Journal of Clinical Medicine: Current Research
Volume 1 (2021) 9 Pages

Research Article | Open Access

Study of Bilateral Training for Improving Fitness and Performance

Brock Peterson[1]*, Cristallo Rixon[2], Livinski Faris[3]

[1]Department of Rheumatology, Massachusetts General Hospital, Boston, USA
[2]Oregon Health Sciences University, Portland, Oregon, USA
[3]Department of Rheumatology, Johns Hopkins University, Baltimore, Maryland, USA

***Correspondence:** Brock Peterson, Department of Rheumatology, Massachusetts General Hospital, Boston, USA.
E-mail: brock_peterson@hotmail.com

Received: August 06, 2021;
Accepted: August 23, 2021;
Published: August 30, 2021

Citation: Peterson B, Rixon C, Faris L. Study of Bilateral Training for Improving Fitness and Performance. J Clin Med Current Res. (2021);1(1): 1-9

Key words: Interannual transfer; Cross education; consecutive motor skill; Motor learning

Abstract

Aim: 2 experiments examined the characteristics of bilateral transfer of force management in an exceedingly consecutive task from a dominant limb to non-dominant limb.

Setting: The experiments were conducted in an exceedingly university research lab settled in Lone-Star State, USA.

Population Sample: a complete of sixty healthy haircoats took part within the study, with thirty participants for every experiment.

Method: Every experiment consisted of 2 clusters; experimental cluster and management group. The participants within the management teams solely participated in pre and posttests. The participants within the experimental teams learned a consecutive task consisting of an occasional force management (10% of most Voluntary Contraction (MVC), Experiment one) and learned a consecutive task with a better force management (50% of MVC, Experiment 2). throughout the pretest, every participant completed the task with each hand before performing arts observe trials together with his or her dominant hand solely. A posttest was conducted one hour later.

Results: For each experimental team, fine control considerably improved with the trained limb. significantly, bilateral transfer of learning was solely ascertained for the experimental cluster once learning with higher degree (i.e. amount) of force management (i.e. five hundredth MVC) in Experiment a pair of, and not for the experimental cluster in Experiment one (i.e. 10% MVC).

Conclusion: These findings indicate that bilateral transfer of force management is sensitive to the degree of the force production being learned. That is, a bilateral transfer of force management will solely be found for a high degree of learning force, like five hundredth of MVC within the gift study, and not with an occasional degree of learning force (e.g. 100 percent of MVC). this might have a bearing on learning and relearning motor skills in sports and rehabilitation setting.

1. Introduction

Since the primary report of bilateral transfer (also brought up as Interannual transfer or cross education) in motor talent learning [1], studies have targeted on examining the direction of bilateral transfer [2,3], exploring the influence of task characteristics on bilateral transfer [4,5], applying bilateral transfer to enhancing the rehabilitation of stroke survivors [6], examination the impact of physical observe and mental observe on bilateral transfer [7,8], determinative if bilateral transfer happens only if the coaching movements square measure dead [9], and finding servomechanisms underlying bilateral transfer [10]. These studies have had direct and indirect implications in sport performance and in rehabilitation settings.

Research has systematically indicated that effects of learned skills transferred from a trained limb to associate undisciplined homologous limb square measure task sensitive. as an example, employing a task to propel a tiny low plastic disk with the finger from a home position to a horizontal target Teixeira [11], found no important bilateral transfer occurred for the contralateral hand. In another study Teixeira [4], found considerably positive transfer once they used a task to find out fine force management committed a wrist-flexion movement. It ought to be noted that the fine force management was indirectly calculable by mensuration movement abstraction accuracy in Teixeira's study [4].

In a study requiring the educational of a particular fine force management, Yao et al. [5] needed participants to exert four little isometric and constant forces (e.g. a consecutive task) with given rhythms (e.g. total movement time =1500 millisecond, and 22.2%, 44.4% and 33.4% of the full movement time for segments one through 3; here segments were outlined as 2 consecutive force exertions). The four syncopated exertions were generated by abducent the finger against associate immoveable force electrical device button. In their study [5], acquisitions of temporal arrangement and force management with the trained limb and transfer of the educational to the contralateral homologous limb were measured. whereas each temporal arrangement and fine motor managements were considerably improved with the trained limb and therefore the learning impact of the temporal arrangement control was considerably transferred to the contralateral limb, the fine force management wasn't transferred to the contralateral limb. The authors [5] attributed the shortage of bilateral transfer impact within the fine force management to the quality of the task (learning each temporal arrangement and force management) and therefore the low degree of force control production (i.e. solely 100 percent MVC).

