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Development of a Small-Group Teaching Method for Enhancing the Learning of Basic Acupuncture Manipulation Optimized with the Theory of Motor Learning

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***Abstract*—**This study developed a method for teaching acupuncture manipulation in small groups optimized with the theory of motor learning. Sixty acupuncture students and their teacher participated in our research. Motion videos were recorded of their manipulations using the lifting-thrusting method. These videos were analyzed using Simi Motion software to acquire the movement parameters of the thumb tip. The parameter velocity curves along Y axis was used to generate small teaching groups clustered by a self-organized map (SOM) and K-means. Ten groups were generated. All the targeted instruction based on the comparative results groups as well as the videos of teacher and student was provided to the members of each group respectively. According to the theory and research of motor learning, the factors or technologies such as video instruction, observational learning, external focus and summary feedback were integrated into this teaching method. Such efforts were desired to improve and enhance the effectiveness of current acupuncture teaching methods in limited classroom teaching time and extracurricular training.

***Keywords*—**Acupuncture, group teaching, video instruction, observational learning, external focus, summary feedback.

I. INTRODUCTION

AS an alternative or complementary medical treatment, acupuncture has been accepted globally for itits low complication rate and minimal side effects. Therefore, acupuncture education has gradually spread across the world; its teaching institutions have also been established in many countries, including China, [1] Japan, [1], [2] South Korea, [1], [3] the United States, [4] Germany, Australia, [5] and others. The systematic teaching content of acupuncture includes meridian theory, acupuncture manipulations and clinical practice. Basic acupuncture manipulations can be divided into lifting-thrusting and twisting, which refers to controlling the up-and-down and rotational motion of the needle using the thumb and forefinger, respectively [6]. As the main approach of acupuncture stimulation, acupuncture manipulation has been proven to have a crucial impact on its clinical efficacy; this idea has been supported by many modern studies [7]-[10]. However, manipulations is often regarded as difficult because it is challenging to be both skilled and proficient.

The learning of acupuncture manipulations can be regarded as a kind of motor learning. Numerous studies of motor learning has reported factors or technologies that have been proved to optimize learning in the cognitive or motor domain, such as the use of video instruction, [11] observational learning, [12] external focus [13] or summary feedback, [11] have already demonstrated their utility for medical training. For instance, the study of Xeroulis GJ et al. showed that video instruction can be as effective as summary expert feedback in the instruction of basic technical skills to medical students, and provides evidence supporting an increased role of summary feedback to effectively train novices in technical skills [11]. However, to date, no acupuncture education institution has introduced the theory of motor learning into teaching and training of acupuncture manipulations. Traditional oral instruction and observation of teacher's manipulation were used consistently from ancient time [6]. In addition, another two shortcomings of classroom teaching also exist. First, the lack of quantitative approaches for assessing the manipulations. Our previous work focused on solving this problem with motion-video analysis, and several kinematic parameters have also been proposed [14]. Second, the lack of feedback for students. With the increasing popularity of acupuncture, the number of students recruited by acupuncture education institutions has accordingly increased each year. Teachers do not have sufficient time in the classroom to give each student summary feedback or targeted instructions during the teaching process. Due to differences in the understanding of different students, distinctions in the operation of the same manipulation method among students were found in some studies [15], [16]. Therefore, it is particularly important for teachers to seek approaches that reduce the deviation in student understanding and enhance the teaching effect using the methods of other disciplines such as motor learning.

In this study, a small-group teaching method was developed in order to provide the possible solution for the problems listed above. Each group was received targeted instructions optimized with the theory of motor learning after quantitative assessment. All groups were based on clustering results of the quantized data (the velocity curves for thumb operation of the acupuncture needle derived from the motion video analysis system) using a self-organized map (SOM) and K-means. We hope such efforts can be used to improve and enhance the effectiveness of current acupuncture teaching methods in limited classroom teaching time and extracurricular training.

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II. Method

A. Participants

This study was approved by the Ethics Committee of Yueyang Hospital, in affiliation with Shanghai University of Traditional Chinese Medicine (reference no. 2016-108). One class with Sixty students and their teacher were selected from the Acupuncture-Moxibustion and Tuina School of Shanghai University of Traditional Chinese Medicine as the study participants. All students received measurements of the basic acupuncture manipulation lifting-thrusting method one-week after they finished the lifting-thrusting chapter in the acupuncture and moxibustion techniques and manipulations course [6] and had hands-on needling experience with the human body.

