Effectiveness of visuomotor program via light signal on simple and choice static eye-hand response time among collegiate karate kumite athletes: pretest-posttest design with a control group

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Yen-Hsiu Liu [1,2ABD], Lai-Chu See [3,4,5ACDE], Shu-Chen Chen [6B], Shih-Tsung Chang [7B], Jiahn-Shing Lee [2AE], Li-Chuan Shieh [8B], Ai Yin Lim [3D], Wei-Min Chen [3BC]

[1] Department of Physical Education, Chang Gung University, Taoyuan City, Taiwan
[2] Department of Ophthalmology, Chang Gung Memorial Hospital at Linkou, Taoyuan City, Taiwan
[3] Department of Public Health, College of Medicine, Chang Gung University, Taoyuan City, Taiwan
[4] Biostatistics Core Laboratory, Molecular Medicine Research Center, Chang Gung University, Taoyuan City, Taiwan
[5] Division of Rheumatology, Allergy and Immunology, Chang Gung Memorial Hospital at Linkou, Taoyuan City, Taiwan
[6] Department of Recreational Sports Management, Yu Da University of Science and Technology, Zaoqiao, Taiwan
[7] Office of Physical Education, Chung Yuan Christian University, Taoyuan City, Taiwan
[8] Graduate Institute of Sports Training, University of Taipei, Taipei City, Taiwan

Received: 19 August 2019; **Accepted:** 16 October 2019; **Published online:** 30 November 2019

AoBID: 12885

Abstract

Background and Study Aim: Quick response time (RT) is crucial in karate kumite. Current training rarely use light as training tool. This study aim is the effectiveness of visuomotor training via light signal with human signal on the simple and choice eye-hand RT among collegiate kumite athletes.

Materials and Methods: We recruited 18-25 years old collegiate karate kumite athletes from three non-sport universities. The routine karate practice was standardized to once a week, consisted of 1-hour fitness training in Gym and 1-hour kumite skill training. Subjects were assigned to group A (light signal) or B (human signal) based on the universities. Both groups were trained twice a week for consecutive 6 weeks. RT was measured before and after training, including 2 simple and 3 choice tasks measured at zero, shoulder-width or random distance: SRT_zero, SRT_shoulder, CRT_zero, CRT_random and CRT_shoulder.

Results: Group A had 13 athletes and group B had 11 athletes. Baseline SRT_shoulder for dominant hands was significantly different for both groups but not the other measures. After 6 weeks of training, group A showed significant improvement in SRT_zero and SRT_shoulder for dominant hands ($p = 0.0066$ and $p = 0.001$, respectively); and SRT_shoulder and CRT_zero for non-dominant hands ($p = 0.0138$ and $p = 0.0015$, respectively). Group B showed deterioration for CRT_shoulder at non-dominant hands after training ($p = 0.0037$) but no significant difference at other tasks. When compared the difference before and after training, for dominant hands, group A improved significantly more in CRT_shoulder ($p =$ 0. 0201) than group B; for non-dominant hands, group A improved significantly more in SRT_shoulder and CRT_shoulder ($p = 0.0206$ and $p = 0.0029$, respectively) than group B.

Conclusions: Six weeks of visuomotor training via light signal improved simple RT and some choice RT in collegiate karate athletes than using human signal. Thus, the visuomotor training method can also be used in health-related training, in improving human motor safety, especially developing self-defense capabilities.

Keywords: light training program • visual stimuli • FITLIGHT TrainerTM System

Conflict of interest: Authors have declared that no competing interest exists

Ethical approval: The study was approved by the local Ethics Committee

Provenance & peer review: Not commissioned; externally peer-reviewed

Source of support: This study was partially supported by Chang Gung Memorial Hospital, Taiwan (CMRPD1F0541, CMRPG3G0451, CMRPD5G0021, CMRPD1H0101, CLRPG3D0045)

Author's address: Lai-Chu See, Department of Public Health, College of Medicine, Chang Gung University, 259 Wen-Hwa 1st Road, Kweisan, Taoyuan 333, Taiwan; e-mail: lichu@mail.cgu.edu.tw

Response time – time from acknowledging stimulation to completing task as in respond with overt action

Speed (speed development) – ***noun*** improving physical and mental reaction times [30].

Agility – ***noun*** a combination of physical speed, suppleness and sill [30].