The task employed by Yao et al.'s study [5] consisted of each force control learning and therefore the part of learning goal movement times. Yao et al. [5] indicated that this task quality may account for the shortage of transfer. in an exceedingly similar study by Park and Shea [12], participants were needed to find out a task consisting of each temporal arrangement and fine force management parts. during this study they additionally found important bilateral transfer of temporal arrangement (relative and total time), however not within the case of force management. it's potential that the low degree (i.e. amount) of force might account for the absence of bilateral transfer in each of those studies.

According to the cross-activation hypothesis, bilateral transfer is thanks to the bilateral plant tissue activities caused by the single-limb coaching [13]. analysis proof has indicated that the degree of activation within the ipsilateral hemisphere is powerfully tormented by the force production of the muscular contraction [14], that successively might influence the impact of bilateral transfer of force production per the cross-activation hypothesis [13]. The ten of MVC employed in Yao et al.'s study [5] could be too little to cause co-activation within the ipsilateral hemisphere, so leading to a failure in terms of the bilateral transfer of force management. The aforesaid findings and assumptions warrant any attention and verification as a result of rehabilitation specialist and/or coaches might have to grasp if the degree of force production ought to be thought of within the observe settings to pursue effective bilateral transfer of force management. Therefore, the consequences of the degree of force management on the bilateral transfer were examined within the current study in 2 separate experiments. the most purpose of Experiment one was to look at if the shortage of transfer of force-control learning was thanks to the task quality. it absolutely was hypothesized that bilateral transfer won't be tormented by reduced task quality and wouldn't lead to important and positive transfer. the aim of Experiment a pair of was to look at whether or not associate exaggerated degree (i.e. amount) of force management would impact the degree of bilateral transfer. it absolutely was hypothesized that associate exaggerated degree of force management throughout learning would facilitate important and positive bilateral transfer. the 2 hypotheses were created supported the analysis findings suggesting that the degree of activation within the ipsilateral hemisphere is powerfully tormented by the force of muscular contraction [14] and therefore the cross-activation hypothesis [13].

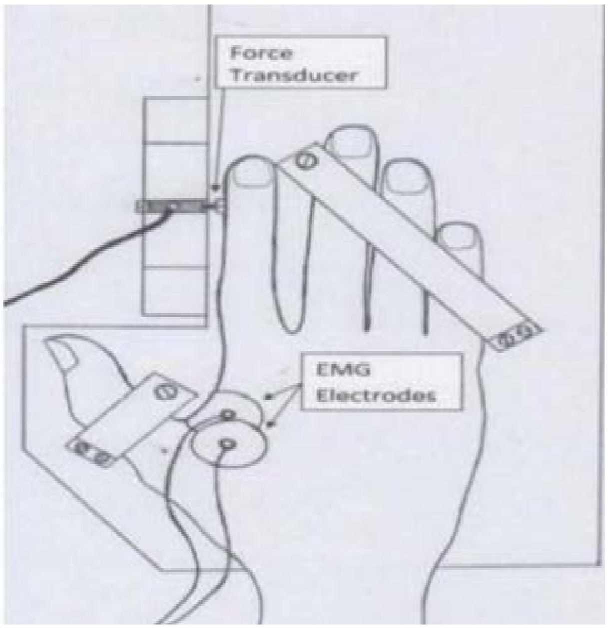

Figure 1: Illustration of the experimental setup.

Experiment 1

2. Methods

2.1 Participants

A total of thirty college boy students volunteered to participate within the study. All participants received credit. The participants had no expertise with the task and weren't responsive to the study's aims. Participants were indiscriminately allotted into 2 teams, fifteen participants in every cluster, experimental cluster (9 females, nineteen to twenty-five years, M=20.15 yrs, SD=2.10) and management cluster (7 females, nineteen to twenty-five (M=21.31 years, SD=2.40). All participants were right-hand dominant, as determined by the Edinburg imbalance Inventory check. The University of Lone-Star State at metropolis Human Participants Committee approved the study protocol. consent was obtained from every of the participants before the experiment.

