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# Optimizing motivation and attention for motor performance and learning

Rebecca Lewthwaite[1] and Gabriele Wulf[2]

We review three lines of recent research at an intersection of motor learning and sport psychology as they relate to motor skill acquisition: enhanced expectancies, autonomy support, and external attentional focus. Findings within these lines of research have been integrated into a new theory, the OPTIMAL (Optimizing Performance through Intrinsic Motivation and Attention for Learning) theory (*i.e.*, OPTIMAL theory, Wulf and Lewthwaite, 2016), and have been applied in motor skill acquisition and performance. Implications range from more effective skill development in children and novice performers to athletes and performers in many fields, including clinical rehabilitation.

**Addresses**
[1] Rancho Los Amigos National Rehabilitation Center and University of Southern California, USA
[2] University of Nevada, Las Vegas, USA

Corresponding author: Wulf, Gabriele (gabriele.wulf@unlv.edu)

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## Introduction

In 1986, legendary golfer Arnold Palmer made a hole-in-one during the Chrysler Cup Pro-Am in Potomac, Maryland. When he later talked about this event, he recalled a TV camera crew showing up on the same hole the next day of the tournament, asking him to hit a hole-in-one again so that they could film it. In the interview, Palmer commented on how ridiculous the suggestion was that he would be able to repeat a hole-in-one on the same hole one day later. Yet, he indeed made another hole-in-one!

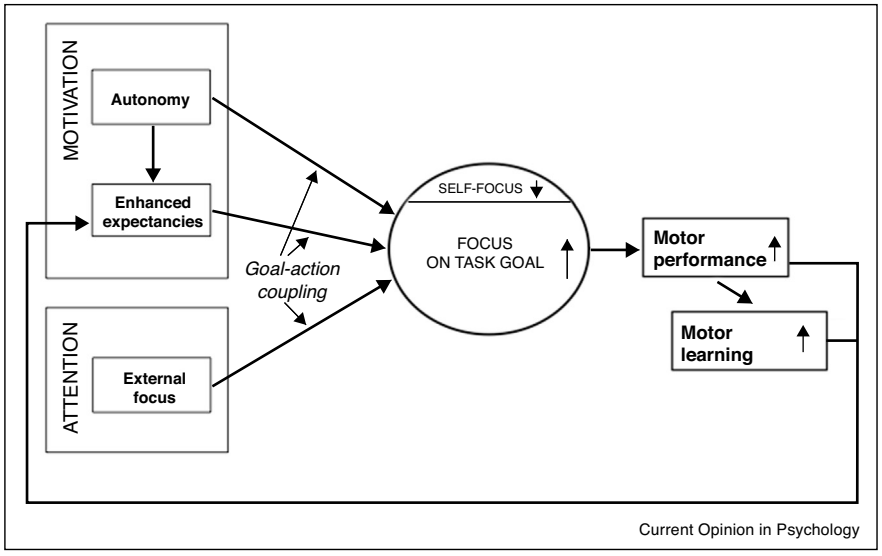
Optimal performance is rare. What does it take to perform the perfect golf shot, penalty kick, or gymnastic routine? This is the goal of most athletes, and instructors, coaches, and others who strive to help athletes optimize their performance. In recent years, researchers in motor learning and performance have generated several lines of evidence that indicate important roles for motivation and attentional focus in motor performance and learning. We recently posed the OPTIMAL theory of motor learning [1••] that integrates this research (see Figure 1). OPTIMAL is an acronym for Optimizing Performance Through Intrinsic Motivation and Attention for Learning. Factors with influence include *enhanced expectancies* for performance (positive experiences or outcomes), performer *autonomy*, and an *external focus of attention*. The putative mechanisms for motivational effects include their roles in generating dopaminergic response in *temporal pairing* with skill practice. This dopaminergic response is thought to strengthen memory and learning [2] and to contribute a form of intrinsic neuromodulation to the development of efficient *goal-action coupling* via structural and functional neural connectivity [3,4•].