B. Measurement Environment Configuration for Quantitative Data

Prior to the measurement, an operation table was placed on a level floor. After adjusting the legs of a tripod to a specified length of 79 cm and the maximum angle, the tripod was placed at a specified location on the floor. A camera was connected to the positioned tripod; level adjustment was performed using the system's built-in leveling control within the camera to ensure horizontal alignment of the lens. The distance from the center of the lens to the floor was 84 cm, and the vertical distance from the lens to the front edge of the experimental operation table was 33 cm. The camera and the fill light were both switched on. The camera parameters were set as follows: aperture F7.1; shutter speed 1/1000 s; ISO 6400; auto white balance; and optical zoom 33 mm.

C. Measurement Methods

Video Capture Method: (1) A small two-dimensional (2D) calibration frame was placed vertically on the horizontal axis of the operation table to permit the 2D calibration operation of Simi Motion 3D version 7.5 (Simi Reality Motion Systems GmbH, Unterschleissheim, Germany).

(2) All participants were seated on the right side of the operation table, and a volunteer was positioned on the other side to expose the acupuncture point LI11 (*Quchi*), located at the lateral end of the transverse cubital crease connecting acupuncture point LU5 (*Chize*) with the lateral epicondyle of the humerus on the right arm.

(3) One trace mark was labeled using a thin marker on the right thumb of each participant (Fig. 1 (A)). This mark was located on the ulnar side of the thumb tip 0.1 inches superior to the nail root corner and was defined as the thumb right (TR).

A 0.3050 mm disposable stainless-steel acupuncture needle (Shenli Medical & Health Material Co., Ltd. Wujiang, China) was inserted at LI11 and was used to test the lifting-thrusting method with video acquisition of the basic acupuncture manipulation.

Video Processing: The same TR trace mark was established in Simi Motion 3D. The 2D calibration frame was overlapped with the real video in Simi Motion, and a rigid structural layout of the fingers was established automatically (Fig. 1A).

After conducting analysis with Simi Motion, the velocity along the Y axis for the TR of each participant was acquired; a typical curve is shown in Fig. 1 (B).

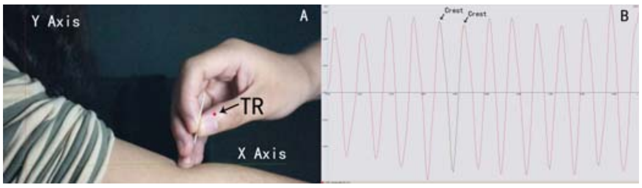

Fig. 1 Configuration of the trace mark and velocity curves along the Y axis of TR, as derived from Simi Motion 3D during the lifting-thrusting method. Panel A shows an illustration of 2D calibration overlapping and the TR trace mark. Panel B shows the velocity curves along the Y axis. A typical single-cycle curve was fetched between adjacent crests or troughs and is shown in green

D. Data Processing

Fetching a Typical Single-Cycle Curve: A typical single-cycle curve for every participant was manually fetched from the original continuous velocity curve. The configurations of a single cycle were as follows. First, the curves between two crests were selected (Fig. 1B). Based on the data for the single-cycle curve, the average velocities, cycles and time course for lifting (T_1) and thrusting (T_2) were calculated for each group.

SOM Clustering: The single-cycle curves were then grouped using a clustering analysis based on the SOM algorithm first developed by Kohonen [17]. As a unsupervised neural learning algorithm, SOM also represents a clustering concept by grouping similar data together after an iterative train. The raw data of the curves are mapped to 50 SOM nodes on a 2D hexagonal grid. Each node is represented by a n-dimensional weight vector $m = [m_1, ..., m_d]$, where d is equal to the dimension of the input vector.

The steps of SOM algorithm are listed as follow:

1) A vector is chosen at random from the set of training data.
2) Every node is examined to calculate which weights are most such as the input vector x using some distance measure. The winning node is commonly known as the Best Matching Unit (BMU), denoted here by c:

$$||x - m_c|| = \min_i\{||x - m_i||\}, \tag{1}$$

where $||.||$ is the distance measure.