2.2 Task and equipment

The participants learned a consecutive talent that was the same as the one employed by Yao et al. [5] with the sole distinction being that it didn't having a temporal arrangement management part. Instead, the participants within the current study were needed to find out to provide a force production at 100 percent MVC. The participant kidnapped his or her finger against associate immoveable button target (Figure 1) to exert four isometric forces at the targeted 100 percent MVC. The four forces were needed to be exerted at intervals 1500 millisecond (i.e. total movement time) with self-paced rhythm (i.e. there have been no relative temporal arrangement goals or external temporal arrangement mechanism).

A button forces electrical device (subminiature load cell, Sensotec, Columbus, OH) was designed into a wood support. once the finger was set in situ and participant tried to provide abduction, the electrical device was ironed and force was recorded. The force was digitized (200 samples/s) by a MP a hundred and fifty information Acquisition System (Biopac Systems, Inc., Goleta, CA). The force signals were displayed on a laptop monitor as visual feedback to the participant

Surface diagnostic technique (EMG) were placed on the belly of left and right FDI to record muscles activity throughout every trial. The EMG signals were amplified (X1, 000) and digitized (2,000 samples/s) by the MP a hundred and fifty information Acquisition System. The surface EMG recordings of every individual's finger muscle were taken for the aim of keeping track of each fingers' activities throughout observe (making positive there was no important coactivity from the index finger on the non-dominant hand, whereas the one on the dominant hand exerted forces).

2.3 Procedures

The management cluster (Crt 100 percent MVC) solely participated in pre and posttests. All participants weekday and faced a one7-inch personal computer monitor that was positioned about 1.5 m away at eye level. The monitor displayed the target force and therefore the force exerted by the participant. The practiced hand was placed so abduction of the finger concerned the knuckle joint and therefore

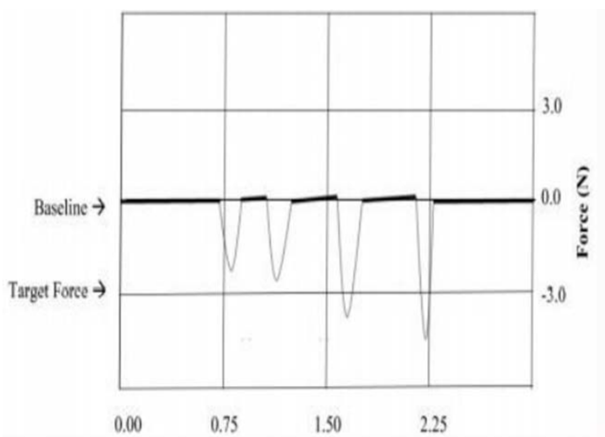

Figure 2: Example of visual feedback provided for force productions.

the movements from different 3 fingers and thumb were prohibited (Figure 1). The unpracticed hand was resting on the ipsilateral thigh and adjusted to participant's comfort. The fingers of the unpracticed hand weren't fastened. All participants were initial tested together with his or her MVC by abducent each the correct and left index fingers against the immoveable button target. The MVC from his/her index fingers was used because the reference for determinative his or her 100 percent MVC forces.

2.4 Practice section

The participants within the experimental cluster (Exp 100 percent MVC) performed sixty observe trials with the finger on his/her dominant hand (right hand) to find out the force-control production at 100 percent MVC within the observe section. The participant received a 30- sec rest between every of the 2 adjacent trials at intervals a block of ten trials. additionally, a 2-min rest between any 2 blocks was provided to attenuate any potential fatigue throughout trials. throughout every 30-sec break, the researchers provided the participants with visual feedback concerning their force production (Figure 2) for associate example of the feedback concerning the force production).

2.5 Testing section

The testing section consisted of 2 tests, a pretest and a posttest. To avoid any learning impact from the pretest on the undisciplined limb (i.e. left hand), the pretest was conducted on the trained hand (i.e. right hand) solely right once the experimenter explained and incontestable the task for every participant. The posttest, however, was conducted on every hand (i.e. dominant and non-dominant hands) one hour once the observe. every of the tests consisted of ten no-feedback trials.

2.6 Data analyses

Before process the subsequent information analyses, all individual participants' Pre- and Posttest means that of manufacturing the ten of MVC was calculated. If their force production was out of vary (meaning that their mean production was ± a pair of SD to the cluster mean) then it absolutely was thought of associate outlier. the whole information of the detected outliers was excluded from any analyses. As such, the results of 1 participant's information within the experimental cluster and 2 participants' information within the management cluster were excluded. Thus, there have been fourteen participants within the experimental cluster and thirteen participants within the management cluster.