Power – ***noun*** **1.** physical force or strength **2.** the ability, strength, and capacity to do something [30].

Balance – ***noun*** **1**. the act of staying upright and in a controlled position, not stumbling or falling **2.** a state of emotional and mental stability in which somebody is calm and able to make rational decisions and judgments **3.** the proportions of substances in a mixture, e.g. in the diet [30].

Coordination – ***noun*** the ability to use two or more parts of the body at the same time to carry out a movement or task [30].

Motor – ***adjective*** relating to muscle activity, especially voluntary muscle activity, and the consequent body movements [30].

Stimulus – ***noun*** something that has an effect on a person or a part of the body and makes them react (NOTE: The plural is **stimuli**.) [30].

Performance – ***noun*** the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [30].

Health-related training (health-related fitness) – involve cardiovascular fitness, muscular strength and endurance, flexibility, and body composition that helps you to stay healthy.

INTRODUCTION

Karate is a physically high-demand sport [1] which involves essential skills such as response time (RT), speed, agility, power, balance, and coordination [2, 3]. RT is particularly important in kumite, the sparring component of karate. Karate kumite is a combat sport where two athletes confront directly with each other in a variable and interfering situation. Quick sensory and motor response determine the chance to outperform the opponent.

RT refers to the speed at which a person moves in response to a stimulus and is a critical element in most sports. RT requires intact sensory skills, decision processing, and motor performance. Kumite athletes need rapid reaction and have more pronounced dependence on perceptual and anticipatory skills given the fast movement between two athletes in a short distance. Simple situation involves only one type of stimuli while choice situation challenges with more than one type of stimuli. On the other hand, motor RT is the duration from the identification of external stimulus to completion of corresponding action [4]. Choice RT involves information processing such as the four identified stages of stimulus coding, stimulus-stimulus translation, stimulus-response translation, and response selection, as suggested by Donders's law [5]. In karate, RT reflects the time an athlete takes to identify the opponent's gesture or movement, interpret it and initiate a corresponding action. RT is usually the decisive factor in winning a contest [6]. Furthermore, choice RT is often more important in kumite with attack and defense that occurs within a very short period.

Visuomotor training for RT among athletes has been long practiced [7-11] but not many involves evaluate the effectiveness among karate athletes. Vando et al [10] designed a visual feedback training program for young karate athletes and reported a positive outcome for the trained group. RT training for karate athletes mostly involved video or human as the stimuli [12-14]. Recent call for light as a stimulus has risen. Paul et al. [13] suggested light stimulus is a better training method than video and human stimuli because it is more reliable, consistent and easy to reproduce. Video stimulus needs specific equipment and is time constrained. Whereas, human involvement affects accuracy, repeatability, costly and safety.

This study aim is the training effect of light signal with human signal on the simple and choice static eye-hand RT among collegiate karate kumite athletes.

MATERIAL AND METHODS

Study design

This was a pretest-posttest design with a control group. The participants were assigned to either light signal visuomotor training (group A) or human signal visuomotor training (group B) based on the university in order to avoid exchange information or technique between the two study groups. The three universities involved are non-sport university. The routine karate practice for all 3 universities were standardized to once a week, consisted of 1-hour fitness training in Gym and 1-hour karate kumite skill training for the karate athletes involved in this study. In addition to the routine karate practice, the visuomotor training session was not combined with the routine karate training and was on a separate day. Various RTs were measured before and after the training for both groups.

This study was approved by the Institutional Review Board of the study institute. All subjects signed the informed consent form (and by their parents if age <20 y/o) after explaining the nature and possible consequences of the study.

Participants

We recruited 24 karate athletes aged 18-25 years old. Exclusion criteria was myopia without correction (best corrected visual acuity ≤0.8 in both eyes or astigmatism of ≥0.75D). Group A (n = 13, mean age 21.31 ±2.25, BMI 23.76 ±3.30 kg/m^2) had 6.08 ±2.75 years in practicing karate. Group B (n = 11, mean age 21.64 ±1.57, BMI 21.64 ±2.06 kg/m^2) had 4.73 ±5.1 years in practicing karate (Table 1). The group A had more participants experienced in karate contest (p=0.0045) and exercised more hours in a week (p = 0.0115) compared to the group B. There was no significant difference in sex distribution, age, BMI, hand and foot dominance, karate practicing years, hours spent with computer or playing video games in both groups. Noted that no one in both groups withdrew from this study.

