Part 2
Optimizing Figure-Skating Performance

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In Part 1, we introduced the OPTIMAL theory for motor learning and its implications for figure skating practice. We presented research to support the first of three factors central to OPTIMAL theory — enhanced expectancies. When then provided examples that apply the research to figure skating practice. Below, we present two other central factors to OPTIMAL theory: autonomy, and an external focus of attention.

Autonomy

Autonomy, that is, the ability to act independently and self-determined, is a basic need of every human being (Deci & Ryan, 2008). This is also reflected in the motor learning process. Practice conditions in which the need for autonomy is satisfied—for example, because the learner is given some choices—enhance learning (see Wulf & Lewthwaite, 2016). If learners have control over certain aspects of the practice conditions, such as when they want to receive feedback (Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997), want to see a demonstration of the goal movement (Lemos, Wulf, Lewthwaite, & Chiviacowsky, 2017), or use an assistive device (Hartman, 2007), it generally has a positive effect on learning.

There are different ways coaches can support and nurture their athlete's autonomous practice behaviors. Coaches should clearly identify choice opportunities so athletes know they are available. Here are some examples:

"As you practice that skill, you can let me know if and when you would like to see a video replay."
"I have the jump harness here. Let me know if and when you'd like to use it again."
"Which skills would you like me to help you with today?"

Even letting learners decide how much to practice has been shown to be conducive to learning. In a study by Post, Fairbrother, Barros and Kulpa (2014), participants in one group had the opportunity to decide how many practice trials of a basketball free throw task they wanted to complete. (Different participants chose between 100 and 244 throws.) Compared to a control group with the same average number of throws, the group that had a choice showed both a better throwing technique and higher shooting accuracy on a retention test. In figure skating practice, coaches can let their athletes decide how much time or how many trials they would like to practice a skill. In cases where the coach would like to provide more guidance, they can select a choice range suitable to the athlete and context. For example, the coach can say: "Would you like to practice the axel 3, 4, or 5 times?"

Research has shown that not only task-related choices promote learning, but also choices that are only indirectly related to the task being learned, or have nothing to do with the task at all. Seemingly trivial options such as the order in which certain tasks are practiced (e.g., Wulf & Adams, 2014) or the color of objects (e.g., balls) being used (e.g., Lewthwaite, Chiviacowsky, Drews, & Wulf, 2015) can lead to improved learning and increase interest in practice (Wulf, Freitas, & Tandy, 2014). Maximum force production and the efficiency of movements can also be increased through self-selected task sequences (e.g., Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2016).

Coaches can give their athletes choice in deciding when they would like feedback and also which type of feedback strategy to adopt in a specific situation (To learn more about autonomy-supportive feedback practices, coaches can refer to CER SCI 303: Provisions for effective feedback). Other forms of choice include which skills to work on in a lesson, which exercises the athlete would like to adopt to improve a skill, how many repetitions to perform of a skill, which skills to perform with a section of music, how many times to rehearse that section, the order in which they practice their skills in a session or lesson, or the degree of challenge to establish within a training session.

Conditions that satisfy learners' need for autonomy—when they are given the opportunity to make certain decisions, or when the coach interacts with students in a "respectful" manner (Hooyman, Wulf, & Lewthwaite, 2014)—increase self-confidence and learners'

expectation for their own performance. In addition, autonomy reduces stress. Stress reactions, often observed under controlling conditions (without autonomy) (Reeve & Tseng, 2011), tend to impair learning.

Importantly, the provision of structure does not have to represent control and the allowance of autonomy does not have to reflect a lack of structure (Mageau and Vallerand 2003). Structure implies that coaches set clear, contingent and consistent guidelines (Ntoumanis 2012). The allowance of autonomy implies that coaches provide rationale for the tasks, rules, and limitations they set; they acknowledge their athletes' feelings and perspectives, and that they provide choice opportunities for their athletes (Mageau and Vallerand 2003).

External focus of attention

An external focus of attention directed towards the intended effect of the movement leads to more effective motor learning and performance than does an internal focus directed towards one's own body movements (for a review, see Wulf, 2013). To date, more than 200 studies have shown the benefits of instructions or feedback that promote an external focus. Positive effects are seen not only in terms of movement effectiveness (balance, accuracy, movement form, etc.), but also in terms of the efficiency or economy of movements (muscle activity, oxygen demand, speed, force production, etc.). In addition, the degree of automaticity is increased with an external focus. Thus, more attention is available for other things (Kal, van der Kamp, & Houdijk, 2013; Wulf, McNevin, & Shea, 2001). The advantage of an external over an internal focus is independent of skill level, type of skill, age, or physical and mental abilities.

An external focus can involve a concentration of the intended motion of an implement (e.g., golf club, trajectory of or spin on a ball), the pressure exerted again an object (e.g., skis, ground, water), a target to be hit (e.g., bullseye, basketball backboard, golf hole), an image such as jumping over a lake or climbing up a cork screw (pirouette) in ballet or (twizzle) in skating. An external focus can even be directed at the movement of an object that is attached to the body (e.g., shirt buttons, belt buckle). In one study (Abdollahipour, Wulf, Psotta, & Palomo Nieto, 2015), in which 12-year old gymnasts were asked to perform a 180-degree turn, asking them to focus on the direction in which a sticker attached to their chest was pointing resulted in greater jump height as well as superior movement form (i.e., fewer deductions) compared with internal focus instructions (direction in which hands crossing in front of chest were pointing) or a control condition with no specific focus instruction. Thus, a simple external focus cue had an immediate (double-)advantage for performance.