3) The neighborhood of the BMU is then calculated. The number of neighbors decreases over time.
4) The winning weight is rewarded by becoming more such as the sample vector. The neighbors also become more such as the sample vector. The SOM update to the rules for the weight vector of unit i is:

$$m_i(t+1) = m_i(t) + \alpha(t)h_{ci}(t)[x(t) - m_i(t)], \tag{2}$$

where t denotes time. The $x(t)$ is an input vector that is randomly drawn from the input data at time t, $h_{ci}(t)$ is the neighborhood kernel around the winner unit c and $\alpha(t)$ is the learning rate at time t.
When the node is closer to the BMU, the more its weight gets altered; conversely, when a neighbor is farther away from the BMU, the less it learns.
5) Repeat step 1 for N iterations

The SOM clustering was completed when all iterations had finished. Two evaluation criteria are used for evaluating the SOM quality, namely, data representation accuracy and data set topology representation accuracy. There are many ways to measure these criteria. The implemented measurement methods described below were chosen for their simplicity.

1) Q_e: Average distance between each data vector and its BMU. Measures data representation accuracy.

$$Q_e = \frac{\sum_{i=1}^{n} ||x - m_c(x)||}{\sum_{i=1}^{n} ||x||}, \quad (3)$$

2) T_e: Topographic error, the proportion of all data vectors for which the first and second BMUs are not adjacent units. Measures data set topology representation accuracy.

$$T_e = \frac{1}{n}\sum_{i=1}^{n} u(x), \quad (4)$$

where n denotes sample size.

Smaller values for these two indicators denote a higher quality of SOM clustering.

K-Means Clustering: K-means [18] was performed for secondary clustering by zoning the grids of the SOM; it classified the data into k clusters. The main idea is to define k centers, one for each cluster. Table 1 shows the algorithm. To select the best k among different clusters, each cluster can be evaluated using some kind of validity index. In our work, we used the Davies-Bouldin index [19], which minimizes the ratio between within-cluster distance and between-cluster distance, thus indicating good clustering results for spherical clusters with low values. The Davies-Bouldin index was calculated by specifying the desired small teaching group number over an interval from 5 to 10; the best clustering result was obtained by identifying the minimal Davies-Bouldin index.

Programming: In this work, SOM and K-means clustering were conducted using the SOM toolbox in MATLAB[19]. The SOM was trained using sequential versions of the algorithm for the data in two phases: a rough training with a large initial neighborhood width and a fine-tuning phase with a small initial neighborhood width. The training lengths of the two phases were both 10 epochs. The generated clusters were defined as small teaching groups.

III. Result

The sample sizes, average velocities, cycles, and T_1 and T_2 values of each group are shown in Table II. Ten groups were generated, with $Q_e = 5.375$ and $T_e = 0$. As shown in Fig. 2, Groups 4, 6, 7, 9, and 10 showed a relatively high degree of feature concentration. In contrast, with the large standard deviation of kinematic parameters found in all the samples and in our previous study, [14] low dispersions were found for most of the groups, especially in the ones including more than five samples, providing additional evidence of high-quality clustering.

The manipulation data of the teacher was classified into cluster four, which also included nine students. Therefore, group 4 can be regarded as the standard group for this method. Compared with the other groups, Groups 1, 2, 3, 5 and 8 featured a lower velocity and a correspondingly longer cycle. Groups 7 and 9 showed a higher velocity and shorter cycle. Groups 6 and 10 showed a higher velocity and a longer cycle, indicating that greater motion amplitude was generated.

In terms of T_1 and T_2, the standard group featured similar time intervals for lifting and thrusting; this characteristic was also found in Groups 2, 3, 7, 8, 9, and 10. Thus, the members of these groups showed better temporal control ability. T_2 was much greater than T_1 in Groups 5 and 6; the opposite result was found only in Group 1.

Based on the above findings, several targeted instructions for adjusting manipulation can be summarized for each group, except Group 4, as shown in Table III. All the targeted instruction as well as the videos of teacher and student will be provided to each group respectively. During the classroom and extracurricular practice, students were required to reach a certain period of video observation simultaneously.

