*Journal of Physical Education and Sport* ® (JPES), Vol. 21 (3), Art 163, pp. 1284 - 1293, May 2021
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

**Original Article**

# Effects of learners' choice of video self-modeling on performance accuracy and perceived cognitive consistency

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Published online: May 31, 2021
(Accepted for publication May 15, 2021)
**DOI:10.7752/jpes.2021.03163**

**Abstract**
**Introduction:** Video self-modeling is often used to improve motor learning. Meanwhile, the need to consider methods that allow learners to make their own choices to provide efficient observational learning has been suggested. **Purpose:** In this study, we examined the effects of viewing video self-modeling created from the material chosen by learners. The results of interest were (1) whether learners' chosen video self-modeling material influenced ball-throwing accuracy and cognitive consistency with success experiences between learners' motor imagery and their video self-modeling and (2) the relationship between cognitive consistency and each variable. **Methods:** Thirty-six participants were randomly assigned to three groups: (1) self-choice group (participants selected the video self-modeling clip), (2) other-choice group (experimenter selected the clip), and (3) control group (no clip viewing). The experimental task involved ball-throwing performed with the non-dominant hand (six blocks with five trials each). We measured motivation, cognitive consistency, self-efficacy, and performance results (ball movement cessation position) by recording ball-throwing accuracy and stability. **Results:**Throwing stability was significantly reduced in blocks 5 and 6 compared to block 1 in all groups. Cognitive consistency scores were significantly higher in the self-choice group than in the other-choice group. In all groups, motivation and self-efficacy were higher after the task. Furthermore, the self-choice group showed a positive correlation between cognitive consistency and motivation and a negative correlation between cognitive consistency and throwing stability. In contrast, the other-choice group only showed a negative correlation between cognitive consistency and ball-throwing stability. **Conclusions:** Although the results of the present study did not demonstrate different effects of video choice on performance, it has been suggested that a learner's chosen video self-modeling material may positively influence ball-throwing stability and variables such as cognitive consistency and motivation.
**KeyWords: observational learning, self-control, throwing stability, throwing accuracy, motivation**

## Introduction

When individuals begin learning a new movement, observing a model performing the movement effectively promotes learning. Video self-modeling (VSM) is an observational learning tool based on the self-modeling theory (Dowrick, 1983, 1999). By observing VSM, observers can change their behaviors and psychological aspects after observing themselves being successful in the past (Dowrick, 1983, 1999, 2012). VSM simulates a successful future event that shows achievement beyond the individual's current capability by integrated or modified the existing behavior in the repertoire (Dowrick, 2012). In particular, aVSM technique called "feedforward" is known to produce very rapid learning and is useful for establishing imagery for people who lack in successful experiences (Dowrick, 2012).

Previous studies on VSM have reported effects on motor movement and outcomes including improved volleyball service success rates (Ram & McCullagh, 2003) and swimming strokes (Clark & Ste-Marie, 2007). Further studies have shown positive effects on psychological aspects, such as promoting self-efficacy and motivation (e.g., Clark & Ste-Marie, 2007; Steel et al., 2018; Zetou, Kourtesis, Getsiou, Michalopoulou, &Kioumourtzoglou, 2008), and improved use of imagery (Rymal& Ste-Marie, 2016). VSM improves learners' understanding by recombining existing skills, and promotes rapid behavior change (Steel et al., 2018). Steel et al. (2018) conducted a cup-transport task to examine the influence of VSM on limb reaching and grasping ability. The researchers reported improved task performance due to the training effects of VSM. Based on this result, they suggested that VSM is useful for improving general movement ability in movement disorders. Most previous studies of motor learning have reported the effects of VSM on motor movement-related variables.

However, the effects of VSM on psychological aspects appear to be inconsistent (e.g., Clark & Ste-Marie, 2007; Rymal& Ste-Marie, 2016; Yamasaki, Sugiyama, Murakami, & Uchida, 2006). Yamasaki et al. (2006) examined the influence of motivational videos based on VSM on performance results, motivation, and self-efficacy in volleyball. The researchers reported mixed results, with self-efficacy and motivation increasing


