Contents Lists is Available Online
International Journal of Motor Control and Learning (IJMCL)
Journal Homepage: www.ijmcl.com

# The Effect of Constant or Variable Training Distance on the Generalization of Throwing Skills

Arezo Ahmadpour[a]*, Farhad Heidari[a], Floris T. Van Vugt[b, c]

[a] Department of Physical Education and Sport Sciences, Faculty of Humanities and Social Sciences, University of Kurdistan, Pasdaran St, Sanandaj, Kurdistan, Iran.
[b] Department of Psychology, University of Montreal, Pavillon Marie-Victorin, 90 avenue Vincent d'Indy, Montréal (QC), H2V 2S9.
[c] Haskins Laboratories, New Haven, Connecticut, USA.

**Keywords**

Generalization
Motor Learning
Skill Acquisition
Throwing
Variability of Practice

**Abstract**

**Background:** Generalization is a vital aspect of real-life motor learning. We asked whether in a realistic skill (bean bag throwing) generalization occurs within or beyond the range of trained movements and whether this is different for constant or variable practice.
**Methods:** what was your outcomes? How you measured them? In two experiments participants threw beanbags at a target at various distances. In the first experiment (n=24), two training groups threw beanbags to a constant near or far target and were examined at an intermediate transfer test. In the second experiment (n=80), participants trained either at a single target (constant), or two targets alternatingly (variable) with targets placed at different distances and they were tested for transfer within and beyond the training range. A control group was included which only performed the transfer tasks.
**Results:** For the near transfer target, no group outperformed controls (P>.05), whereas all groups except the near constant group (P=.072) performed better than the control group at the intermediate target, and only the far constant training group performed better than controls at the far target (P<.02).
**Conclusion:** These results suggest that generalization is limited in this task. The generalization that was found depends mostly on the distance between the training and the transfer target, not on whether the transfer target is within the trained movement range. The superiority of the far constant group over other groups further suggests that the farther away the goal was, the greater the need for specialized training.

**Arezo Ahmadpour**
Email: arezoahmadpour@uok.ac.ir

Received: 2021/11/18
Accepted: 2022/02/15
Published: 2022/02/25

## Introduction

Learning a motor skill such as playing tennis or a musical instrument is a challenging process requiring prolonged training. A key challenge of researchers and sports coaches has been to determine what constitutes the optimal practice schedule for learners to maintain their performance over time (retention) and also improve their performance in other situations (transfer). Two theoretical positions have addressed this issue; the specificity of learning derived from Henry's specificity of hypothesis (Henry & Rogers, 1960) and Adams's close-loop theory of motor skill (Adams, 1971), and the variability of practice hypothesis based on Schema theory (Schmidt, 1975). In variable practice, a participant train in several versions of a skill, for example throwing darts at targets at different positions, while constant practice includes practicing only one version of a skill in the same manner. Schema theory predicts that variable practice leads to better retention than constant practice. Generally speaking, constant practice results in automation (Adams, 1971; Henry & Rogers, 1960), while variable practice leads to generalization (Schmidt, 1975). Although some studies on continuous skills favor variable practice (Heitman, Pugh, Kovaleski, Norell, & Vicory, 2005; Yao, DeSola, & Bi, 2009), most research evidence has shown the advantages of variable practice over constant practice in discrete skills (Kerr & Booth, 1978; Schmidt, 1975; Shea & Kohl, 1990, 1991; Zetou et al., 2014). Among these studies, there are some experiments that have not reported significant differences between variable and constant practice in retention and transfer tests (Breslin, Hodges, Steenson, & Williams, 2012; Shoenfelt, Snyder, Maue, McDowell, & Woolard, 2002). The last two of these studies used tasks related to sports (basketball shot set), and variable practice had no superiority over constant practice in retention and transfer tests. The two other studies in which participants threw beanbags at targets, reported very limited effect of variable practice not only in short-term motor learning but also in long term motor learning and the advantage disappeared after two weeks (Willey & Liu, 2018a, 2018b). In sum, there are still conflicting ideas about the effectiveness of variable training over constant training.