IV. Discussion

According to the theory and research of motor learning, some optimizing factors or technologies were integrated into this small group teaching method. First, instruction and quantitative assessment based on motion video analysis. To our knowledge, this technology was used in instructing and assessing the acupuncture manipulation for the first time. But it has been widely applied to the teaching of finger-related skills. For instance, the baseball pitching [20] and piano playing[21]. Studies has proved that video instruction can make efficient use of faculty time and serve as a useful pedagogic adjunct for basic skills training [11]. With the help of video instruction, fewer face-to-face teaching is required, and fewer geographic and temporal constraints are placed on both teachers and students [22]. Furthermore, It’s reported that learning can be enhanced when learners have the opportunity to make decisions about aspects of practice conditions such as skill demonstrations, [23], [24] even small or incidental choices that do not have direct task relevance can provide sufficient performance enhancement [25], [26]. Video instruction allows learners to progress at their preferred pace, the teacher’s video can be repeated, interrupted or resumed at will of students, which may provide additional autonomy support for students.

Second, observing the videos combined with manipulation practice can be considered as a typical observational practice. Compared with single physical practice, previous findings showed it is typically not effective, [27] but research has

TABLE I
PROCEDURE OF THE K-MEANS ALGORITHM

No.	Procedure
1	Initialize the number of clusters, k, and k means vectors, $\mu_1, \mu_2 ..., \mu_k$.
2	Classify the input vectors according to the closest means vectors, μ_i.
3	Re-compute μ_i.
4	If there are any changes in each μ_i for all input vectors, return procedure 2. Otherwise stop.