2.7 Acquisition section

Absolute error of total force (TFAE) was calculated because the following:

TFAE = |F1 - goal F| + | F2 - goal F | + | F3 - goal F | + | F4 - goal F |

Where Fi = (the actual force production of every of the four sub-force exertions) and goal F is 100 percent MVC for every participant. The TFAE throughout the acquisition section was analyzed with unidirectional perennial live Analyses of Variance (ANOVA) (Practice Block) for the experimental cluster.

2.8 Test phase

The TFAEs throughout the take a look at part were analyzed for the trained limb and undisciplined lime individually. to look at the coaching result, a two-way ANOVA (Phase x Group) with repeated-measures on part was analyzed for the proper limb solely (trained limb for the experimental group). there have been 2 levels on the part issue (i.e. pre- and posttests), and 2 levels on the cluster issue (i.e. experimental cluster and management group). to look at the transfer of the coaching result from the trained right limb to the undisciplined left limb, a two-way ANOVA (Hand x Group) with repeated-measures reachable was analyzed for each limb with the posttest knowledge. there have been 2 levels on the hand issue (i.e. right and left limbs), and 2 levels on the cluster issue (i.e. experimental cluster and management group). All applied math significance was set at $P \leq$ zero.05.

3. Results

3.1 Acquisition part

MVC: The MVC of the proper associated left index fingers was analyzed with an freelance Samples t-test. No

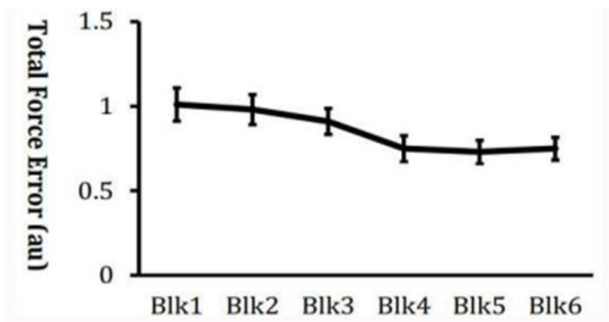

Figure 3: Means and standard errors of Total Force Absolute Error (TFAE) as a function of blocks of practice trials.

vital distinction in MVC, t (38) =1.48, p=0.15, was found between the proper and left fingers, M=33.88 N, SD=3.27 and M=32.45 N, SD=2.79, severally.

Muscle activity throughout the task: electromyogram records taken throughout the apply trials were analyzed parenthetically if any vital muscle coactivations occurred on the undisciplined (left) FDI once the trained (right) FDI exerted force. the numerous coactivity was outlined because the electromyogram values of the undisciplined FDI throughout the acting amount; these were on the far side the vary of the mean ± three Mount Rushmore State of the electromyogram throughout the resting period. The results failed to show vital coactivity on the undisciplined FDI. The results failed to show any vital coactivation on the left FDI. That is, the typical worth of the corrected surface electromyogram on the undisciplined FDI throughout {the amount|the amount} of the trained FDI exerting force was among a variety of the mean ± three Mount Rushmore State of the corrected surface electromyogram on the trained FDI throughout the resting period (i.e. the baseline).

Total force error (TFAE): The result of block on TFAE was vital, F (5, 65) =4.01, p

3.2 Testing part

Total force error (TFAE) of the trained limb (Right hand) with the pretest data: the most result of part was vital, F (1, 25) =14.36, p< 0.01, partial η2 =0.36. the most result of cluster wasn't vital, F (1, 25) =3.49, p=0.073, partial η2 =0.84. However, the interactive result of the 2 factors was vital, F (1, 25) =6.67, p< 0.05, partial η2 =0.21. The logical fallacy Bonferroni take a look at indicated that the interaction was because of the very fact that there have been no vital variations in TFAE between pre- and posttests for the management cluster on the trained hand, however there was a major distinction for the experimental cluster. See Figure 3 for the suggests that and normal errors of TFAE for the take a look at.