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in some, while decreasing in others, after viewing VSM. They suggested that the different results among participants may have been due to cognitive discrepancies regarding the definition of successful behavior betweenthe athletes and the experimenter. This result suggests that coaches should consider the individual preferences of athletes regarding performance analysis. Furthermore, Rymal and Ste-Marie (2016) found that viewing VSM adversely affected performance in early interventions for athletes with low visual imagery ability. They stated that people with poor visual imagery abilities could be adversely affected, as they would need to use visual techniques to successfully integrate new motor movements. Therefore, we thinkit is important to understand the degree of consistency between individuals' motor imagery and viewing VSM (defined as cognitive consistency). If a person with insufficient motor knowledge, such as a beginner or novice, views VSM in the early stages of learning, then the integration of video and motor imagery may not be successful. Accordingly, learners who view self-chosen VSM material would be expected to exhibit higher cognitive consistency with the imagery, as there would be no discrepancy between the learner's ideal motor imagery and the VSM.Based on the findings of these studies, Ste-Marie (2013) emphasized the need to consider cognitive, emotional, and motor optimizationfor it to be used effectively in motor learning and exercise.Therefore, recent studies havesuggested the importance ofconsidering how to provide observational videos(for review, Ste-Marie, Law, Rymal, Jenny, Hall, & McCullagh, 2012; Ste-Marie, Lelievre, & St. Germain., 2020).

One claimed method of improving the effectiveness of observational learning was to allow the learner to control (i.e., choice) the experimental taskand content such as feedback timing and provision of demonstration(Ste-Marie et al., 2012; Ste-Marie et al., 2020). Choice has been reportedtoaffectmotor learning (Lemos, Wulf, Lewthwaite, &Chiviacowsky, 2017; Ste-Marie, Vertes, Law, &Rymal, 2013; Wulf,Iwatsuki, Machin, Kellogg, Copeland, & Lewthwaite, 2018), performance (Murayama, Matsumoto, Izuma, Sugiura, Ryan, Deci, & Matsumoto, 2015), motivation (Deci, Connell, & Ryan, 1989; Deci & Ryan, 1985; Ryan & Deci, 2000, 2009; Ste-Marie et al., 2013; Wulf, Freitas, & Tandy, 2014), and the illusion of control (Murayama, Izuma, Aoki, & Matsumoto, 2016; Rose, Geers, Rasinski, & Fowler, 2012; Sullivan-Toole, Richey, &Tricomi, 2017). For example, Lemos et al. (2017) allowed learners to choose when a demonstration video on learning ballet movement forms was presented. Learners in the self-choice groupshowed enhanced ability to acquire movement forms, as well as increased self-efficacy and positive affect, compared to the other-choice group. Moreover, Rose et al. (2012) examined the effects of the illusion of control on subjective pain in a group that chose their preferred treatment from two optionsand in agroup that could not. The results showed a reduction of painin the choice group compared to the no-choice group. Rose et al. (2012) reported that the act of choice may control the cognitive processing of events via the illusion of control. Based on these research reports, it is possible to optimize the effects of choice on the cognitive and emotional aspects of learning.Previous studies using VSM have reported that cognitive discrepancies can occur, (Yamasaki et al., 2006) and that the internal cognitive integration of VSM and novel motor movement is difficult during the early stages of interventions (Rymal& Ste-Marie, 2016). Allowing participants to make choices in a VSM research paradigm could be expected to improve the issues with cognitive discrepancies, integration with VSM and motor imagery, and motivation.

This study examined whether learners' chosen VSM material influences ball-throwing accuracy and cognitive consistency. In addition, the relationships between cognitive consistency and throwing accuracy, throwing stability, self-efficacy, and motivation were also evaluated. As a motor task, this study used a ball-throwing task. In observational learning, it is important to form cognitive representations that accurately reproduce the observation target. Motor performance in this study was evaluated by noting the throwing form (i.e., from the start of motor behavior to the ball release) and throwing results (i.e., from after ball release to the ball ceasing motion). We chose these tasks to examine the cognitive consistency between VSM material and the learners' own imagery. Currently, no data detail the determinants of cognitive consistency. Collecting and examining these data should help develop a strategy for the effective use of VSM. We proposed the following hypotheses: (1) the motor performance results would be more accurate and stable when viewing self-chosen VSM compared to the other conditions; (2) self-choice VSM observation would enhance cognitive consistency compared to viewing other-choice VSM.

**Material & methods**

*Participants*

Thirty-sixuniversity students (male: 16, 44.4%; female: 20, 55.6%; mean age = 21.04 years, standard deviation [SD] = 1.24) were recruited for the study. All participants were right-handed, as assessed by the Chapman Handedness Inventory (Chapman & Chapman, 1987). This study was approved by the ethics committee of Doshisha University (approval number: 18065). Informed consent was obtained from all participants. The necessary sample size which would have adequate power (i.e.,1-β ≥0.80)was determined using G*Power version 3.1.9.3(Faul, Erdfelder, Lang, & Buchner, 2007). For a medium effect size (f = 0.25), significance level (α) set at 0.05, and power (1-β) set at 0.80.The mixed-factor analysis of variance (ANOVA) calculation yielded a recommended total sample size of 24 for the interaction between groups (three levels) and blocks of motor performance (six levels).In addition, it calculated a sample size of 36 for the interaction between groups and time of affective response (three levels).