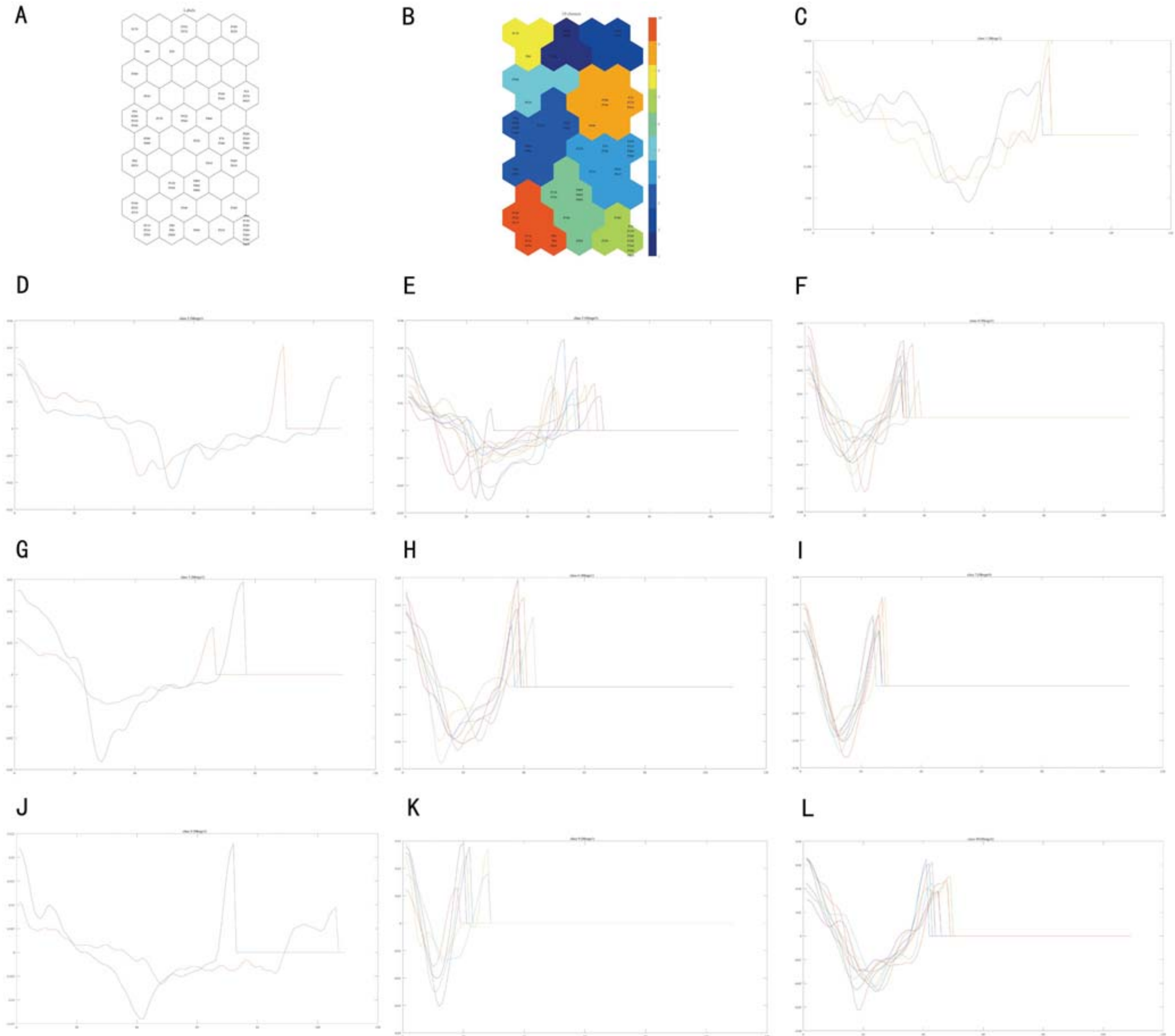

Fig. 2 Clustering result for the lifting-thrusting method. (A) Clustering result after SOM; all the samples were clustered into a regular two-dimensional grid. (B) Secondary clustering result of K-means; different colors represent different clusters. (C)-(L) Separate illustrations of the velocity curves of Groups 1-10

TABLE II
SAMPLE SIZE AND MOTION PARAMETERS FOR EACH CLUSTER OF THE LIFTING-THRUSTING METHOD

Group	Sample size (n)	Average velocity (cm/s)	Average cycle (s)	T_1 (s)	T_2 (s)
All	61	1.2950.713	1.4840.678	0.7300.352	0.7540.389
1	2	3.320.448	0.8620.251	1.5340.185	1.0670.240
2	2	2.6360	0.4110.078	1.5840.259	1.7340.188
3	11	0.7880.263	1.7550.322	0.8120.160	0.9430.345
4*	10	1.1220.295	1.1210.065	0.5930.136	0.5270.132
5	2	0.9090.415	2.3680.235	1.0010.047	1.3670.283
6	7	1.2740.223	1.2910.076	0.5760.146	0.7140.169
7	9	2.7410.368	0.8670.044	0.4330.057	0.4330.072
8	2	0.5290.241	2.9690/802	1.5010.141	1.4670.660
9	6	1.2980.408	0.7610.140	0.3940.049	0.3660.094
10	9	1.4970.096	1.4840.678	0.7300.087	0.7670.104

This group included the manipulation data of the teacher and was defined as the standard group.

TABLE III
TARGETED INSTRUCTIONS FOR EACH SMALL TEACHING GROUP WITH THE LIFTING-THRUSTING METHOD

Group	Targeted instructions
1	Significantly increase the manipulation velocity, especially the lifting velocity, and shorten the operating cycle.
2	Slightly increase the manipulation velocity and significantly reduce the motion amplitude to shorten the operating cycle.
3	Slightly increase the manipulation velocity and shorten the operating cycle.
5	Slightly increase the manipulation velocity, especially the thrusting velocity, and significantly reduce the motion amplitude to shorten the operating cycle.
6	Slightly reduce the manipulation velocity and motion amplitude to shorten the operating cycle, especially the time intervals of thrusting.
7	Significantly reduce the manipulation velocity and motion amplitude and extend the operating cycle slightly.
8	Significantly increase the manipulation velocity and reduce the motion amplitude to shorten the operating cycle.
9	Slightly reduce the manipulation velocity and increase the motion amplitude to significantly extend the operating cycle.
10	Slightly reduce the manipulation velocity and significantly reduce the motion amplitude to shorten the operating cycle.

indicated that observational practice offers the learner a chance to conduct processing that could not occur simultaneously with physical practice, which provide unique and important contributions to learning [28], [29]. Shea CH et al. [12] explained this finding at a behavioural level that observation may give the learner unique opportunities either to extract important information concerning appropriate coordination patterns and subtle requirements of the task or to evaluate the effectiveness of strategies that would be difficult, if not impossible, if he or she were to prepare and execute an impending movement concomitantly. In our method, a certain amount of observational practice was scheduled for students to re-examine their own skills and extract more informations from the video of teacher.