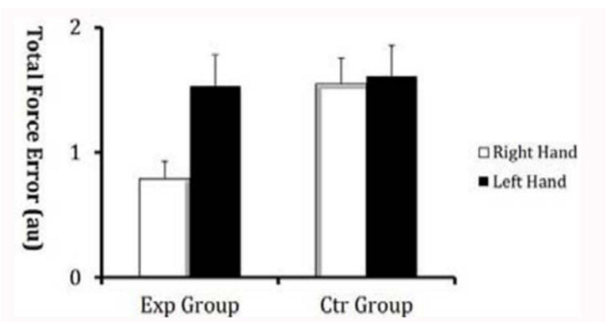

Figure 4: Means and standard errors of Total Force Absolute Error (TFAE) as a function of Posttest for Both Limbs.

Total force error (TFAE) of each trained and undisciplined limb with the post take a look at data: the most result of the hand was vital, F (1, 25) =6.91, p< 0.05, partial η2 =0.21. the most result of cluster was vital, F (1, 25) =4.41, p=0.05, partial η2 =0.88. However, the interactive result of the 2 factors was additionally vital, F (1, 25) =4.75, p< 0.05, partial η2 =0.16. The logical fallacy Bonferroni take a look at indicated that the interaction was because of the very fact that the proper hand of the experimental cluster (i.e. the trained limb) outperformed the undisciplined hand. There was no vital distinction in TFAE between the hands for the management cluster, however there was a major distinction for the experimental cluster. See Figure 4 for the suggests that and normal errors of TFAE for the take a look at.

4. Discussion

Experiment one examined if the reduced task quality within the task utilized by Yao et al. [5], would lead to a major and positive bilateral management. Overall, coaching improved task performance from pretest to posttest. Moreover, posttest performance of the experimental cluster victimization the trained limb was considerably higher than the management cluster throughout posttest. However, the coaching result was restricted to the trained limb solely, and wasn't transferred to the undisciplined limb. within the experimental cluster, the performance of the undisciplined limb (i.e. left limb) was considerably poorer than that of the trained limb and no totally different from the performance of the left limb of the management cluster throughout posttest. Thus, the findings of Experiment one area unit in step with Yao et al.'s study [5] however inconsistent with Teixeira's study [4], during which a major bilateral transfer for the acquisition of the force management was found, though this transfer was abundant weaker than the temporal arrangement transfer. we advise that task variations may account for the disparities in results. moreover, the present study measured the force directly by observation force production throughout a force estimation task, whereas Teixeira's study [4] indirectly measured the force by accounting for special movement errors throughout aiming movements.

The results of Experiment one tentatively counsel that the task quality wasn't {accountable for|in charge of|in command of|in management of|answerable for} the shortage of bilateral transfer of fine force control in Yao et al.'s study [5]. This finding left the degree of the fine force management, as we tend to assumed, to be the potential issue to cause the shortage of bilateral transfer in Yao et al.'s study [5]. This assumption was created in line with the prediction of the cross-activation hypothesis [13]. in line with this hypothesis, bilateral transfer is because of the bilateral plant tissue activities caused by single limb coaching [13]. This hypothesis has been productive in predicting bilateral transfer with force management tasks [14-17]. moreover, proof has indicated that the degree of activation within the ipsilateral hemisphere is powerfully stricken by the force of the shortening [14], that successively might influence the result of bilateral transfer of force production. within the current experiment, solely 100 percent of MVC was created. this might be too little for inflicting co-activities within the ipsilateral hemisphere, therefore leading to a failure in terms of the bilateral transfer for the force management. Thus, with relation to the low force needed within the gift experiment (i.e. solely 100 percent of MVC), a proof for the absence of bilateral transfer may be derived from the cross-activation hypothesis [13].

In summary, the task quality isn't a serious issue to have an effect on the bilateral transfer of fine force management. Thus, this diode to Experiment a pair of during which the degree (i.e. amount) of force was examined to verify if it competes a major role within the bilateral transfer of fine force management. it absolutely was usually hypothesized that bilateral transfer ought to be influenced by the degree of force management learning and therefore the increased degree of force management (i.e. five hundredth MVC) would lead to a major and positive bilateral transfer.

Experiment 2

5. Methods

5.1 Participants

A total of thirty undergrad students (16 females and fourteen males) World Health Organization failed to participate in Experiment one volunteered for Experiment a pair of.

All participants received attainment, had no expertise with the task, and weren't tuned in to the study's aims.