*Task and apparatus*

This study involved a ball-throwing task in which a seated participant used the non-dominant hand to throw a bocce ball (circumference: 270 mm, SD = 8 mm; weight: 275 g, SD = 12.0 g) to a target circle (diameter: 10 cm) 4.2 meters away. The target was hidden by a screen (height 173 cm × width 121 cm) placed 26 cm in front of the participant. Two cameras recorded the throws: Camera 1 (C1: SONY HDR-CX630V) was attached to a tripod, 60 cm above the ground, while camera 2 (C2: SONY HDR-CX630V) was 1.3 m above the ground attached to a tripod. The C1 lens was positioned 0 m laterally and 2.25 m vertically from the target, while the C2 lens was aligned 1 m laterally and 5.90 m vertically from the participants. The experimental setup is illustrated in Figure 1. iMovie (version 10.1.10) was used to edit the footage and construct the VSM (see, the *Procedures* section for details of the editing process). The VSM movie created for each participant was displayed on a 21-inch monitor (ASUS, E261448).


Figure 1. Arrangement of experimental apparatus

*Measurements*

To investigate inter-individual differences in participants' internal imagery and the VSM that they watched (i.e., cognitive consistency), we collected ratings from participants on two questions using a 100 mm visual analog scale (VAS). The two questions were, "How closely do you feel that the throwing form of the viewed video matches your imagery of your own throwing form?" and "How closely do you feel that the throwing outcome of the viewed video matches the imagery of your own throwing result?" Throwing form was defined as the start of the throwing motion until just before the ball is released, and throwing outcome was defined from the ball release until the ball is stopped.The 0-mm point on the scale indicated "not closely at all," and the 100-mm point indicated "very closely." Participants marked the most applicable position on the scale with a line. Participants' degree of motivation to accomplish the experimental tasks was evaluated using the VAS and the question, "How motivated are you feeling about the task?"

The self-efficacy measure was developed based on Bandura's (2006) guidelines. Participants were asked, "How well can you do the tasks from now on?" Responses were collected using an 11-point rating scale with 10-point intervals, ranging from 0 (not at all) through 50 (to a certain extent), to 100 (can do it very well). Participants provided a checkmark at the appropriate point.

Accuracy in the throwing task was defined as the average distance (in cm) from where the ball's movement ceased to the center of the target. The distance between the vertical and horizontal coordinates from the center of the circle to the ball stop position was measured, and the length of the straight distance was calculated using the Pythagorean theorem. Stability was defined as the standard error of the accuracy in each block using the following formula:

$$Stability = \sqrt{\frac{1}{n}\sum_{i=1}^{n}|X_i - \bar{X}|^2}$$

*Procedure*

The participants were randomly assigned to one of three groups. First, the self-choice group (SCG) was defined as one in which the participants chose and watched a video, with their own option. Second,the other-choice group (OCG) was defined as one in which the experimenters selected the video clip with the best outcome and provided it to the participants to watch. Finally, the control group (CG) was defined as one in which the participants only performed the experimental tasks and did not watch any video. The final study design consisted of a pre-test (before watching the VSM material)with three blocks of five trials, used to generate the VSM material. Following the pre-test, the participants viewed the VSM material and then performed the post-test, also consisting of three blocks with five trials each.

Before the experiment (defined as Time 1), we asked participants to watch a demonstration video of the experimental task, and after viewing, respond to the self-efficacy question and the motivation question. After responding, the participants practiced the throwing task three times without the screen. After practicing, they performed the throwing task in three blocks of five trials each (pre-test; block1, block2, and block3). The number of trials was chosen by determining the minimum number of trials after which throwing performance was no longer enhanced based on preliminary experiments.Participants in the SCG were asked to select one video of the movement form in each block that they thought was closest to the target. After making this choice, the participants received visual feedback on their motor performance. For the OCG participants, the experimenter explained that a video that showed the closest throw to the target had been selected from the block;the experimenter had measured the distance between the final position of the ball and the center of the target circle at the end of each trial. The experimenter informed the participant about which video had been chosen. After the experimenter chose the VSM material, we provided feedback on the task outcome for the SCG. The CG received feedback,but did not choose and/or view any video material.