In addition to the variability of training, generalization is thought to be greater when the transfer target is within the range of experienced movements, not beyond (Mattar & Ostry, 2010). Mattar & Ostry (2010) had participants make movements to a target in which they were perturbed by a force field and learned to compensate. It was found that participants who practiced on a target that was 15cm away, produced less force than expected in a 30cm transfer test, and they were unable to produce velocities exceeding those experienced in the acquisition phase. This indicates there was no transfer from 15cm training to 30cm testing. On the contrary, the second group that practiced on the 30cm target and was tested for generalization at 15cm showed complete transfer learning to the 15cm target. This shows transfer of learning occurs in the range of a trainee's experience, but not beyond that range. In two other experiments in the same study, it was found that when 30cm targets were presented intermittently during 15cm target training, performance on the 30cm test was identical to the 30cm training group. Although they let the participants have an interleaved practice of 30cm targets among 15cm trials, the generalization test was done at one of the trained targets (30cm), not beyond, and as a result the question remains open whether the learning during this variable training could transfer to targets that are outside of the training range. Another question is, if they had a constant group which trained just the farthest distance of the variable group, how these two groups would perform at within and beyond training range.

Here we asked whether in a realistic skill (beanbag throwing) generalization occurs within or beyond the range of trained movements and whether this is different for constant or variable practice. Further, we hypothesized that variable practice groups should show greater generalization than the constant training groups.

## Method

### Experiment 1

#### Subjects

24 right-handed, male volunteers (mean age 22.3 years; SD=1.83) who reported no physical and mental disabilities, and no previous experience of the task took part in this experiment. All of the participants were naïve to the purpose of the experiment. Before taking part in this experiment, all subjects signed a consent form which was approved by the Ethical Committee in Human Experimentation at the relevant university.

#### Apparatus and task

Participants were asked to throw beanbags (100 g) at a target put on the floor (Chiviacowsky, Wulf, Laroque de Medeiros, Kaefer, & Wally, 2008). The task was done using the nondominant hand; the dominant hand was determined by asking participants which hand they use to write. The circular target had a 10 cm radius. For assessing the throw accuracy, concentric circles with radii of 20, 30, up to 100 cm were drawn around the target. If the beanbag landed in the target center, 100 points were granted. The farther the beanbag is from the target, the lower the points. They received the following points for each circle moving away from the target: 90, 80, 70, 60, 50, 40, 30, 20, 10 respectively, and 0 for landing outside the largest circle.

#### Procedures

Participants were randomly assigned in either the far or near training group. The target was placed in either 5 m (far group) or 3 m (near group) from the participant. Each participant completed a total of 90 trials in the acquisition phase, which consisted of 6 blocks of 15 trials. There was a 2-min break between the blocks. As in ballistic sports, where athletes are able to see the result of their throws, all participants could see the results of their throws and received verbal feedback on how many points they had scored. 5 minutes after completing the acquisition phase, the immediate retention test was conducted which consisted of 15 trials. Approximately 24 hours after the acquisition phase, the delayed retention test (15 trials) was conducted. After another 5-min break, a 4-meter transfer test (15 trials) was performed (The transfer test uses to estimate motor skill learning, usually referring to a change of task situation). In the retention and transfer tests, participants did not receive verbal feedback of their points.

#### Data analysis

Points of accuracy were analyzed in 2 (groups: near, far) × 6 (blocks of 15 trials) analysis of variance (ANOVA), with repeated measures on the blocks in the acquisition phase. The same analysis was used for the retention tests; 2 (groups) × 2 (blocks of the tests) ANOVA with repeated measures on the tests was used, and also One Way ANOVA was used for the transfer test. The level of alpha was set at 0.05.

### Experiment 2

In the first experiment, we tested two groups practicing constantly on a near or far target, and then tested them for generalization on an intermediate target. If generalization only occurs within the training range (as was the case for Mattar & Ostry's experiment), then we expect that the far training group should show generalization (because the transfer target is within their training range) but not the near training group. We refer to this idea as the asymmetric generalization hypothesis: generalization only occurs within the range of trained movements, not beyond (as suggested by Mattar & Ostry in the context of force field learning). Alternatively, generalization may instead depend on the proximity between a transfer target and the trained direction (proximity hypothesis; suggested by data from Willey and Liu, 2018), in which case both groups in experiment 1 should show similar transfer.