Third, external focus. Our previous work has provided an advice for teachers that a focus on guiding students to increase the motion amplitudes along the X axis by training them to appropriately flex their PIP is advised [14]. However, this advice induces a typical internal focus of attention according to the theory of motor leaning. It has been demonstrated in many studies that internal focus of attention on performers movements of body parts such as fingers, hands, etc. are relatively ineffective. On the contrary, directing attention to the task goal of the individuals movements, (e.g., implement trajectory, exerting force against the obstruction) will induce an external focus and generally result in more effective performance and learning [30]-[32]. Because An external focus is an important contributor to goal-action coupling [33]. In this method, we adjusted the previous measurement scheme, only one trace mark on thumb tip was placed for measurement. Although it was still a part of human body, due to the connection between the needle handle and the tips of thumb, forefinger tip, thumb tip, and needle can be regarded as the different points of same rigid structure, the needle movement can be represented by TR on kinematic parameters. Therefore, all the targeted instructions were based on the comparative results of needle movement between standard group and other groups, and the external focus was expected to be induced for more effective and efficient learning.

Finally, the targeted instructions were summary feedbacks. Many studies have argued the role of feedback in the performance and learning of medical skills [34]-[36]. Although the methods and types of feedback have obvious relevance for medical training and goal setting has been shown to enhance learning, [37] a caveat of such studies is that the amount and type of feedback are often confounded. Some findings indicate that the motivational properties of feedback can have an important influence on learning. For example, the research of Kernodle et al. [38] showed motion video combined with information feedback (eg. correction guidance) can lead to significant gains in skill acquisition, but studies also indicatted that performance is above or below expectations especially when presented repeatedly may have positive or negative effects on learning [39]-[41]. Although there was no better or worse judgement in our teaching method, students in the standard group might have positive motivations that will benefit their learning, and the opposite results may also exist in other groups. Therefore, a control study is necessary for verifying the role of augmented feedback.

The grouping scheme in our study is designed to cluster the students with similar manipulation for improving instruction efficiency, it was similar to homogeneous group teaching, [42] which provide extra benefits for learning. According to related research on homogeneous group teaching [42]-[44], we predict that this type of teaching method will facilitate communication and interaction among students both between groups and within groups. For example, students in the standard group can help train students in other groups during their spare time, and students within the same group can instruct each other. This method also contributes to the evaluation of teaching effectiveness in a relatively simple way, e.g., the observation of the sample size in the standard group by re-measurement and clustering analysis after a period of targeted instruction and training.

There has been no significant breakthrough or improvement in acupuncture teaching methods for many years; this study establishes a grouping scheme for basic acupuncture manipulation optimized with the theory of motor learning. This is very urgent in our future work that control study and evaluation of the effectiveness of this teaching method should be performed. Moreover, after this first attempt at the most basic manipulation, further efforts is needed to apply this method to the learning of other single or compound acupuncture manipulations.

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References

[1] H.-L. Park, H.-S. Lee, B.-C. Shin, J.-P. Liu, Q. Shang, H. Yamashita, and B. Lim, "Traditional medicine in china, korea, and japan: a brief introduction and comparison," *Evidence-Based Complementary and Alternative Medicine*, vol. 2012, 2012.

[2] N. Ishizaki, T. Yano, and K. Kawakita, "Public status and prevalence of acupuncture in japan," *Evidence-Based Complementary and Alternative Medicine*, vol. 7, no. 4, pp. 493–500, 2010.

[3] S. M. Ock, J. Y. Choi, Y. S. Cha, J. Lee, M. S. Chun, C. H. Huh, S. Y. Lee, and S. J. Lee, "The use of complementary and alternative medicine in a general population in south korea: results from a national survey in 2006," *Journal of Korean Medical Science*, vol. 24, no. 1, pp. 1–6, 2009.

[4] D. Su and L. Li, "Trends in the use of complementary and alternative medicine in the united states: 2002–2007," *Journal of health care for the poor and underserved*, vol. 22, no. 1, pp. 296–310, 2011.

[5] S. Janz, J. Adams *et al.*, "Acupuncture education standards in australia: a critical review," *Australian Journal of Acupuncture and Chinese Medicine*, vol. 6, no. 1, p. 3, 2011.

[6] F. chun Wang, *Acupuncture and Moxibustion Techniques and Manipulations*. Shanghai Science and Technology Press, 2009.

[7] S.-h. Hong, S.-s. Ding, F. Wu, Y. Bi, F. Xu, Y.-j. Wan, and L.-h. Xuan, "Efficacy and safety of manual acupuncture manipulations with different frequencies on epigastric pain syndrome (eps) in functional dyspepsia (fd) patients: study protocol for a randomized controlled trial," London, 2017.