After the pre-test, the VSMs of the SCG and OCG were edited into one video that represented the three throwing actions chosen by the learner or by the experimenter, respectively. One results video was generated that showed the closest distance to the target among the recorded throwing forms; the VSM was created by combining the three best throwing forms and one throwing result (Figure 2). The length of each throwing-form clip was c. 3–5 seconds, while the length of the results clip was c. 5 seconds. The edited video playback time was c. 20–30 seconds. Participants in the SCG and OCG were asked to watch the VSM while sitting in a chair.

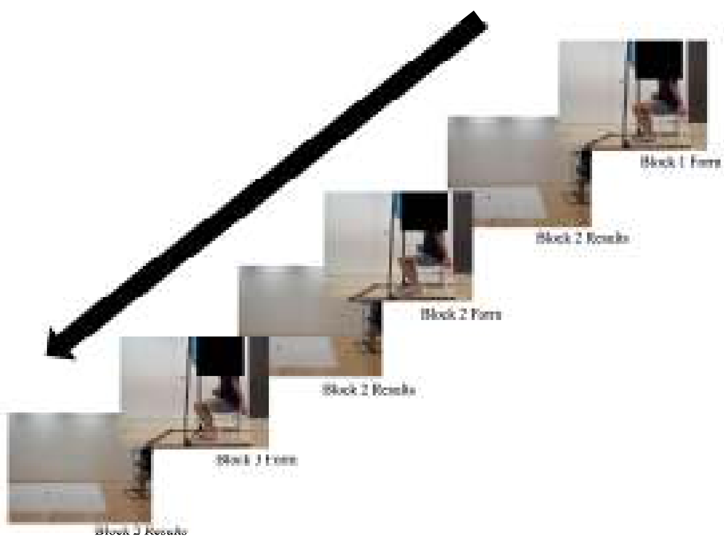


Figure 2. VSM components. The participant chose one throwing form example he or she thought was closest to the target for each block of the pre-test (in the other-choice group, the experimenter chose the throw that was closest to the target). The learner and/or experimenter chose a total of three examples of throwing form footage, and the experimenter determined the footage that showed the closest throw to the target from among them. Throwing result footage was presented after the form footage of each block. The VSM viewing time was c. 20-30 seconds.

After watching the video, the SCG and OCG responded to a question that assessed cognitive consistency and responded to the questions that were presented at Time 1 for a second time (defined as Time 2). The CG only answered the same questions as at Time 1. After answering the questions, the participants performed the post-test. The post-test was performed in three blocks (block4, block5, and block6) the same as the pre-test, except that feedback was not given following each block. Finally, after completing the task (defined as Time 3), participants responded to the self-efficacy and motivation questions.

*Data analysis*

Cognitive consistency data were compared between SCG and OCG using an independent t-test. The motivation and self-efficacy data were analyzed via a 3 Group (SCG, OCG, CG) × 3 Time (times 1, 2, 3) ANOVA, in which time was a repeated-measures factor. Accuracy and stability data were analyzed via a 3 Group (SCG, OCG, CG) × 6 Block (blocks1, 2 3, 4, 5,and 6) ANOVA, in which block was a repeated-measures factor. Holm's Sequentially Rejective Bonferroni test was used for multiple comparisons following the calculation of the ANOVAs. We examined the Pearson product-moment correlations between cognitive consistency and each variable, namely self-efficacy, motivation, accuracy, and stability. The significance level (alpha; α) of this study was set to 5% ($p< .05$). Furthermore, the marginally significant difference was set to 10% ($p< .10$). Regarding effect size, for the ANOVAs, we computed partial eta-squared values ($\eta_p^2$), and for the multiple comparisons and t-tests, we computed Cohen's *d*. The 95% confidence interval (CI) standardized effect size was calculated based on a noncentral distribution.

**Results**

*Accuracy of choice*

In each block, the SCG participants' chosen most accurate throwing footage was three of the 12 learners in block1, three learners in block 2, and five learners in block 3 within the SCG. In addition, participants' chosen most inaccurate throwing footage was five of the 12 learners in block 1, one learner in block 2, and one learner in block 3. Consequently, learners did not choose completely accurate or inaccurate performances throughout the block.