The obtained results in experiment 1 led us to conduct an additional experiment. In experiment 2, we further wanted to compare variable and constant practices in four different experimental groups and a control group (participants of the control group took part just in the transfer tests): far variable practice (4.5m and 5.5m), near variable practice (2.5m and 3.5m), far constant practice (5.5m) and near constant practice (3.5m) on acquisition phase, retention and transfer tests (Figure 1). We recruited 80 undergraduate participants and randomly assigned them to either far variable, near variable, far constant, near constant and control groups. All participants were healthy, right-handed, and threw the beanbags using their nondominant hands. Experiment 2 was conducted on two days; day 1 included 8 training blocks of 12 trials and an immediate retention test (12 trials); day 2 included four blocks (12 trials) of a delayed retention test and 3 transfer tests. In the acquisition blocks, the constant groups always had the same target whereas in the variable groups, participants performed one block, i.e., 12 trials, in one target and continued with the other target in the next block (the order was counterbalanced). There was a 2-min break between blocks in the acquisition phase and transfer tests. 5 minutes after completion of the acquisition phase, participants took part in the immediate retention test. Approximately 24 hours after the immediate retention test, participants performed the delayed retention test. Before continuing with the transfer tests, participants took a 5-min break. There were three transfer tests in this experiment. In all groups, the 4-m transfer test was performed before the other two transfer tests (2m and 6m) because this distance was different for the two far and near groups in terms of being within or beyond the training range. Willey and Liu (2018) demonstrated that the main factor for generalization is the proximity to untrained distances, not the variability of practice schedule. To investigate their finding, we had participants also take part in 2m and 6m transfer tests which were different to the groups in terms of proximity to the trained target distances. The order of throwing to different distances was counterbalanced not only in the last two transfer tests, but also in the acquisition phase and both retention tests. Participants of variable groups performed 6 trials of each version in the retention tests. All other procedures were similar to experiment 1.

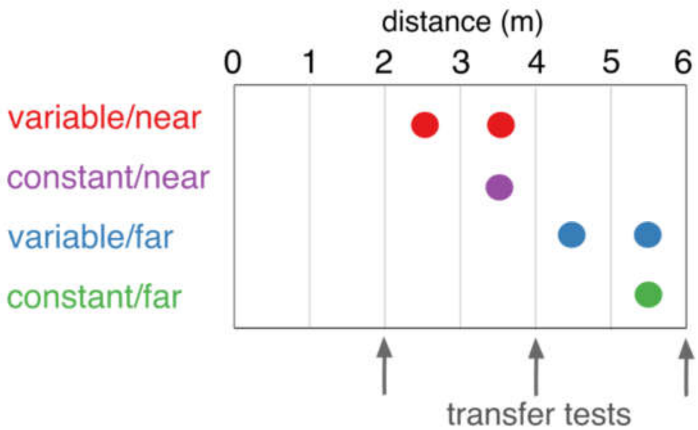


**Figure 1. Training target distances for the 4 groups.**
Variable groups trained on two targets (2.5m and 3.5m vs. 4.5m and 5.5m) whereas constant groups trained on a single target only (3.5m vs. 5.5m). Gray arrows indicate the transfer tests (2m, 4m and 6m) administered after training.

## Results

### Experiment 1

### Acquisition phase

The accuracy points of both groups increased during the acquisition phase; the main effect of training (block) was significant ($F_{(5, 110)} = 4.531$, $P \leq 0.001$). Throwing accuracy was significantly higher in the near distance group ($F_{(1, 22)} = 39.081$, $P<0.001$), whereas group and block interactions were not significant ($F_{(5, 110)} = 0.482$, $P>0.05$).

### Retention and transfer phase

The main effect of test (2 blocks: immediate retention test, delayed retention test) ($F_{(1,22)} = 1.873$, $P>0.05$), and the interaction of test * group ($F_{(1,22)} = 2.237$, $P>0.05$) were not significant whereas the main effect of group ($F_{(1,22)} = 34.971$, $P<0.001$) was significant. In the 4-meter transfer test, One Way ANOVA showed no significant difference between groups ($F_{(1, 23)} = 1.406$, $P>0.05$).