[8] G. H. Kim, M. Yeom, C. S. Yin, H. Lee, I. Shim, M. S. Hong, C.-J. Kim, and D.-H. Hahm, "Acupuncture manipulation enhances anti-nociceptive effect on formalin-induced pain in rats," *Neurological Research*, vol. 32, no. sup1, pp. 92–95, 2010.

[9] W. Li and A. Ahn, "Effect of acupuncture manipulations at li4 or li11 on blood flow and skin temperature." *Journal of acupuncture and meridian studies*, vol. 9, pp. 128–33, Jun 2016.

[10] T. Huang, X. Huang, W. Zhang, S. Jia, X. Cheng, and G. Litscher, "The influence of different acupuncture manipulations on the skin temperature of an acupoint," *Evidence-Based Complementary and Alternative Medicine*, vol. 2013, 2013.

[11] G. J. Xeroulis, J. Park, C.-A. Moulton, R. K. Reznick, V. LeBlanc, and A. Dubrowski, "Teaching suturing and knot-tying skills to medical students: a randomized controlled study comparing computer-based video instruction and (concurrent and summary) expert feedback," *Surgery*, vol. 141, no. 4, pp. 442–449, 2007.

[12] C. H. Shea, G. Wulf, and C. Whltacre, "Enhancing training efficiency and effectiveness through the use of dyad training," *Journal of motor behavior*, vol. 31, no. 2, pp. 119–125, 1999.

[13] G. Wulf, N. McNevin, and C. H. Shea, "The automaticity of complex motor skill learning as a function of attentional focus," *The Quarterly Journal of Experimental Psychology Section A*, vol. 54, no. 4, pp. 1143–1154, 2001.

[14] W.-C. Tang, H.-Y. Yang, T.-Y. Liu, M. Gao, and G. Xu, "Motion video-based quantitative analysis of the lifting-thrustingmethod: a comparison between teachers and students of acupuncture," *Acupuncture in Medicine*, pp. acupmed–2016, 2017.

[15] T. Liu, L. Kuai, H. Yang, and M. Gao, "Preliminary research on the standardization of acupuncture manipulation," *Zhongguo zhen jiu= Chinese acupuncture & moxibustion*, vol. 28, no. 5, pp. 356–358, 2008.

[16] R. T. Davis, D. L. Churchill, G. J. Badger, J. Dunn, and H. M. Langevin, "A new method for quantifying the needling component of acupuncture treatments," *Acupuncture in Medicine*, vol. 30, no. 2, pp. 113–119, 2012.

[17] T. Kohonen, "The self-organizing map," *Neurocomputing*, vol. 21, no. 1, pp. 1–6, 1998.

[18] J. MacQueen *et al.*, "Some methods for classification and analysis of multivariate observations," in *Proceedings of the fifth Berkeley symposium on mathematical statistics and probability*, vol. 1, no. 14. Oakland, CA, USA, 1967, pp. 281–297.

[19] J. Vesanto, "Som-based data visualization methods," *Intelligent data analysis*, vol. 3, no. 2, pp. 111–126, 1999.

[20] T. Matsuo, T. Jinji, D. Hirayama, D. Nasu, H. Ozaki, and D. Kumagawa, "Middle finger and ball movements around ball release during baseball fastball pitching," *Sports biomechanics*, pp. 1–12, 2017.

[21] A. Hadjakos, E. Aitenbichler, and M. Mühlhäuser, "Potential use of inertial measurement sensors for piano teaching systems: Motion analysis of piano playing patterns," in *Proceedings of the 4th i-Maestro Workshop on Technology-Enhanced Music Education*, 2008, pp. 61–68.

[22] T. Greenhalgh, "Computer assisted learning in undergraduate medical education," *BMJ: British Medical Journal*, vol. 322, no. 7277, p. 40, 2001.

[23] E. L. Deci and R. M. Ryan, "Self-determination theory: A macrotheory of human motivation, development, and health." *Canadian psychology/Psychologie canadienne*, vol. 49, no. 3, p. 182, 2008.

[24] D. I. Cordova and M. R. Lepper, "Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice." *Journal of educational psychology*, vol. 88, no. 4, p. 715, 1996.