*Accuracy*

The accuracy results are shown in Table 1. To examine the effect of viewing the chosen video material on accuracy in the ball-throwing task, a 3 Group (SCG, OCG, CG) × 6 Block (blocks 1 to 6) ANOVA was conducted, in which 'block' was a repeated-measures factor. There was a significant main effect of 'block'[$F(5, 165) = 3.03$, $p = .012$, $\eta_p^2 = 0.08$, 95% CI = 0.02–0.14]. However, post hoc tests revealed no significant differences between pairs of blocks. In addition, there was a marginally significant interaction [$F(10, 165) = 1.75$, $p = .074$, $\eta_p^2 = 0.10$, 95% CI = 0.04–0.12]. The post hoc tests, however, revealed that the mean distance from the target was longer for the OCG than for the CG in block2 [$p = .016$, $d = 1.26$, 95% CI = 0.33–2.18]. The main effect of 'group' was not significant [$F(2, 33) = 1.05$, $p = .363$, $\eta_p^2 = 0.06$, 95% CI = 0.00–0.18].

*Stability*

The stability results are shown in Table 1. To examine the effect of viewing the chosen video material on stability in the ball-throwing task, a 3 Group (SCG, OCG, CG) × 6 Block (blocks 1 to 6) ANOVA was conducted, in which 'block' wasa repeated-measures factor. There was a significant main effect of 'block' [$F(5, 165) = 2.50$, $p = .033$, $\eta_p^2 = 0.07$, 95% CI = 0.01–0.11]. Post hoc tests showed that throws were stable in block 5 [$p = .018$, $d = 0.57$, 95% CI = 0.09–1.05] and block6 [$p = .031$, $d = 0.71$, 95% CI = 0.22–1.19]compared to block 1. However, neither the main effect of 'group'[$F(2, 33) = 1.35$, $p = .273$, $\eta_p^2 = 0.08$, 95% CI = 0.00–0.21], nor the interaction [$F(5, 165) = 0.34$, $p = .969$, $\eta_p^2 = 0.02$, 95% CI = 0.01–0.02]wassignificant.

Table 1. Accuracy and stability scores

| Variable | Group | Block 1 (SD) | Block 2 (SD) | Block 3 (SD) | Block 4 (SD) | Block 5 (SD) | Block 6 (SD) | *Interaction* *F*-value (Effect size, 95% CI) | Main effects *F*-value (Effect size, 95% CI) Group | Block |
|---|---|---|---|---|---|---|---|---|---|---|
| Accuracy | Self-choice | 75.44 (24.20) | 71.17 (26.99) | 58.76 (22.49) | 56.12 (16.54) | 59.94 (23.03) | 59.47 (18.12) | $1.75^{\dagger}$ ($\eta_p^2 = 0.10$, 0.04-0.12) | 1.05 ($\eta_p^2$ = 0.06, 0.00-0.18) | $3.03^{*}$ ($\eta_p^2$ = 0.08, 0.02-0.14) |
| | Other-choice | 85.46 (43.79) | 88.49 (30.61) | 64.26 (20.23) | 73.03 (30.07) | 63.74 (20.90) | 61.12 (25.37) | | | |
| | Control | 75.92 (24.10) | 57.06 (17.79) | 68.69 (20.15) | 77.91 (29.20) | 69.16 (24.45) | 67.03 (23.90) | | | |
| Stability | Self-choice | 38.80 (20.40) | 33.55 (16.68) | 29.41 (16.17) | 25.80 (10.76) | 25.37 (16.39) | 24.71 (9.81) | 0.34 ($\eta_p^2 = 0.02$, 0.01-0.02) | 1.35 ($\eta_p^2$ = 0.08, 0.00-0.21) | $2.50^{*}$ ($\eta_p^2$ = 0.07, 0.01-0.11) |
| | Other-choice | 47.76 (34.15) | 44.03 (40.03) | 36.88 (22.27) | 39.86 (26.37) | 32.04 (15.44) | 28.78 (17.85) | | | |
| | Control | 38.51 (18.18) | 31.60 (22.05) | 33.88 (31.58) | 38.05 (13.96) | 31.09 (19.05) | 28.95 (13.63) | | | |

$^{\dagger}p< .10$, $^{*}p< .05$

*Note: CI, confidence interval; SD, standard deviation*

*Cognitive consistency*

The cognitive consistency of throwing form and throwing outcome is shown in Table 2. The cognitive consistency form score was marginally significantly higher in the SCG ($M$ = 82.08, $SD$ = 12.20) than in the OCG ($M$ = 72.50, $SD$ = 12.28), [$t(22) = 1.92$, $p = .068$, $d = 0.78$, 95% CI = −0.10–1.66]. In addition, the cognitive consistency outcome score was significantly higher in the SCG ($M$ = 88.09, $SD$ = 9.10) than in the OCG ($M$ = 66.67, $SD$ = 15.86), [$t(22) = 4.06$, $p = .001$, $d = 1.66$, 95% CI = 0.67–2.64].