The participants aged from nineteen to twenty-five (M=21.31 years, SD=2.40) and were all right-hand dominant, as determined by the Edinburg laterality Inventory take a look at. The University of Lone-Star State at metropolis Human Participants Committee approved the study protocol.

Informed consent was obtained from every of the participants before the experiment.

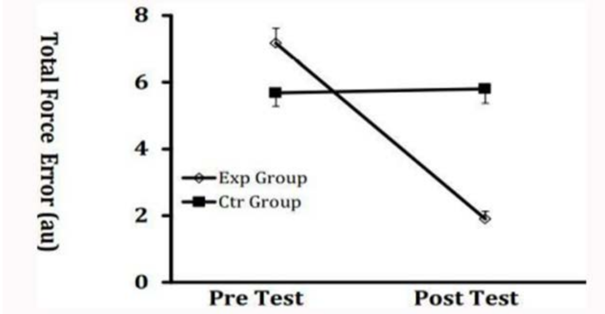

Figure 5: Means and standard errors of Total Force Absolute Error (TFAE) as a function of Pre and Posttests for the Trained Limb (Right Hand).

5.2 Task and equipment

The participants learned an equivalent task as Experiment one except they were needed to find out the consecutive talent by exerting four little isometric and constant forces of their five hundredth MVC, rather than 100 percent MVC. As in Experiment one, surface diagnostic procedure (EMG) was placed on the left and right FDI muscles to record muscle activity throughout every trial. before playacting the next knowledge analyses, all participants' knowledge was screened for outliers (i.e. the mean of dependent variables were out of the vary of the cluster mean ± a pair of SD). the complete knowledge of the detected outliers were excluded from any analyses.

5.3 Procedures and knowledge analyses

Same as in Experiment one, the participants were every which way appointed to 2 teams, experimental cluster (Exp five hundredth MVC) and management cluster (Crt five hundredth MVC), fifteen participants in every cluster. The management cluster solely participated in pre and posttests. The procedures and knowledge analyses in Experiment a pair of were an equivalent as in Experiment one.

6. Results

6.1 Acquisition part

MVC and muscle activity throughout the task: The MVC and electromyogram were the same as Experiment one. Total Force Error (TFAE): The result of block on TFAE was vital, $F_{(5, 65)} = 10.45$, $p < 0.01$, partial $\eta^2 = 0.45$. Post-hoc Bonferroni take a look at on block indicated that TFAE was higher in block one than in blocks four to six. There was no vital distinction in the other try comparison. See very cheap panel of Figure 5 for the suggests that and normal errors of TFAE for the apply blocks.

6.2 Testing part

Total force error (TFAE) of the trained limb (Right hand) with the pretest data: the most result of part was vital, $F (1, 25) =21.68$, $p< 0.01$, partial $\eta2 =0.51$. the most result of cluster wasn't vital, $F (1, 25) =2.93$, $p=0.09$, partial $\eta2 =0.11$. However, the interactive result of the 2 factors was vital, $F (1, 25) =23.28$, $p< 0.01$, partial $\eta2 =0.48$. The logical fallacy Bonferroni take a look at indicated that the interaction was because of the very fact that there was vital distinction in TFAE between pre- and posttests for the experimental cluster solely, however not for the management cluster.

Total force error (TFAE) of each trained and undisciplined limb with the posttest data: the most result of hand wasn't vital, $F (1, 25) =0.03$, $p=0.85$, partial $\eta2 =0.01$. the most result of cluster was vital, $F (1, 25) =22.00$, $p< 0.01$, partial $\eta2 =0.47$. There was no vital interactive result of the 2 factors. The suggests that and normal errors of TFAE for the take a look at.

7. Discussion

This experiment examined the result of the degree of learned force on the bilateral transfer of the consecutive force management task. The results showed that when coaching, the trained limb improved considerably. The performance of the trained limb within the posttest for the experimental cluster wasn't solely higher than that within the pretest, however additionally considerably higher than the management cluster throughout posttest. moreover, the coaching result was additionally extended to the undisciplined limb as shown by considerably higher performance of the undisciplined limb (i.e. left limb) for the experimental cluster than that of the management cluster. It ought to even be noted that there was no vital distinction within the posttest between the proper and left limbs for the experiment cluster, that is any proof to point the positive bilateral transfer in Experiment a pair of. The results from Experiment a pair of give supporting proof to point that the degree of force is associate cogent issue to see the result of bilateral transfer of the learned fine force management from the trained limb to the undisciplined limb. It ought to be noted that this bilateral transfer result won't be caused by co-activities of the homologous muscles on the undisciplined limb as evident in Experiment one, though the degree of the learned force increased to five hundredth MVC during this experiment (2), the electromyogram values of the undisciplined FDI throughout the acting amount wasn't considerably co-activated. Thus, the bilateral transfer result found within the current experiment could also be from the central systema nervosum.