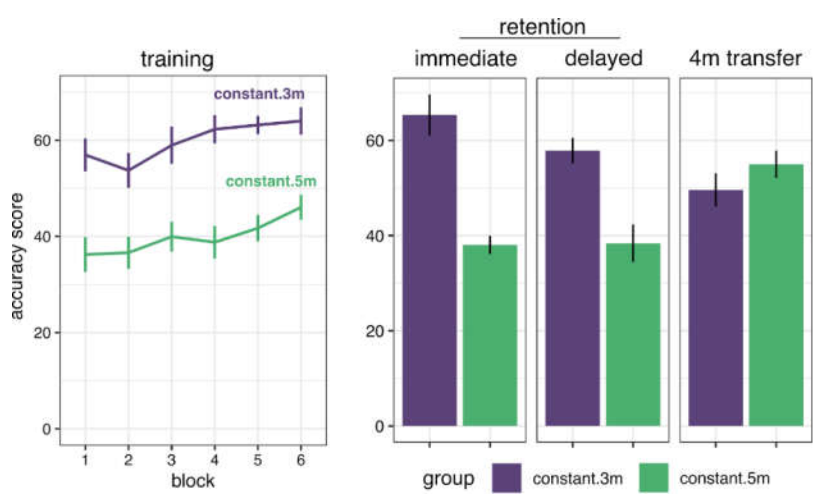


**Figure 2. Groups trained on a near (3m) or far (5m) target both showed learning, but the far (5m) training group outperformed the 3m group on the 4m transfer task.**
Mean scores and standard errors of the two groups for beanbag throw in the acquisition phase, retention and transfer test.

### Experiment 2

#### Acquisition phase

A 4 (groups) × 8 (blocks) repeated-measures ANOVA showed that all four groups significantly increased their throwing accuracy during training ($F_{(7, 420)}$ = 9.380, P<0.001) and the average accuracy scores also showed that the near training groups received significantly higher scores than farther training groups in the acquisition phase ($F_{(3, 60)}$ = 2364.223, P<0.001), whereas the interaction of block * group was not significant ($F_{(3, 60)}$ = 0.298, P>0.05) (see figure 3).

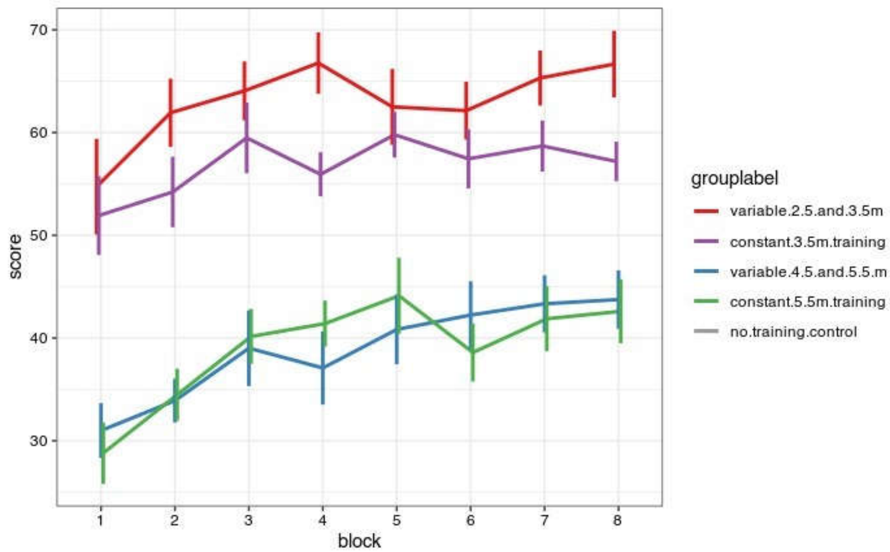


**Figure 3. Mean accuracy scores and standard errors of the four groups for beanbag throw in the acquisition phase.** Variable groups trained on two different distances, while constant groups trained on one distance. Although all groups showed learning, the near groups had higher scores than far groups.

#### Retention and transfer tests

The subjects' scores during the retention test phase were analyzed in an ANOVA with group as factor (4 levels), and testing time as repeated-measures factor (2 levels: immediate or delayed). The main effect of the testing time ($F_{(1, 60)}$ = 29.953, P<0.001) was significant, indicating that overall participants performed better on the immediate retention test than on the delayed retention test. The factor group was also significant ($F_{(3, 60)}$ = 21.838, P< 0.001), indicating that near groups (constant and variable) significantly performed better than far groups (constant and variable) (all P< 0.001); the near variable group is also significantly better than the near constant group (P= 0.048). This confirmed that throwing to distances further away is more challenging, leading to lower scores. The interaction of group * testing time was not significant ($F_{(3, 60)}$ = .618, P> 0.05). In order to investigate the difference in performance on the two training targets in the variable groups' delayed retention test, a paired sample t test was performed. Results showed no significant difference between 2.5m and 3.5m in the near variable training ($t_{(15)}$ = 1.338, P>.05) or between the 4.5m and 5.5m in the far variable training ($t_{(15)}$ =1.194, P>0.05). For comparing 5.5m trials of far variable and 5.5m trials of far constant groups at the delayed retention test, the independent sample t test was used which showed no significant difference between these two groups ($t_{(30)}$ =-0.362, P>0.05).

