222895.1991.9942040
31. Hodges NJ, Lee TD. The role of augmented information prior to learning a bimanual visual-motor coordination task: do instructions of the movement pattern facilitate learning relative to discovery learning. *Br J Psychol*. 1999;90:389–403. doi.org/10.1348/000712699161486
32. Wulf G, Weigelt C. Instructions about physical principles in learning a complex skill: To tell or not to tell . . . *Res Q Exerc Sport*. 1997;68:362–7. doi.org/10.1080/02701367.1997.10608018
33. Masters RSW, van Duijn T, Uiga L. Advances in implicit motor learning Skill acquisition in sport: Research, theory and practice. In: Hodges NJ, Williams AM, editors. *Skill acquisition in sport: Research, theory and practice*. 3rd ed. New York: Routledge; 2020. p. 77–95.
34. Crocker RE, Dickinson J. Incidental psychomotor learning: The effects of number of movements, practice, and rehearsal. *J Mot Behav*. 1984;16(1):61–75. doi.org/10.1080/00222895.1984.10735311
35. Salmoni AW, Schmidt RA, Walter CB. Knowledge of results and motor learning: A review and reappraisal. *Psychol Bull*. 1984;95:355–86. doi.org/10.1037/0033-2909.95.3.355
36. Sweller J. Cognitive load during problem solving: Effects on learning. *Cogn Sci*. 1988;12:257–85. doi.org/10.1016/0364-0213(88)90023-7
37. Sweller J, Levine M. Effects of goal specificity on means-ends analysis and learning. *Exp Psychol Learn Mem Cogn*. 1982;8:463–74. doi.org/10.1037/0278-7393.8.5.463
38. Tolman EC. Purposive behavior in animals and men. New York: Appleton-Century Crofts; 1932.
39. Simons DJ, Chabris CF. Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception*. 1999;28(9):1059–74. doi.org/10.1068/p281059
40. Harlow HF. The formation of learning sets. *Psychol Rev*. 1949;56:51–65. doi.org/10.1037/h0062474
41. Lee HS, Anderson JR. Student learning: What has instruction got to do with it? *Annu Rev Psychol*. 2013;64:445–69. doi.org/10.1146/annurev-psych-113011-143833
42. Anderson DI, Lohse KR, Lopes TCV, Williams AM. Individual differences in motor skill learning: Past, present and future. *Hum Mov Sci*. 2021;78. doi.org/10.1016/j.humov.2021.102818
43. Memmert D. Teaching tactical creativity in sport: Research and practice. New York: Routledge; 2015.
44. Mosston M, Ashworth S. Teaching physical education. 5th ed. Columbus: Merrill; 2002.
45. Miller CS, Lehman JF, Koedinger KR. Goals and learning in microworlds. *Cogn Sci*. 1999;23(3):305–36. doi.org/10.1207/s15516709cog2303_2

46. Anderson DI. What can complementary and alternative approaches to movement education teach Kinesiology. *Kinesiol Rev*. 2020;9(3):181–9. doi.org/10.1123/kr.2020-0027
47. Schöllhorn WI, Mayer-Kress G, Newell KM, Michelbrink M. Time scales of adaptive behavior and motor learning in the presence of stochastic perturbations. *Hum Mov Sci*. 2009;28:319–33. doi.org/10.1016/j.humov.2008.10.005
48. Stephens J, Hillier S. Evidence for the effectiveness of the Feldenkrais method. *Kinesiol Rev*. 2020;9:228–35. doi.org/10.1123/kr.2020-0022
49. Bakker A. Discovery learning: zombie, phoenix, or elephant? *Instr Sci*. 2018;46:169–83. doi.org/10.1007/s11251-018-9450-8

Citation: Anderson DI, Steel KA. (2022). It's not the type of practice that matters, it's the attitude: The impact of playful practice on motor skill learning. *Brazilian Journal of Motor Behavior*, 16(2):179-193.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
Competing interests: The authors have declared that no competing interests exist.
DOI: https://doi.org/10.20338/bjmb.v16i2.278