Psychology of Sport and Exercise 31 (2017) 28–34

Contents lists available at ScienceDirect

Psychology of Sport and Exercise

journal homepage: www.elsevier.com/locate/psychsport

Autonomy support enhances performance expectancies, positive affect, and motor learning

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ARTICLE INFO

Article history:
Received 3 October 2016
Received in revised form
13 March 2017
Accepted 13 March 2017
Available online 18 March 2017

Keywords:
Choice
Modeling
Ballet

ABSTRACT

Objectives: According to the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016), autonomy support contributes to successful performance and learning in part by enhancing learners' expectancies. The present study was designed to test expectancy-related predictions. Specifically, we examined the effects of practice with autonomy support on learners' self-efficacy, positive affect, and thoughts during practice.
Design: Experimental study with two groups. Movement form was assessed in two different experimental phases, supplemented by questionnaire data.
Method: Ten-year old children were shown a sequence of 5 ballet positions they were asked to learn: Preparatory position, *demi plié*, *tendu* with arms and legs in second position, *passé* with arms in first position, and *elevé* with feet in first position. In the autonomy-support (AS) group, participants were able to choose video demonstrations throughout practice, while control (C) group participants were provided with demonstrations based on their yoked counterparts' choices. One day after practice, participants performed in a retention test.
Results: The AS group demonstrated greater improvements in movement form during practice and enhanced learning relative to the C group. Furthermore, AS participants had higher self-efficacy and greater positive affect than the C group. Also, AS participants reported having more positive thoughts during practice relative to C group participants, who reported more negative and self-related thoughts.
Conclusions: The present findings are in line with OPTIMAL theory predictions. They highlight the motivational underpinnings of the learning benefits that are seen when learners are given choices.

Learner autonomy is important for successful skill learning, and it is therefore a key factor in the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016). Practice conditions that satisfy learners' need for autonomy (Deci & Ryan, 2000, 2008) — including the provision of choices — have reliably been found to result in more effective motor skill learning compared with conditions that do not provide autonomy support (for reviews, see Lewthwaite & Wulf, 2012; Sanli, Patterson, Bray, & Lee, 2013). In most studies examining the effects of so-called self-controlled practice, performers' choices were relevant to task performance. As such they have included the delivery of feedback (e.g., Chiviacowsky & Wulf, 2002; Janelle, Barba, Frehlich, Tennant, & Cauraugh, 1997; Patterson & Carter, 2010), augmented task information (Patterson & Lee, 2010), use of assistive devices (Chiviacowsky, Wulf, Lewthwaite, & Campos, 2012; Hartman, 2007; Wulf & Toole, 1999), or demonstrations of the goal movement (e.g., Bund & Wiemeyer, 2004; Wulf, Raupach, & Pfeiffer, 2005). Relative to control groups, in which participants were yoked (in terms of feedback delivery, etc.) to participants in self-control groups, learning was typically enhanced in the latter groups.

More recent studies have shown that even choices that are more or less incidental to the task can benefit skill learning. For instance, given a choice regarding the order of different balance tasks to be performed, learners' retention performance was superior to that of learners without such choice (Wulf & Adams, 2014). Choice of task order has also been found to increase force production in skilled

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http://dx.doi.org/10.1016/j.psychsport.2017.03.009
1469-0292/

athletes (Halperin, Chapman, Martin, Lewthwaite, & Wulf, 2016). In other studies, allowing participants to choose the color of a ball to be putted (Lewthwaite, Chiviacowsky, Drews, & Wulf, 2015; Experiment 1) or thrown (Wulf, Chiviacowsky, & Cardozo, 2014) led to more effective task learning than yoked conditions. Perhaps most compelling, the learning of a balance task was enhanced when participants were given a choice related to one of two tasks they would practice afterwards, and when they were asked their opinion as to which of two prints of paintings should be hung in the laboratory (Lewthwaite et al., 2015; Experiment 2). Relative to yoked participants who were simply informed of the second task or the print to be hung, the former group demonstrated more effective retention performance on the balance task.

Overall, supporting learners' need for autonomy has been found to enhance learning in numerous studies. Independent of which factor the learner is given control over – or whether or not this factor is directly related to the task to be learned – the learning benefits appear to be very robust. In the literature, various explanations for this effect have been suggested, most of which are related to deeper information processing (e.g., Chen & Singer, 1992; Chiviacowsky & Wulf, 2005; McCombs, 1989; Watkins, 1984) resulting from "self-control." However, findings showing that even incidental choices (e.g., Lewthwaite et al., 2015), or autonomy-supportive as opposed to controlling language (Hooyman, Wulf, & Lewthwaite, 2014), have beneficial effects on learning suggest that information processing is not the root cause of this effect. According to the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016), learner autonomy primarily impacts learners' motivational state. The sense that one is in a situation in which one has control enhances expectations for future success (e.g., self-efficacy). Self-efficacy, or the anticipation of positive experience, aligns thoughts, attention, motivation, and neuromuscular activity to the performer's goals. Thus, autonomy support contributes to what Wulf and Lewthwaite (2016) called *goal-action coupling*, that is, the establishment of effective neural connections that facilitate performance and lead to more effective learning.