We then analyzed the transfer test data, where a no-training control group was included (see Fig. 4). Accuracy scores were analyzed in a separate ANOVA for each transfer target (2m, 4m and 6m) with group as factor (5 levels). Analysis of variance at the 2m transfer test showed no significant difference among groups ($F_{(4, 79)}$ = 1.811, P> 0.05). In the 4m transfer test, there was a statistical trend for a main effect of group ($F_{(4, 79)}$ = 2.440, P= 0.054) while LSD Post Hoc test at 4m transfer test showed that all groups performed better than the control group (all p< 0.05) except for the near constant group (p= 0.072). In the 6m transfer test there was a main effect of group ($F_{(4,79)}$ = 3.414, P= 0.013), which reflected that the far variable group performed significantly better than all other groups (p < 0.02).

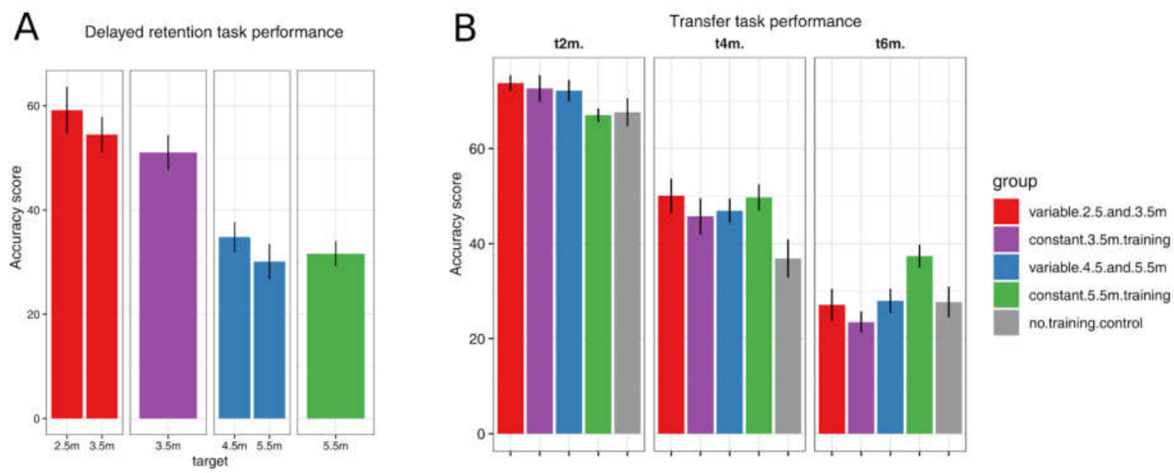


**Figure 4. A: Mean accuracy scores and standard error of the four groups for beanbag throw in the delayed retention test, in which for the variable groups the score of two different targets is shown separately. B: Mean accuracy score and standard error of the transfer tests showed comparable performance in the 2m transfer test.** All groups had higher scores than the control group (except constant 3.5m) in the 4m transfer test, and constant 5.5m had better performance than others in the 6m transfer test.

## Discussion and Conclusion

The present study examined transfer in a simple bean bag throwing task, asking whether learning generalized to movements within the trained movement range or beyond, and whether this depended on the type (variable or constant) of practice. In experiment 1, participants practiced throwing beanbags either to a far (5m) or near (3m) target. In the acquisition phase, the near group showed a higher score than the far group and both groups showed an improvement at the end of acquisition phase. When tested for transfer on a 4m target, both groups showed similar performance at the intermediate target. Although the far group performed better at the transfer test than its training phase, the performance of both groups during transfer was comparable. This may indicate that both groups show equal transfer to a novel distance (4m). However, it is also possible that neither group showed any transfer. For this we recruited a control group in the next experiment. In experiment 2, four groups performed constant training (the same near or far target) or variable training (alternating between two near or two far targets) (see Fig 1). In the learning stage, near groups showed a higher score than far groups. The groups were then tested for transfer at three different target distances (2m, 4m, 6m) and a control group did not perform training and only performed the transfer tests. We found that performance of the experimental groups in the near transfer test (2m) was not significantly different from the control group. This suggested that their learning had no effect on performance in the near (2m) transfer task, and perhaps there are ceiling effects in very close targets. In the intermediate target (4m), all practice groups performed better than controls (except the near constant group), indicating transfer of learning, but there were no differences between the groups, indicating that there generally were not any advantages for any type of training over another. In contrast, when the test was located beyond all experimental groups training directions (6m), the far constant group performed better than all other groups, which in turn did not differ from controls. Surprisingly, in spite of this difference in transfer, there was no significant difference between far constant and far variable groups at the delayed retention test, even when comparing their performance on the common target (5.5m).