Measurements

Subjects were first measured for their static visual acuity (SVA) and then baseline RT by testing on the simple and choice RT tasks. After 6 weeks of training, the subjects were tested again on the RT tasks. SVA was performed using a standard Landolt C chart. SVA in decimal acuity for both eyes were recorded. All participants received an auto-refractometric exam and refractive correction to obtain their refractive state and best corrected visual acuity of each eye. Subjects with best corrected visual acuity ≥0.8 in both eyes and astigmatism of ≤0.75D were eligible.

RT was measured using FITLIGHT Trainer™ system, FITLIGHT Sports Corp., Canada. The FITLIGHT Trainer™ system (FTS) is a wireless light system comprised of 8 RGB LED powered lights controlled by a tablet (Figure 1). The lights are used as targets for the user to deactivate as per the examination routine. Various measurements can be captured for immediate feedback in relation to the user's performance or can later be downloaded to a central computer for future analysis. The lights can be deactivated by use of the user's hands, feet, head, or sport/fitness related equipment, either through full contact or proximity. In this study, eye-hand RT was

Motor safety is consciousness of the person undertaking to solve a motor task or consciousness the subject who has the right to encourage and even enforce from this person that would perform the motor activity, who is able to do it without the risk of the loss of life, injuries or other adverse health effects [31].

Table 1. Elementary characteristics and karate experience at baseline among collegiate karate athletes (n = 24) between group A and group B.

Variables	Group A (n = 13)	Group B (n = 11)	P value
Sex (n(%))			0.4307
Male	8 (61.54)	5 (45.45)	
Female	5 (38.46)	6 (54.55)	
Age (years)	21.31 ±2.25	21.64 ±1.57	0.6876
BMI (kg/m^2)	23.76 ±3.30	21.64 ±2.06	0.0822
Hand dominance (n(%))			1.0000
Right	12 (92.31)	10 (90.91)	
Left	1 (7.69)	1 (9.09)	
Foot dominance (n(%))			0.0983
Right	9 (69.23)	11 (100)	
Left	4 (30.77)	0 (0)	
Karate practicing years (year)	6.08 ±2.75	4.73 ±5.1	0.4306
Karate contest experience in the past 5 years			0.0045
No	2 (15.38)	8 (72.73)	
Yes	11 (84.62)	3 (27.27)	
Exercise habit (hour/week)	10.88 ±8.62	3.64 ±2.38	0.0115
Hours spent with computer (hour/week)	11.88 ±20.3	26.73 ±18.88	0.0790
Hours spent playing video games (hour/week)	13.08 ±14.59	11.73 ±17.2	0.8370

Group A: light signal training; Group B: human signal training

Figure 1. Light disc and tablet controller of the FITLIGHT Trainer™ system (FTS).

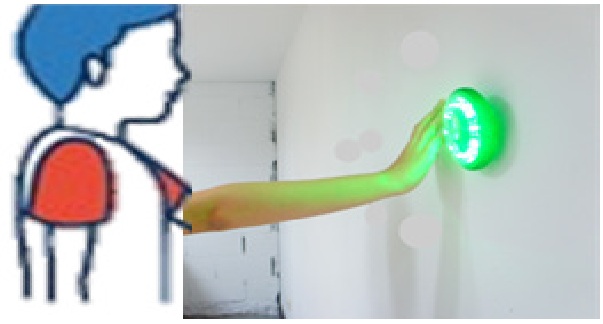

Figure 2. Measuring SRT/ CRT_zero.

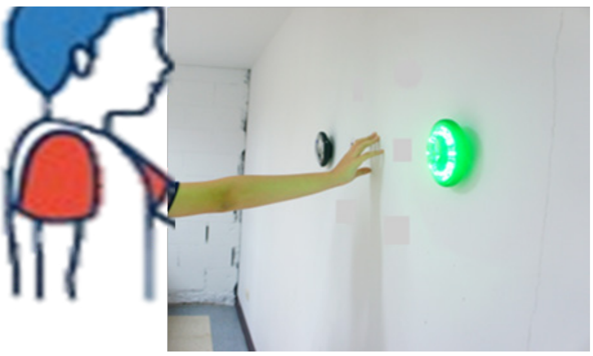

Figure 3. Measuring SRT/ CRT_shoulder.

