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Autonomy facilitates repeated maximum force productions

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ABSTRACT

Performer autonomy (or self-control) has consistently been shown to enhance motor learning, and it can also provide immediate benefits for motor performance. Autonomy is also a key variable in the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016). It is assumed to contribute to enhanced expectancies and goal-action coupling, affecting performance effectiveness and efficiency. The purpose of the present study was to examine whether providing autonomy support by giving performers choices would enhance their ability to maintain maximum force levels. Participants were asked to repeatedly produce maximum forces using a hand dynamometer. After 2 initial trials with the dominant and non-dominant hand, stratified randomization was used to assign participants with the same average maximum force to one of two groups, choice or yoked control groups. Choice group participants were able to choose the order of hands (dominant, non-dominant) on the remaining trials (3 per hand). For control group participants, hand order was determined by choice-group counterparts. Maximum forces decreased significantly across trials in the control group, whereas choice group participants were able to maintain the maximum forces produced on the first trial. We interpret these findings as evidence that performer autonomy promotes movement efficiency. The results are in line with the view that autonomy facilitates the coupling of goals and actions (Wulf & Lewthwaite, 2016).

1. Introduction

Autonomy, or being able to make one's own decisions, is considered to be a fundamental psychological need (Deci & Ryan, 2000, 2008) or even biological need (Leotti, Iyengar, & Ochsner, 2010). Like humans, other animals prefer to have choices. Removing opportunities for choice may cause negative responses such as increased stress-related behavior (Owen, Swaisgood, Czekala, & Lindburg, 2005) and cortisol release (Glavin, Paré, Sandbak, Bakke, & Murison, 1994). In contrast, having choices is inherently rewarding (Leotti & Delgado, 2011). Supporting individuals' need for autonomy is critical for performance and well-being in many situations. Autonomy-supportive climates have been associated with persistence in activity engagement and adherence over longer courses of participation (Hagger, Sultan, Hardcastle, & Chatzisarantis, 2015; Yu et al., 2015). It has also been shown to be important for motor performance and learning.

In the motor learning literature, numerous studies have shown that allowing learners to make their own decision about aspects of

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the practice conditions, so-called self-controlled practice, benefits learning relative to yoked control conditions. For instance, learning advantages have been found when learners were allowed to have control over practice variables, including the amount of practice (Lessa & Chiviacowsky, 2015; Post, Fairbrother, & Barros, 2011), timing of performance feedback (Ali, Fawver, Kim, Fairbrother, & Janelle, 2012; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Lim et al., 2015), or use of assistive devices (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2012; Hartman, 2007; Wulf & Toole, 1999).

Furthermore, several studies have shown that even incidental choices, or those not directly related to the task, can enhance learning (e.g., Wulf et al., 2017). For example, choice of golf ball color led to enhanced learning of a golf putting task (Lewthwaite, Chiviacowsky, Drews, & Wulf, 2015, Experiment 1). Also, being able to choose the order of balance exercises resulted in more effective balance learning than did an assigned order of the same exercises (Wulf & Adams, 2014). Even choices that are completely unrelated to the task (e.g., choosing a picture to be hung on a wall) have been found to facilitate motor learning (Lewthwaite et al., 2015, Experiment 2). Moreover, in one recent study, involving the learning of a novel motor skill (throwing a lasso), task-relevant (video demonstration) and task-irrelevant (color of mat placed under the target) choices resulted in the same learning benefits relative to a control condition without choice (Wulf et al., 2017). The fact that learning is facilitated when performers are given choices, regardless of the type of choice, suggests that the underlying mechanisms of this effect are motivational in nature (Lewthwaite & Wulf, 2012; Wulf & Lewthwaite, 2016).

Autonomy is a key variable in the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016). It is assumed to contribute to enhanced expectancies and goal-action coupling, thereby affecting effective and efficient performance. Anticipation to act autonomously has been shown to be related to activation in brain regions associated with a sense of agency (Lee & Reeve, 2013), a state associated with dopamine release (Aarts et al., 2012). Thus, a sense of autonomy would be expected to result not only in longer-term learning benefits but also in immediate enhanced performance. Indeed, in a recent study, letting kickboxers choose the order of different punches led to greater punching velocity and higher impact forces than did an assigned order of punches (Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2016). That is, a relatively incidental choice shortly before task execution produced greater maximal forces compared with those seen in a standard test protocol (with no choice).

Given the potential theoretical and practical implications of those findings, we wanted to replicate them and examine their generalizability. In the present study, participants (non-athletes) were asked to repeatedly produce maximal forces using a hand-grip dynamometer. In one group (choice), participants were able to choose the order of hands (dominant, non-dominant), whereas in another group (control) hand order was determined by the participant's counterpart in the choice group. In contrast to Halperin et al., we used a between-participant design. Thus, participants in one group (choice or control) were not aware of the experimental condition of the other group. We used the perceived choice scale of the Intrinsic Motivation Inventory (IMI; Ryan, 1982) as a manipulation check. We hypothesized that participants in the choice group would have higher ratings of perceived choice and be able to maintain force levels across trials to a greater extent than would control group participants.

2. Method

2.1. Participants

Participants were 30 college students (18 males, 12 females) with an average age of 25.7 years (*SD* = 5.78). Informed consent was obtained from all the participants before the beginning of the experiment. Participants were not aware of the specific purpose of the study, but were informed that maximum forces would be assessed. The university's institutional review board approved the study.

2.2. Apparatus and task

A handgrip dynamometer (MG-4800, Marsden, England) was used to measure the maximum forces produced with the dominant and non-dominant hand. The participant was seated in a chair without armrest. The hand grasping the dynamometer was held in a "hand-shake" position with the elbow flexed at 90 degrees. The display of the dynamometer was turned away from the participant so that they did not receive feedback about the forces produced.

2.3. Procedure

Each participant was first asked to perform a maximum effort trial with the dominant hand, followed by the non-dominant hand. Based on the average force produced on the first 2 trials, a stratified randomization procedure was used to assign participants to one of two groups with similar initial force, the choice or yoked control groups. Participants in the choice group were then asked in which order they wanted to complete the remaining 6 trials. Specifically, they were asked before each trial which hand they wanted to use, with the understanding that they were to perform 3 trials with each hand. Control group participants also understood that they had to perform 3 trials with each hand, but they were informed before each trial which hand to use (determined by their choice-group counterpart). There were 20-s rest periods between trials. Subsequently, participants filled out the perceived choice sub-scale of the IMI (Ryan, 1982). It consisted of 8 statements (e.g., I believe I had some choice regarding this activity) that were rated on a 7-point Likert scale with response options ranging from 1 (*not at all true*) to 7 (*very true*). Participants were then debriefed, provided with performance feedback, and thanked for their time.