In the present study, we contrasted two hypotheses about how generalization occurs. According to the asymmetric generalization hypothesis, generalization only occurs within the range of trained movements, not beyond (as suggested by Mattar & Ostry in the context of force field learning). Alternatively, generalization may instead depend on the proximity between a transfer target and the trained direction (proximity hypothesis; suggested by data from Willey and Liu, 2018).

We observed that during training, scores were higher for the near compared to the far targets. In experiment 1, *nominal task difficulty* (Guadagnoli & Lee, 2004) of the two groups was not the same, and the far group needed more precision to throw, so it is expected to see that the far group had a lower score than the near group in the acquisition phase. In addition, a higher score of the far group in the transfer test than its acquisition phase is also expected, because the transfer task for this group was much easier than its trained task. According to principles of variability, the farther away from the target, the lower the accuracy of the throw (Breslin et al., 2012; Keetch, Schmidt, Lee, & Young, 2005). Although the far group outperformed the near group at the transfer test, the difference was not statistically significant, contrary to what is predicted by the asymmetric generalization hypothesis. One possibility is that the number of trials in the acquisition phase may not have enabled enough learning, thus limiting transfer as well. In Mattar and Ostry's study (2010), a group which trained moving to a target 15cm away was tested at a 30 cm target and a group of 30cm training was tested at a 15cm target. Results showed that a 30cm training group which tested at 15cm target had a better performance than the 15cm target tested at 30cm target. In their second and third experiments, the 15cm group was additionally trained on a 30cm target and then tested at a 30cm target. Interleaving training improved performance of the 15cm group during the generalization test, so the author's claimed generalization is tied to the extent of overlap between practice and test conditions. Our findings of experiment 1 are in contrast with the asymmetric generalization hypothesis, according to which one would have expected the far group should perform better than the near group (because the transfer target is within the range of training for the far group but not for the near group), while supporting the proximity hypothesis, which predicts both groups perform the same (because the transfer target is equally close to both training distances).

Results of experiment 2 showed that performance of all groups in the closest (2m) transfer test were comparable which is in line with asymmetric generalization finding which predicts all groups can transfer their learning to targets in the training range. A possible reason for this performance similarity is that the near target transfer task was not difficult enough to show the differences and performance reached ceiling in short distances because it was not challenging enough. Guadagnoli and Lee (2004) proposed that learning is affected by information which comes from performance, and it should be optimized by nominal (how difficult the task is, regardless of who is the performer and what is the condition) and functional task difficulties (including the learner's level and training conditions). In the context of the present study, nominal task difficulty may have been too low in the 2m transfer test. In the 4m transfer test, all experimental groups showed comparable performance, and all but the near constant group were significantly better than the control group. This finding is in line with the proximity hypothesis which predicts learning transfers to nearby distances and similar to a study which reported identical performance from constant and variable groups in free-throw basketball shooting (Breslin et al., 2012; Shoenfelt et al., 2002). However, generalization of near groups at the beyond target cannot be explained by the asymmetric generalization hypothesis. Most probably, the combination of constant and near training, may not be challenging enough and therefore give rise to less learning. In the 6m transfer test, only the far constant group showed greater performance than the control group. The far constant group (trained at a 5.5m target) was able to generalize to a 6m transfer test, which is in line with the proximity hypothesis; but the far variable group (trained on 4.5m and 5.5m) was not able to generalize to 6m, which contradicts the proximity hypothesis.