[25] P. G. Post, J. T. Fairbrother, and J. A. Barros, "Self-controlled amount of practice benefits learning of a motor skill," *Research quarterly for exercise and sport*, vol. 82, no. 3, pp. 474–481, 2011.

[26] G. Wulf, M. Raupach, and F. Pfeiffer, "Self-controlled observational practice enhances learning," *Research Quarterly for Exercise and Sport*, vol. 76, no. 1, pp. 107–111, 2005.

[27] P. McCullagh and M. R. Weiss, "Modeling: Considerations for motor skill performance and psychological responses," in *Handbook of sport psychology*. Wiley, 2001, pp. 205–238.

[28] W. L. Shebilskem, J. W. Regian, W. Arthur Jr, and J. A. Jordan, "A dyadic protocol for training complex skills," *Human Factors*, vol. 34, no. 3, pp. 369–374, 1992.

[29] C. H. Shea, D. L. Wright, G. Wulf, and C. Whitacre, "Physical and observational practice afford unique learning opportunities," *Journal of motor behavior*, vol. 32, no. 1, pp. 27–36, 2000.

[30] G. Wulf, "Attentional focus and motor learning: a review of 15 years," *International Review of Sport and Exercise Psychology*, vol. 6, no. 1, pp. 77–104, 2013.

[31] ——, *Attention and motor skill learning*. Human Kinetics, 2007.

[32] G. Wulf, S. Chiviacowsky, and R. Drews, "External focus and autonomy support: Two important factors in motor learning have additive benefits," *Human Movement Science*, vol. 40, pp. 176–184, 2015.

[33] Y.-A. Kuhn, M. Keller, J. Ruffieux, and W. Taube, “Adopting an external focus of attention alters intracortical inhibition within the primary motor cortex,” *Acta Physiologica*, vol. 220, no. 2, pp. 289–299, 2017.
[34] A. OConnor, S. Schwaitzberg, and C. Cao, “How much feedback is necessary for learning to suture?” *Surgical endoscopy*, vol. 22, no. 7, pp. 1614–1619, 2008.
[35] D. Stefanidis, J. R. Korndorffer, B. T. Heniford, and D. J. Scott, “Limited feedback and video tutorials optimize learning and resource utilization during laparoscopic simulator training,” *Surgery*, vol. 142, no. 2, pp. 202–206, 2007.
[36] M. C. Porte, G. Xeroulis, R. K. Reznick, and A. Dubrowski, “Verbal feedback from an expert is more effective than self-accessed feedback about motion efficiency in learning new surgical skills,” *The American Journal of Surgery*, vol. 193, no. 1, pp. 105–110, 2007.
[37] E. A. Locke and G. P. Latham, “The application of goal setting to sports,” *Journal of sport psychology*, vol. 7, no. 3, pp. 205–222, 1985.
[38] M. W. Kernodle and L. G. Carlton, “Information feedback and the learning of multiple-degree-of-freedom activities,” *Journal of motor behavior*, vol. 24, no. 2, pp. 187–195, 1992.
[39] S. Chiviacowsky and G. Wulf, “Feedback after good trials enhances learning,” *Research Quarterly for Exercise and Sport*, vol. 78, no. 2, pp. 40–47, 2007.
[40] G. Wulf and R. Lewthwaite, “Effortless motor learning? an external focus of attention enhances movement effectiveness and efficiency,” *Effortless attention: A new perspective in attention and action*, pp. 75–101, 2010.
[41] ——, *Attentional and motivational influences on motor performance and learning*. na, 2009.
[42] B. P. Brown, T. Hedinger, and G. Mieiing, “The power in universality of experience: A homogeneous group approach to social skills training for individuals with learning disabilities,” *Journal for Specialists in Group Work*, vol. 20, no. 2, pp. 98–107, 1995.
[43] B. Du-Babcock, “A comparative analysis of individual communication processes in small group behavior between homogeneous and heterogeneous groups,” in *Proceedings of the 68th Association of Business Communication Convention, Albuquerque, New Mexico, USA*, 2003, pp. 1–16.
[44] P. Maftoun and N. Ghafori, “A comparative study of the effect of homogeneous and heterogeneous collaborative interaction on the development of efl learnerswriting skill,” *The Journal of Applied Linguistics*, vol. 1, no. 2, pp. 127–58, 2009.

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