8. General Discussion

The aim of the present study was to see the factors that caused the shortage of bilateral transfer of fine force management in Yao et al.'s study [5]. The combined results of the 2 experiments within the current study indicated that the degree of force management was ready to account for the shortage of the bilateral transfer in Yao et all's study [5]. These results of the present studies area unit in step with the cross-activation hypothesis [13].

As same, the cross-activation hypothesis attributes bilateral transfer to the bilateral plant tissue activities caused by single limb coaching [13], and is very roaring in predicting bilateral transfer with force-control tasks [14-17]. However, vital bilateral plant tissue activities won't happen unless the degree of force (forcefulness of muscle contraction) applied on the coaching limb reaches to a definite level [14]. Therefore, within the gift study positive bilateral transfer was found only the degree of fine force management augmented from 100% MVC to five hundredth MVC. As such, there should exist a necessary minimum quantity of force production throughout learning to facilitate bilateral learning.

It ought to be noted that as a result of the my orgasm on the untrained muscles weren't considerably activated, though the degree of the fine force controlled raised up to five hundredth MVC (Experiment 2), the bilateral transfer found within the experiment may well be because of the changes of motor cortexes at higher levels of the central systema nervosum, rather than at peripheral level. because of the limitation of the experimental style, this study isn't ready to verify the particular square measurea|cortical region|area|region} or areas that are in command of the bilateral transfer, and may solely speculated from the literature on systema nervosum centrale contributions. to the current extent, findings from previous analysis indicates that the first cortical area cingulate cortical area, and premotor space and Supplementary square measurea|motor region|motor cortex|Rolando's area|excitable area|cortical region} (SMA) are all concerned in generating bilateral transfer. last, Ruddy et al. instructed that supplementary motor areas could play a vital role in bilateral transfer. Their finding is in line with alternative studies relating to the role of SMA in movement management and bilateral transfer. for instance, Tanji and Shima's study found that SMA plays an outstanding role in successive movement designing (e.g. the task within the current study is within the class of successive movement task), and a study by Perez et al. found a high relationship between degree of bilateral transfer and activities within the SMA.

It should be distinguished that this study solely determined that a task with augmented degree of fine force management (i.e. five hundredth MVC) and reduced task quality (i.e. no temporal arrangement control) resulted in positive bilateral transfer. However, it cannot conclude whether or not associate degree augmented degree of force management whereas maintaining identical level of task quality as in Yao et al.'s [5] study (consisting of each temporal arrangement and fine force management learning), can likewise cause bilateral transfer. It's vital to grasp the character of bilateral management for a task with each temporal arrangement and fine force management as a result of most successive motor movements contains the 2 parts in everyday life. Thus, more studies are necessary to clarify the contributions of every in-task element.

Importantly, solely the transfer of learning from the dominant to non-dominant limbs was examined within the current study. Thus, the authors will solely draw conclusions relating to transfer from dominant to non-dominant limb. Thus, more analysis is critical to look at the campaign of bilateral transfer of fine force management from the non-dominant hand to the dominant hand. therewith being aforementioned, a study by Stöckel & Weigelt found that the bilateral transfer for a throwing-accuracy task (e.g. the same as the fine force management task within the current study) was a lot of favored by having initial coaching with the non-dominant hand. In associate degree earlier study, that et al. according the same finding employing a figure drawing task. Findings showed that abstraction accuracy transferred best from the non-dominant to the dominant hand, whereas movement time transferred best from the dominant to the non-dominant hand. Therefore, the combined findings from these studies tentatively recommend that bilateral transfer can occur if the non-dominant limb is that the trained limb (i.e. having initial coaching with the non-dominant limb).