In order to investigate the effect of training variability on generalization, we compared the generalization of the near (variable vs. constant) and far (variable vs. constant) training groups. We found opposite effects for the 4m and 6m transfer test: in the 4m transfer test, the near constant group did not show transfer (they were not different from controls) whereas the near variable group did. In the 6m transfer test, the far constant group showed significant transfer whereas the far variable group did not. This difference in pattern of results between the 4m and 6m test is surprising because the near groups (variable and constant) have the same relative distances to the 4m transfer test as the far groups (variable and constant) have to the 6m transfer test. According to Schema theory which predicts only the variable group is able to generalize to untrained targets we expected to see the same pattern for both near and far groups. On the other hand, the asymmetric generalization hypothesis predicts there would be no generalization beyond trained distances, and the proximity hypothesis predicted the same performance for near and far groups due to the equal proximity to the training targets. The different performances in the 4m and 6m transfer tasks cannot be explained by single theory. One of the possibilities for this different performance is the selected distances that may play a critical role in this study. According to the challenge point model there might be the optimal challenge point with the combination of longer distance and constant training than variable training. The longer the distance, the more special training is needed. Overall, our findings for overlapped targets (i.e., targets that are within the trained range) and the further away targets largely follow the predictions of the asymmetric generalization hypothesis, whereas the nearby targets largely follow the proximity hypothesis.

Generalization of the near variable group in the 4m transfer test and far constant group in the 6m transfer test is in line with the proximity hypothesis which showed that generalization of simple throwing tasks depends more on the proximity between the training and the test situation than the variability of the training phase. Although our finding in the near distances confirmed this idea and there was no difference between constant and variable groups, in the far distances the constant group outperformed the variable group, which is in contrast to Willy and Liu's study (2018) and also Kerr and Booth (1978). The first possibility for the apparent discrepancy between our data (in the far groups) and that of Willy and Liu's study and also Kerr and Booth (1978) seems to be the distance chosen for training and testing. The maximum distances selected in Willey and Liu (2018) and Kerr and Booth (1978) experiments were 13 and 5 feet which is almost equal to 4m and 1.5m respectively. We have the same finding with Willey and Liu (2018) in that range (the near groups) and the difference came from the longer distances. In most papers that had compared variable and constant training, researchers had chosen the constant distance around the mean of distances which were chosen for variable groups (Breslin, Hodges, Kennedy, Hanlon, & Williams, 2010; Breslin et al., 2012; Keetch et al., 2005; Kerr & Booth, 1978; Shoenfelt et al., 2002; Willey & Liu, 2018a, 2018b), while we chose the maximum range of the variable group that could be the second reason for that contradiction. When Willey and Liu (2018) had the participant do constant training with the maximum training distance of the variable group, the difference between constant and variable groups at targets beyond the training range disappeared. Another difference between their study and ours is that in the present study, participants could see the result of their performance, as is common for real-life motor tasks, were facing the target and threw over arm, whereas in the aforementioned studies (Kerr &

Booth, 1978; Willey & Liu, 2018a, 2018b), they were deprived of visual feedback, were with their backs to target and threw over their shoulder. The last reason that may affect the results is that in these previous studies participants performed pretests which gave them experience for untrained distances. In addition, both far groups (variable and constant) trained at 5.5m and they performed comparably at the delayed retention test, but the far constant group had higher scores at 6m transfer test. The reason might be that when the task gets harder (e.g. when the transfer target is further away and needs more precision), it requires more specific training, thereby reducing the effectiveness of variable training. It seems that a more distant situation may need more specialized training. Our findings support a combination of the asymmetric generalization and proximity hypothesis: the groups that trained the far distances can transfer learning to the overlapped distances and also show generalization to a limited distance beyond the trained targets.

To summarize, the present study asked whether in a realistic skill (beanbag throwing) generalization occurs within or beyond the range of trained movements and whether this is different for constant or variable practice. Our findings show that beanbag throwing learning largely generalizes within the range of training, regardless of training distance and practice arrangement (variable or constant). In addition, generalization can occur beyond the training distance but only within a limited range. For throwing distances which need more precision (e.g., far targets) training needs to be closer to the transfer distance to be of benefit. Our findings which showed in far distances constant training is better than variable, while in near distances variable training is better than constant, do not support the idea that variable training causes better generalization overall. However, these findings derived from a beanbag throwing task and additional research in other skills and tasks are needed.

**Conflicts of interests**

The authors report no potential conflict of interest.