Figure 4. Measuring CRT_random.

measured for both dominant and non-dominant hands, included 2 simple and 3 choice tasks measured at zero, shoulder-width or random distance: SRT_zero, SRT_shoulder, CRT_zero, CRT_shoulder and CRT_random (Figure 2-4). A detailed description of procedure was written in our previous study, Liu et al. [15].

Training program

The visuomotor training program was designed by the first author who is a karate coach, health fitness instructor, university professor for 20 years, and was a national-level karate athlete. Group A was trained via light signals while group B was trained via human signals. Both groups followed the same program as shown below, but only group A had set signal time. Light signal flashed blue or red light as pre-programmed in FTS (Figure 5). Both groups' duration and frequency are very similar. Participants practiced biweekly for a consecutive 6 weeks with a progressive plan of punches and kicks. Table 2 showed the details of the training program.

The training program was progressively intensified every week in terms of the number of simultaneous signals, the duration of each round, the number of rounds, and the breaks between rounds. All sessions were conducted in the evening. Before each session, participants performed general warm up exercise for 15 minutes. The program focused on simple task for week 1 to 4 and progressed to a choice task at week 5 and 6. Blue signal was used as go task and red signal was used as no/go task. For week 1, only one blue signal was flashed (simple task) at a time, 5 sets in total (12.5min) and each set lasted for 2min. From week 2 to 3, two blue signals were flashed in each set, 6 sets in total (14.5min) and each set lasted for 2min. For week 4, three blue signals were flashed in each set, 6 sets in total (14.5min) and each set lasted for 2min. For week 5, 4 blue signals and 2 red signals (choice tasks) were flashed at each set, 4 sets in total (16min) and each set lasted for 3 min. For week 6, 5 blue signals and 2 red signals were flashed at each set, 4 sets in total (16min) and each set lasted for 3 min. Week 1 to 4, 30s rest was given and prolonged to 60s at week 5 and 6. Table 2 showed the details of the training program.

For group A (light signal), the signal time was set at 8 seconds for week 1 and 2, subsequently reduced to 6 seconds for week 3 and 4 then 5 seconds at week 5 and 6, to increase the difficulty. For group B, human signal involved other

Table 2. Progressive training program for karate athletes.

Week	Signal time(sec)*	Number of signals	Time for each set (min)	Set	Rest in between (sec)	Total duration (min)
1	8	1	2	5	30	12.5
2	8	2	2	6	30	14.5
3	6	2	2	6	30	14.5
4	6	3	2	6	30	14.5
5	5	4 blue 2 red	3	4	60	16
6	5	5 blue 2 red	3	4	60	16

Remarks: *signal time only present in group A.

teammates wearing two-colored (blue and red) sparring gloves (Figure 6). A line was marked on the floor using black tape and participants were asked to stand behind the black line and act according to two conditions: hit the blue signals and hold for the red signals. For a blue signal, participants were instructed to hit the target as quickly as possible with any standard karate technique (jabbing punch, reverse punch, lunge punch, back fist strike, front kick, and roundhouse kick) and returned to the starting position. For a red signal, participants were instructed to hold and do nothing.

Data analysis

Descriptive statistics, such as mean, standard deviation (SD or ±) and frequency (%), was used. Paired t-test was made to compare the RT before and after training within the group. Independent t-test was made to compare the RT and the difference of RT before and after training between two groups. The significant level was set at 0.05.

RESULT

At baseline, all the collegiate karate kumite athletes (n = 24) averagely spent 314.5 ±39.05ms and 347.42 ±59.69ms for SRT_zero and SRT_shoulder; and 400.21 ±58.52ms, 445.56 ±56.19ms, 455.06 ±64.09ms for CRT_zero, CRT_shoulder and CRT_random, respectively for dominant hands (Figure 7). RT for non-dominant hands was shown in Figure 8. RT by dominant hands was faster than non-dominant hands. Before training, group A and group B differed significantly in only SRT_shoulder for dominant hands but not the other measures (Figure 7). RT for non-dominant hands had no significant difference at baseline between both groups (Figure 8).

After training, the group A showed significant improvement in SRT_zero and SRT_shoulder for dominant hands (p = 0.0066 and p = 0.001, respectively); and SRT_ shoulder and CRT_zero for non-dominant hands (p = 0.0138 and p = 0.0015, respectively). The group B did not

Figure 5. Group A (Light signal training).