9. Conclusion

In summary, this study hints that the degree of fine force management, accounted for the shortage of the bilateral transfer of the fine control in Yao et al.'s study. Further analysis is required to more examine whether or not bilateral transfer still exists once a task consists of each temporal arrangement management and a high level of fine force management (e.g. five hundredth MVC) before we will absolutely perceive the character of bilateral transfer in learning a successive task with each temporal arrangement and force management. These findings can have impact on learning and/or relearning motor skills in sports and rehabilitation settings by optimizing follow schedules. These findings have clinical implications in terms of optimizing follow schedules. For instance, bilateral transfer of a learned talent is usually one among the key considerations and/or goals in rehabilitation coaching with stroke patients. Commonly, people affected by a stroke a solely ready to voluntarily move one facet of their body. Practitioners, UN agency a treating this neural structure incapacity, usually have stroke patients follow their intact limbs with expectation or hope that this may facilitate rehabilitation of the limb of the affected facet. Supported this finding, a practitioner would expect a big bilateral transfer for a force-control once associate degree acceptable degree of force management (i.e. five hundredth MVC) is applied. Future studies are required to research at the least level of force production necessary to facilitate bilateral transfer.

10. Reference

1. Teixeira LA. Timing and force components in bilateral transfer of learning. Brain Cogn. 2000;44(3):455 -69.
2. Yao WX, Cordova A, Huang Y, Wang Y, Lu X. Bilateral transfer for learning to control timing but not for learning to control fine force. Percept Mot Skills. 2014;118(2):400-10.
3. Ausenda C, Carnovali M. Transfer of motor skill learning from the healthy hand to the paretic hand in stroke patients: A randomized controlled trial. Eur J Phys Rehabil Med. 2011;47(3):417-25.
4. Land WM, Liu B, Cordova A, Fang M, Huang Y, Yao WX. Effects of physical practice and imagery practice on bilateral transfer in learning a sequential tapping task. PloS One. 2016;11(4):e0152228.
5. Romkema S, Bongers RM, Vander SCK. Influence of mirror therapy and motor imagery on intermanual transfer effects in upper-limb prosthesis training of healthy participants: A randomized pre-posttest study. PLoS One. 2018;13(10):e0204839.
6. Bolton DAE, Buic AR, Carroll TJ, Carson R G. Interlimb transfer and generalisation of learning in the context of persistent failure to accomplish a visuomotor task. Exp Brain Res. 2019;237:1077-92.
7. Ruddy KL, Leemans A, Woolley DG, Wenderoth N, Carson RG. Structural and functional cortical connectivity mediating cross education of motor function. J Neurosci. 2017;37(10):2555-64.
8. Teixeira LA. Bilateral transfer of learning: The effector side in focus. J Human Movement Studies. 1993;25:243-53.
9. Park JH, Shea CH. Effector independence. J Motor Behav. 2003;34(3):253-70.
10. Parlow SE, Kinsbourne M. Asymmetrical transfer of training between hands: Implications for interhemispheric communication in normal brain. Brain Cogn.1989;11(1):98-113.
11. Dettmer C, Fink GR, Lemon RN, Stephan KM, Passingham RE, Silbersweig D, et al. Relation between cerebral activity and force in the motor areas of the human brain. J Neurophysiol. 1995;74(2):802-15.
12. Cramer SC, Finklestein SP, Schaechter JD, Bush G, Rosen BR. Activation of distinct motor cortex regions during ipsilateral and contralateral finger movements. J Neurophysiol. 1999;81(1):383-7.

13. Kawashima R, Roland PE, O'Sullivan BT. Activity in the human primary motor cortex related to ipsilateral hand movements. Brain Res. 1994;663(2):251-6.

14. Koeneke S, Lutz K, Herwig U, Ziemann U, Jancke L. Extensive training of elementary finger tapping movements changes the pattern of motor cortex excitability. Exp Brain Res. 2006;174:199-209.

15. Kobayashi M, Hutchinson S, Schlaug G, Pascual-Leone A. Ipsilateral motor cortex activation on functional magnetic resonance imaging during unilateral hand movements is related to interhemispheric interactions. Neuroimage. 2003;20(4):2259-70.

16. Kermadi I, Liu Y, Rouiller EM. Do bimanual motor actions involve the dorsal premotor (PMd), cingulate (CMA) and posterior parietal (PPC) cortices? Comparison with primary and supplementary motor cortical areas. Somatosens Mot Res. 2000;17(3):255-71.

17. Koeneke S, Lutz K, Wustenberg T, Jancke L. Bimanual versus unimanual coordination: What makes the difference? Neuroimage. 2004;22(3):1336- 50.