Table 2. Cognitive consistency of movement form and motor results

| Variable | Group | mm (SD) | $t$-value (Effect size, 95% CI) |
|---|---|---|---|
| Cognitive Consistency Form | Self-choice | 82.08 (12.20) | 1.92$^{\dagger}$ (Cohen's $d$ = 0.78, -0.10-1.66) |
| | Other-choice | 72.50 (12.28) | |
| Cognitive Consistency Outcome | Self-choice | 88.08 (9.10) | 4.06$^{***}$ (Cohen's $d$ = 1.66, 0.67-2.64) |
| | Other-choice | 66.67 (15.86) | |

$^{\dagger}p< .10$, $^{***}p< .001$

*Note: CI, confidence interval; SD, standard deviation*

*Motivation*

The results for motivation are shown in Table 3. To investigate the effect of VSM viewing on motivation, a 3 Group (SCG, OCG, CG) × 3 Time (Time 1, 2, 3) ANOVA was conducted, in which 'time' was a repeated-measures factor. There was a significant main effect of 'time'[$F(2, 66) = 5.11$, $p = .008$, $\eta_p^2 = 0.13$, 95% CI = 0.02–0.25]. Post hoc tests showed that motivation at Time 2 was higher than at Time 1 [$p = .027$, $d = 0.33$, 95% CI = −0.15–0.80] and at Time 3 [$p = .007$, $d = 0.38$, 95% CI = −0.10–0.85]. However, the main effect of 'group' was not significant [$F(4, 66) = 0.50$, $p = .125$, $\eta_p^2 = 0.01$, 95% CI = 0.00–0.32], nor was the interaction [$F(2, 33) = 2.22$, $p = .737$, $\eta_p^2$= 0.03, 95% CI = 0.00–0.06].

*Self-efficacy*

The results for self-efficacy are shown in Table 3. To examine the effects of viewing chosen video material on self-efficacy, a 3 Group (SCG, OCG, CG) × 3 Time (Time 1, 2, 3) ANOVA was performed, in which 'time' was a repeated-measures factor. There was a significant main effect of time, [$F(2, 53) = 19.33$, $p = .000$, $\eta_p^2 = 0.37$, 95% CI = 0.15–0.50]post hoc tests showed that self-efficacy was greater at Time 2 than at Time 1 [$p = .001$, $d = 0.70$, 95% CI = 0.22–1.19] and at Time 3 [$p = .014$, $d$ =0.30, 95% CI = −0.17–0.78], and self-efficacy at Time 3 was also significantly greater than at Time 1 [$p = .000$, $d = 0.37$, 95% CI = −0.85–0.10]. However, neither the main effect of group [$F(2, 33) = 1.18$, $p = .400$, $\eta_p^2 = 0.05$, 95% CI = 0.00–0.16] nor the interaction [$F(4, 66) = 0.50$, $p = .330$ , $\eta_p^2 = 0.07$, 95% CI = 0.01–0.12] was significant.

Table 3. Motivation and self-efficacy score

| Variable | Group | Time 1 (SD) | Time 2 (SD) | Time 3 (SD) | *Interaction* $F$-value (Effect size, 95% CI) | Main effects $F$-value (Effect size, 95% CI) Group | Time |
|---|---|---|---|---|---|---|---|
| Motivation | Self-choice | 7.73 (1.17) | 8.41 (1.40) | 7.81 (1.48) | 2.22 ($\eta_p^2$ = 0.03, 0.00-0.06) | 0.50 ($\eta_p^2$ = 0.01, 0.00-0.32) | 5.11$^{**}$ ($\eta_p^2$ = 0.13, 0.02-0.25) |
| | Other-choice | 7.23 (1.38) | 7.95 (1.61) | 7.22 (1.30) | | | |
| | Control | 6.92 (1.76) | 7.03 (1.57) | 6.57 (1.76) | | | |
| Self-Efficacy | Self-choice | 64.17 (13.79) | 78.33 (9.37) | 75.00 (13.14) | 0.50 ($\eta_p^2$ = 0.07, 0.01-0.12) | 1.18 ($\eta_p^2$ = 0.05, 0.00-0.16) | 19.33$^{***}$ ($\eta_p^2$ = 0.37, 0.15-0.50) |
| | Other-choice | 60.83 (17.30) | 70.83 (16.21) | 67.50 (16.58) | | | |
| | Control | 60.83 (21.52) | 70.00 (15.37) | 62.50 (19.60) | | | |