### Enhanced expectancies

Certainly, past performance accomplishments establish a foundation for a sense of confidence or self-efficacy [5] and previously positive outcomes give rise to positive expectations for future outcomes in similar circumstances. Further, confidence has been recognized as a prospective predictor of motor performance [6–8], and learning (retention and/or transfer of skill) [9–11]. A variety of means to experimentally influence a performer's perception of ability or prospective confidence have been found to affect performance and learning. Among these are the provision of normatively superior or better-than-average performance feedback [12–15], evidence of the performer's own best performance [16,17], liberal definitions of task success or descriptions of relative task ease [18,19,20•], stereotype-relevant and other priming [21,22], visual illusions [23,24], conceptions of ability as incremental [25,26], and positive affect. Clearly, not all approaches to enhancing expectancies, including deception and the provision of external rewards, are suitable for translation into practice.

Several studies of novice, experienced, and expert performers illustrate the impact of a sense of success on subsequent performance. Palmer *et al.* [19] provided non-golfers with instructions that putting to a target located within smaller or larger concentric circles would constitute 'good' golf putts. The group for whom the larger circle was identified putted more accurately in practice and in later 24-hour retention and transfer tests than did the group with the more conservative or higher standard of success. The larger-circle group experienced 22% of their trials on average as 'good' by definition,

**Figure 1**




Schematic of the Optimizing Performance Through Intrinsic Motivation and Attention for Learning (OPTIMAL) theory [1••]. Conditions that provide the performer with a sense of autonomy and enhance expectancies for future performance, and an external focus of attention, facilitate goal-action coupling by keeping attention directed at the task goal and reducing a detrimental self-focus. The resulting successful motor performance and ease of movement further contribute to learning and subsequent performance.

whereas the smaller-circle participants 'saw' success on only 7.9% of their practice-phase trials.

Stoate *et al.* [15] provided feedback to one group of experienced competitive runners while running on a treadmill at 75% of their maximal oxygen consumption that indicated they were performing more efficiently than others (*e.g.*, "You're doing great. Your oxygen consumption is in the top 10th percentile for your age and gender"). Perceived running ease and positive affect increased, fatigue was reduced, and oxygen consumption decreased after the expectancy enhancement for that group but remained the same in a control group who did not receive this purported insight. A study by Rosenqvist and Skans [8] of professional male golfers on the European Professional Golfers' Association tour examined performance in subsequent tournaments one week after a golfer marginally made or missed the prior tournament's cut line. After accounting for pre-existing ability (scoring average) differences, those golfers who in effect received a boost of confidence from just making the cut outperformed those who just failed to make the cut, by approximately a quarter of a shot after two rounds in the subsequent tournament.

## Autonomy

Practice conditions that support a performer's sense of agency [27], or autonomy and self-determination [28], even in ostensibly small ways [29,30], can affect motor performance and learning [1••]. In one example of a burgeoning literature with learner control over aspects of practice, Post *et al.* [31] provided one group of basketball novices with the opportunity to determine how many set shots to take and the spacing of those shots within 15-min practice epochs. A yoked group shot at the rate and inter-shot spacing of counterparts in the learner-controlled group. Participants in the learner-controlled group received higher form scores from blinded raters and shot more accurately during the retention test than did those in the yoked group.

Lewthwaite *et al.* [29] demonstrated that choices incidental to the task, such as choice of golf ball color in a golf putting task, could produce learning differences from yoked counterparts not given these opportunities. These findings parallel effects of a wide variety of task-relevant and not-so-relevant choices on learning, as well as other autonomy-supportive conditions including respect for learner opinions [29, Experiment 2] and instructor language antithetical to authoritarian control [32] (see Wulf and Lewthwaite [1••] for further examples).

Does the autonomy-support effect seen in novice motor learners hold for more expert performers? Although few studies have examined this issue in elite performers to date, Halperin *et al.* [33•] showed that giving athletes choice can have immediately beneficial effects on motor performance. A world-champion kickboxer ([33•], Study 1) and amateur kickboxers with national-level competitive experience ([33•], Study 2) performed under counterbalanced conditions marked by choice over the order of type of punch to be thrown or experimenter-determined