**References**

1. Adams, J. A. (1971). A closed-loop theory of motor learning. *Journal of Motor Behavior, 3*(2), 111-150. doi:https://doi.org/10.1080/00222895.1971.10734898
2. Breslin, G., Hodges, N. J., Kennedy, R., Hanlon, M., & Williams, A. M. (2010). An especial skill: Support for a learned parameters hypothesis. *Acta Psychologica, 134*(1), 55-60. doi:https://doi.org/10.1016/j.actpsy.2009.12.004
3. Breslin, G., Hodges, N. J., Steenson, A., & Williams, A. M. (2012). Constant or variable practice: Recreating the special skill effect. *Acta Psychologica, 140*(2), 154-157. doi:https://doi.org/10.1016/j.actpsy.2012.04.002
4. Chiviacowsky, S., Wulf, G., Laroque de Medeiros, F., Kaefer, A., & Wally, R. (2008). Self-controlled feedback in 10-year-old children: Higher feedback frequencies enhance learning. *Research Quarterly for Exercise and Sport, 79*(1), 122-127. doi:https://doi.org/10.1080/02701367.2008.10599467
5. Guadagnoli, M. A., & Lee, T. D. (2004). Challenge point: A framework for conceptualizing the effects of various practice conditions in motor learning. *Journal of Motor Behavior, 36*(2), 212-224. doi:https://doi.org/10.3200/JMBR.36.2.212-224
6. Heitman, R. J., Pugh, S. F., Kovaleski, J. E., Norell, P. M., & Vicory, J. R. (2005). Effects of

specific versus variable practice on the retention and transfer of a continuous motor skill *Perceptual and Motor Skills, 100*(3c), 1107-1113. doi:https://doi.org/10.2466%2Fpms.100.3c.1107-1113
7. Henry, F. M., & Rogers, D. E. (1960). Increased response latency for complicated movements and a "memory drum" theory of neuromotor reaction. *Research Quarterly, 31*(3), 448-458. doi:https://doi.org/10.1080/10671188.1960.10762052
8. Keetch, K. M., Schmidt, R. A., Lee, T. D., & Young, D. E. (2005). Especial skills: Their emergence with massive amounts of practice. *Journal of Experimental Psychology: Human Perception and Performance, 31*(5), 970-978. doi:https://doi.apa.org/doi/10.1037/0096-1523.31.5.970
9. Kerr, R., & Booth, B. (1978). Specific and varied practice of motor skill. *Perceptual and Motor Skills, 46*(2), 395-401. doi:https://doi.org/10.1177%2F003151257804600201
10. Mattar, A. A. G., & Ostry, D. J. (2010). Generalization of dynamics learning across changes in movement amplitude. *Journal of Neurophysiology, 104*(1), 426-438. doi:https://doi.org/10.1152/jn.00886.2009
11. Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological review, 82*(4), 225-260.
12. Shea, C. H., & Kohl, R. M. (1990). Specificity and variability of Practice. *Research Quarterly for Exercise and Sport, 61*(2), 169-177. doi:https://doi.org/10.1080/02701367.1990.10608671
13. Shea, C. H., & Kohl, R. M. (1991). Composition of practice: Influence on the retention of motor skills. *Research Quarterly for Exercise and Sport, 62*(2), 187-195. doi:https://doi.org/10.1080/02701367.1991.10608709
14. Shoenfelt, E. L., Snyder, L. A., Maue, A. E., McDowell, C. P., & Woolard, C. D. (2002). Comparison of constant and variable practice conditions on free-throw shooting. *Perceptual and Motor Skills, 94*, 1113-1123. doi:https://doi.org/10.2466%2Fpms.2002.94.3c.1113
15. Willey, C. R., & Liu, Z. (2018a). Limited generalization with varied, as compared to specific, practice in short-term motor learning. *Acta Psychologica, 182*. doi:https://doi.org/10.1016/j.actpsy.2017.11.008
16. Willey, C. R., & Liu, Z. (2018b). Long-term motor learning: Effects of varied and specific practice. *Vision Research, 152*, 10-18. doi:https://doi.org/10.1016/j.visres.2017.03.012
17. Yao, W. X., DeSola, W., & Bi, Z. C. (2009). Variable practice versus constant practice in the acquisition of wheelchair propulsive speeds *Perceptual and Motor Skills, 109*(1), 133-139. doi:https://doi.org/10.2466/pms.109.1.133-139
18. Zetou, E., Papadakis, L., Vernadakis, N., Derri, V., Bebetsos, E., & Filippou, F. (2014). The effect of variable and stable practice on performance and learning the header skill of young athletes in soccer. *Procedia-Social and Behavioral Sciences, 152*, 824-829. doi:https://doi.org/10.1016/j.sbspro.2014.09.328