$^{**}p< .01$, $^{***}p< .001$

*Note: CI, confidence interval; SD, standard deviation*

*Correlations*

Correlations were generated to examine how cognitive consistency in the SCG and OCG was associated with cognitive and motor variables (Table 4). In the SCG, cognitive consistency of throwing form was positively correlated with throwing outcome [*r* = .65, *p* = .023, 95% CI = 0.12–0.89] and motivation at Time 3 [*r* = .67, *p* = .017, 95% CI = 0.16–0.90]. In the SCG, cognitive consistency of throwing outcome was positively correlated with throwing form [*r* = .64, *p* = .023, 95% CI = 0.12–0.89] and motivation at Time 2 [*r* = .60, *p*= .039, 95% CI = 0.04–0.87], and negatively correlated with stability in block 6 [*r* = −.58, *p* = .005, 95% CI = −0.87 to−0.01]. Although cognitive consistency of throwing form in the OCG was not significantly (*n.s.*) correlated with any variables, cognitive consistency of throwing results was negatively correlated with stability in block 1 [*r* = −.72, *p* = .008, 95% CI = −0.92to−0.25] and block 6 [*r* = −.64, *p*= .026, 95% CI = −0.89 to−0.10].

Table 4. The Correlation of Cognitive Consistency × Motivation & Stability

| | | Cognitive Consistency | | Motivation | | | Stability | |
|---|---|---|---|---|---|---|---|---|
| Group | Variable | Form | Outcome | Time 1 | Time 2 | Time 3 | Block 1 | Block 6 |
| SCG *n* =12 | Cognitive Consistency Form | | .65* (0.12, 0.89) | .20 (-0.42, 0.70) | .52 (-0.07, 0.85) | .67* (0.16, 0.90) | .56 (-0.02, 0.86) | .24 (-0.39, 0.71) |
| | Cognitive Consistency Outcome | .65* (0.12, 0.89) | | .21 ( -0.42, 0.70) | .60* (0.04, 0.87) | .49 (-0.12, 0.83) | -.05 (-0.60, 0.54) | -.58* (0.87, - 0.01) |
| OCG *n* =12 | Cognitive Consistency Form | | .20 (-0.42, 0.69) | .07 (-0.52, 0.62) | -.06 (-0.62, 0.53) | .08 (-0.52, 0.62) | .12 (-0.49, 0.65) | .01 (0.57, 0.58) |
| | Cognitive Consistency Outcome | .20 (-0.42, 0.69) | | -.11 (-0.64, 0.50) | .19 (-0.43, 0.69) | -.16 (-0.67, 0.46) | -.72** (-0.92, - 0.25) | -.64* (-0.89, - 0.10) |

$^{*}p< .05$ $^{**}p< .01$

*Note:Regarding the group defined as follows, SCG is the self-choice group and OCG is the other-choice group. Only variables with a statistical significance correlation are shown. The 95% confidence interval is in parentheses.*

**Discussion**

This study examinedwhether learners' chosen VSM material influences ball-throwing accuracy and cognitive consistency between learners' motor imagery and their behavior. In addition, the relationship between cognitive consistency and each variable, namely self-efficacy, motivation, accuracy, and stability, was also considered.Throwing accuracy and stability did not differ between the groups. Motor stability was better in blocks 5 and 6, than in block 1,that is, practice seemed to have a positive effect on stability, regardless of viewing the chosen video or not. The OCG demonstrated less accurate throwing than the CG in block 2. Therefore, our first hypothesiswas not supported in this experiment that the motor performance results would be more accurate and stable when viewing self-chosen VSM compared to the other conditions. In this study, the forced determination of the video elements to be viewed may have affected motor performance in the subsequent block; however, the effect was not observed after block 2, and it is unclear why the OCG was less accurate than the control group. Thus, further verification is needed for the effect of the forced-choice viewing on accuracy.Cognitive consistency between the VSM and the learner's imagery was higher for self-choice VSM than for the VSM chosen by another person. The learner's chosen VSM material was useful for enhancing cognitive consistency, thus supporting our second hypothesis that self-choice VSM observation would enhance cognitive consistency compared to viewing other-choice VSM.