The objective of the present study was to further examine the underlying mechanisms of the effects of autonomy support on motor learning. One specific purpose was to explore whether autonomy support enhances expectancies for future performance, or self-efficacy. Only a few previous studies have assessed and demonstrated increased self-efficacy as a result of providing learners choices (Chiviacowsky, 2014; Hooyman et al., 2014; Wulf, Chiviacowsky, & Drews, 2015; Wulf et al., 2014). We hypothesized that self-efficacy would be higher in the choice group. Furthermore, we wanted to assess positive affect as a function of autonomy support. We hypothesized that positive affect would be heightened as a result of choice. While positive affect may simply be a correlate of enhanced expectancies, it has been associated with dopamine release and found to improve cognitive performance in persons with Parkinson's disease (Ridderinkhof et al., 2012). Dopamine also contributes to the consolidation of motor memories when present during and after motor practice (e. g., Floel et al., 2008; Kawashima et al., 2012). Autonomy support is assumed to facilitate motor learning as it signals the rewarding circumstance of control and thus makes dopamine available for neural pathway development and memory consolidation (Murayama, Izuma, Aoki, & Matsumoto, 2017; Wulf & Lewthwaite, 2016). Therefore, we measured the extent of "happiness" the participants experienced during practice. We also determined its correlation with self-efficacy. Finally, we hoped to gain further insight into learners' thoughts and perhaps affective responses by asking them about their thoughts while practicing the ballet sequence. In line with the OPTIMAL theory (Wulf & Lewthwaite, 2016), we assumed that, by enhancing expectancies for success, autonomy support might facilitate a beneficial focus on the task, as opposed to a self-focus that would more likely result from a lack of autonomy support.

In summary, in the present study 10-year old children were asked to learn a series of ballet positions. In the autonomy-supportive condition, participants were given the opportunity to request video demonstrations of the sequence during practice (choice group). In the control group, participants were shown the video whenever their (yoked) counterpart in the choice group had asked for it. Aside from learning, as measured by as assessment of movement form on a delayed retention test, we were interested in the effects, if any, of autonomy support on self-efficacy, positive affect, and learners' thoughts during practice.

1. Methods

1.1. Participants

Twenty-four girls, with an average age of 10.58 years ($SD = 0.5$) and without mental or physical disabilities, participated in the study. They were recruited from a southern Brazilian city. Calculation of the sample size was carried out using G*Power 3.1, with an α level of 5%, effect size (f) of 0.62, and a power of 80%, 2 groups, based on effect sizes reported in previous work using similar designs (e.g., $\eta_p^2 = 0.78$ in Chiviacowsky, 2014; $\eta_p^2 = 0.25$ in Lewthwaite et al., 2015). All participants were naive as to the purpose of the experiment and none of them had experience with classical ballet. The children gave their assent, and informed consent was obtained from their parents or guardians. The study was approved by the university's institutional review board.

1.2. Apparatus and task

The task involved learning the movement forms associated with five classical ballet positions: Preparatory position, *demi plié*, *tendu* in second position of arms and legs, *passé* with arms in first position, and *elevé* with feet in first position. The experiment was conducted in a gymnastics hall. Photos of a ballet dancer performing the sequence of positions were used in the initial instruction of the task (see Fig. 1). A laptop computer was used for the video demonstrations. A video camera facing the participant was set up at a distance of 4 m to record performances for later analysis.

1.3. Procedure

Participants were randomly assigned to the choice or control groups, with an equal number of participants in each group. Before the beginning of practice, each participant was shown photos of the 5 sequential positions. In addition, the experimenter gave them a verbal description of the task, in which she highlighted five aspects of each position (arms, legs, feet positions, hip alignment, and trunk axis). Participants then performed the first trial. Each trial consisted of the participant's performing each of the five sequential positions. After the first trial, choice group participants were informed that they would be able to ask for video demonstrations of the entire sequence of five positions before any of the remaining practice trials. Control group participants were told that the experimenter would occasionally show them a video demonstration of the task. Each participant in the control group was yoked to a participant in the choice group and also received a demonstration of all five positions before the same trials on which their counterpart had requested one. The practice phase consisted of 50 trials. A retention test was performed one day later. It consisted of 10 trials without reminders or demonstrations.