Similar effects have been demonstrated for other tasks. In a golf study (An, Wulf & Kim, 2013), learners instructed to focus on the pressure they were exerting against the ground (external focus), relative to the foot (internal focus) with which they were exerting the pressure, led to immediate and long-term improvements in movement form, as well as a greater carry distance of the ball.

Numerous attentional focus studies have used balance tasks and consistently demonstrated enhanced balance performance and learning when attention was directed externally, and not to body movements. When participants were asked to concentrate on wheels under a platform (Wulf, Höß, & Prinz, 1998) or a balance board (Totsika & Wulf, 2003) or an inflated rubber disk they were standing on (Wulf, Landers, Lewthwaite, & Töllner, 2009), balance learning was found to be facilitated relative to an internal focus on their feet.

An external focus has the twofold advantage of directing attention to the task goal and preventing a detrimental self-focus (McKay, Wulf, Lewthwaite, & Nordin, 2015). The increased self-efficacy as a result of good performance with an external focus (Pascua, Wulf, & Lewthwaite, 2015) can have additional indirect positive effects. Below we provide ways coaches can promote an external focus of attention in figure skating. This includes the use of physical objects and images familiar to the athletes.

Physical objects as an external focus of attention

Coaches can introduce objects into their lessons. Rather than direct athletes' attention to their feet, they can direct attention to their boots (e.g., "Touch your boots together"). Rather than focus on the hands, athletes can focus on their gloves (e.g., "Move your glove through on the takeoff"). Skaters can wear stickers on different parts of their bodies to reinforce an external focus of attention. For example, a sticker can be placed on each shoulder with the instruction of "keep the stickers level with one another." Several figure skating specific devices promote an external focus of attention such as the ankle strap that produces a sound when the boots come together in the air position. Coaches can also have their athletes hold objects such as soft batons or tennis balls (when safe and appropriate) to trigger an external focus of attention. To promote full extension on pushes, coaches can hold an object down by the ice for the athlete to reach back and "touch" with their toe pick after each push.

External focus of attention as an image

Another way to promote an external focus of attention is through an image. Importantly, the image should be concepts that are familiar to the athlete so they are easy to understand. This approach is already incorporated within learn to skate program teaching manuals. For example, coaches ask skaters to make pizzas (forward swizzles) or to stomp on the bugs (to initiate marching). Below are several examples:

"Look up over the fence"—to achieve extension through the body, especially on jump takeoffs.
"Elevator"—refers to the hips staying upward (rather than the torso breaking forward) as the knee bends.
"Touch the wall with your toe pick."—refers to pointing the toe on an extension.
"Turn through the doorway."—refers to keeping the arms close as the body turns on a jump takeoff.

"Goal-Action Coupling"

The three key factors in the OPTIMAL theory—enhanced expectancies, learner autonomy, and an external focus of attention—are essential for optimal motor performance and learning. We have called the mechanism by which these factors take effect, *goal-action coupling* (see Figure 1). The efficient coupling of goals and actions is facilitated by conditions that increase self-efficacy, including opportunity for choice (autonomy), and direct concentration towards the intended movement outcome or task goal (external focus). All factors are assumed to facilitate a focus on the movement goal and reduce a self-related focus (internal focus, doubts about one's own abilities, self-regulation, etc.). These conditions promote the functional connectivity of task-relevant brain areas that is associated with efficient and fluid movement, and that is typically observed at a high level of performance (Kim, Chang, Kim, Seo, Ryu, Lee et al., 2014; Milton, Solodkin, Hluštík, & Small, 2007). Structural changes in the brain (neuroplastic processes) will also be promoted under these conditions.

Implications for Practice

In practical settings, movement learning often takes place under conditions in which teachers decide which tasks should be practiced, feedback is primarily aimed at corrections, and instructions are related to body movements. In this scenario, learners have little autonomy, they lack the confidence necessary for optimal performance and learning, and an internal focus of attention hinders the development of automaticity. The effect is a heightened self-focus that has negative consequences for motivation, performance and learning—and these effects can potentially reinforce one another and in a vicious cycle.

Optimizing motor skill learning requires an approach that combines positive motivation and effective external focus instructions. Performance expectations can be increased in various ways, including the occasional mentioning of successful performance or learning progress. Furthermore, even small or task-irrelevant choices are sufficient to satisfy the learner's need for autonomy. Finally, with a little creativity, instructions or feedback can be re-worded so that they induce an external rather than internal focus. Often, this results in immediate performance improvements. The consequence of these conditions is potentially a virtuous cycle, with further increases in motivation and continued improvements in performance and learning.

Finally, it should be noted that enhanced expectancies, performer autonomy, and an external focus seem to be indispensable prerequisites for optimal learning. That is, all three factors appear to make relatively independent contributions to learning, and all of them should therefore be part of coaching practice. A series of studies has shown that all possible combinations of two of these factors led to more effective learning than did one factor (or none) (Wulf, Chiviacowsky, & Cardozo, 2014; Pascua et al., 2015; Wulf, Chiviacowsky, & Drews, 2015). Moreover, in another study, a condition with all three factors was found to be more effective or learning than those with any combination of two factors (Wulf, Lewthwaite, Cardozo, & Chiviacowsky, 2018). The implementation of these factor can also have immediate performance benefits. In one study (Chua, Wulf, & Lewthwaite, 2018), increases in maximum jump height were found with the addition of each factor. In that study, one group was provided enhanced expectancies, autonomy support, or an external focus instruction, in a counterbalanced order, on three consecutive trials blocks. With each addition of another factor, jump height increased further whereas it did not change in a control group. Thus, the learning benefits of the OPTIMAL factors appear to be additive in nature. To optimize learning, coaches should therefore incorporate all factors in their training sessions. ❖

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