In previous VSM studies, early interventions were not integrated with imagery (Rymal& Ste-Marie, 2016), and there were cognitive discrepancies between participants and experimenters.In other words, what the experimenter chosen as the ideal video may not have beendesiredby the participant(Yamasaki et al., 2006). The availability of choice can facilitate a positive impression of learners' goals and movement more effectively (Lemos et al., 2017), and can control the perception of desired outcomes (Leotti, Iyengar, & Ochsner, 2010; Rose et al., 2012).The allowance of choosing the VSM material oneself should facilitate better recognition of the cognitive dynamics and interactions that occur between learners' motor performance and the VSM, than when the VSM material chosen by another person.Furthermore, this result has been quite interesting inthat the chosen footage was not definitely always the best one. Choice givesthe illusion of control to induce positive cognition inindividuals (Murayama et al., 2016; Rose et al., 2012; Sullivan-Toole et al., 2017).It has been reported that learning is facilitated when learners perceive a better outcome than the actual result (Palmer, Chiviacowsky, & Wulf, 2016).This effect could possibly contribute to the improvement of task motivation and performance stability.

In the SCG, cognitive consistency was associated with motivation and motor stability, whereas in the OCG, it was only associatedwith motor stability. This indicates that the results support some of the results of previous studies. The choice is rewarding per se (Aoki et al., 2014; Leotti& Delgado, 2014; Leotti et al., 2010), improves motivation (Deci & Ryan, 1985; Ste-Marie et al., 2013; Wulf et al., 2014), and enhances task performance (Iwatsuki, Abdollahipour, Psotta, Lewthwaite, & Wulf, 2017; Lewthwaite, Chiviacowsky, Drews, & Wulf, 2015; Murayama et al., 2015; Wulf et al., 2018). When a person's behavior is motivated based on decision-making, learning can be conceptually understood deeper than when a person's behavior is notmotivated (Ryan & Deci, 2009).Although this deduction must be interpreted with caution,as it could be based on correlation not causality, increased cognitive consistency in the SCG could be enhancing motivation and motor performanceby working as a reward for participantsmaking their own choice.

However,viewing VSM did not show a direct impact on motivation and self-efficacy. Therefore, further studies are necessary to explain these findings. Steel et al. (2018) found an increase in anxiety while doingnew tasks; this finding may be relevant to the results of this study. In the introspective reports, many participants showed anxiety in their answers to the questions, which were asked after the experiment, including "The difficulty of the task has risen," "I am anxious because I can't confirm the performance results," and "I do not know if I am approaching the target in the second half of the test." Anxiety has been suggested to reduce self-efficacy and motivation. From these findings, it may be possible that there was no difference between the effects of self-choice and other-choice VSM. Self-choice VSM also needs to consider other approaches to improve self-efficacy and motivation.

These results demonstrate that the effect of choice can be observed by choosing some, but not all, of the materials that comprise the VSM. However, as mentioned before, the influence of choice on motivation or performance was not seen. Additionally, even though the current chosen video were not necessarily best choice, they were shown to have high cognitive consistency. This may be because of the illusion of control caused by freedom of choice. Future research should investigate the conditions and situations in which self-choice VSM affects motor performance, motivation, and accuracy of choice, to provide learners with efficient VSM for motor learning.

**Conclusions**

Through this study, it has become clear that (1) the learner's chosen VSM material increased cognitive consistency with the learner's motor imagery, compared to viewing the VSM chosen by others, and (2) the chosen VSM also influenced motivation and motor performance stability by increasing cognitive consistency. This finding may affect future research using VSM. In many previous studies, VSM was produced by the experimenter and provided to the learner (e.g., Clark & Ste-Marie, 2007; Rymal& Ste-Marie, 2016). In these cases, discrepancies between the VSM and the learner's motor imagery could have hindered the development oflearners' motorskills. In a motor learning situation, not only acquiring of the motor behavior, but also the learner's motivation and attitude toward the task are important as elements that promote learning (Sanli, Patterson, Bray, andLee, 2013). In recent research, many intervention methods have been studied, primarily using the self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000). According to the self-determination theory,choice enhances intrinsic motivation, whereas feeling controlled weakens intrinsic motivation (Deci et al., 1989).Thus, self-choice VSM would indirectly promote motivation and motor acquisition by consistency between video and motor imagery more than other-choice VSM.These findings may be useful for learners when choosing the video elements in VSM.

Based on this study's findings, it is expected that VSM will not only been used in motor learning situations, but it will also be applied to physical education and other skill training in the future. However, this study could not examine the effects of VSM on motor learning, and this is a subject for future research. Furthermore,it has not completely explained why the cognitive consistency score of the SCG was increased regardless of inaccuracy of choice. It will be necessary to consider what accuracy of choice influenced cognitive consistency and motor learningin order to understand cognitive consistencyExamining methods that foster learners' agency and learning (e.g., viewing angle of the movement and the number of options to choose) could be used to achieve these applications and answer the remaining questions related to VSM.

**Conflicts of interest**

The authors declare that they have no competing interests.

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