Figure 6. Group B (Human signal training).

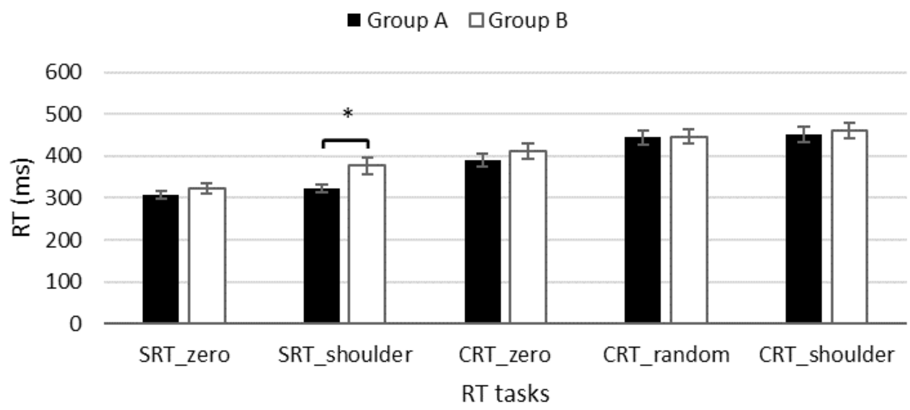

Figure 7. Baseline RT for dominant hands of group A and group B.

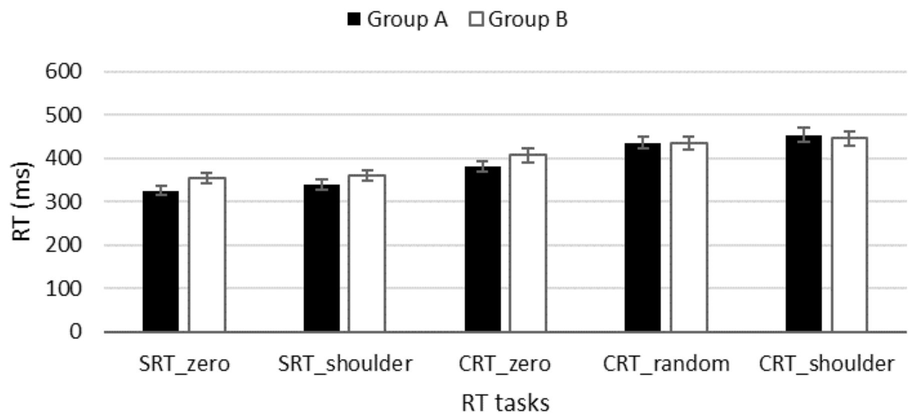

Figure 8. Baseline RT (non-dominant hands) of group A and group B.

⌐*¬ significant difference between group A and B; * significant difference within group A or B; **SRT** simple response time; **CRT** choice response time; presented error bar is for standard error (SE). **SRT_zero** simple response time at zero distance; **SRT_shoulder** simple response time at shoulder distance; **CRT_zero** choice response time at zero distance; **CRT_shoulder** choice response time at shoulder distance; **CRT_random** choice response time at random distance.

show significant changes for RT tasks by dominant hand, but took longer time for CRT_shoulder for non-dominant hands (p = 0.0037). When compared the difference before and after training, for dominant hands, group A improved significantly more in CRT_shoulder (p = 0. 0201) than group B (Figure 9); for non-dominant hands, group A improved significantly more in SRT_shoulder and CRT_shoulder (p = 0.0206 and p = 0.0029, respectively) (Figure 10).

DISCUSSION

Comparable at baseline between the two study groups

Participants in group A were recruited from two universities while group B were from one university. Although both groups had similar age, sex distribution, BMI and did not differed statistically in the years of practising karate, group A has more participants experienced in karate contest for the past 5 years. This is due to grouping according to university and the participation in karate contest varied in each university.

Regarding to various RT, group A reacted faster in SRT_shoulder by dominant hands at baseline than group B. Simple task did not involve decision making and is a one action-required task [5, 16]. Simple task that tested at shoulder width distance required some core stability and satisfactory shoulder girdle control. This possibly affects the motor response. In order to have a fairer comparison to examine their training effect between the two study groups, we

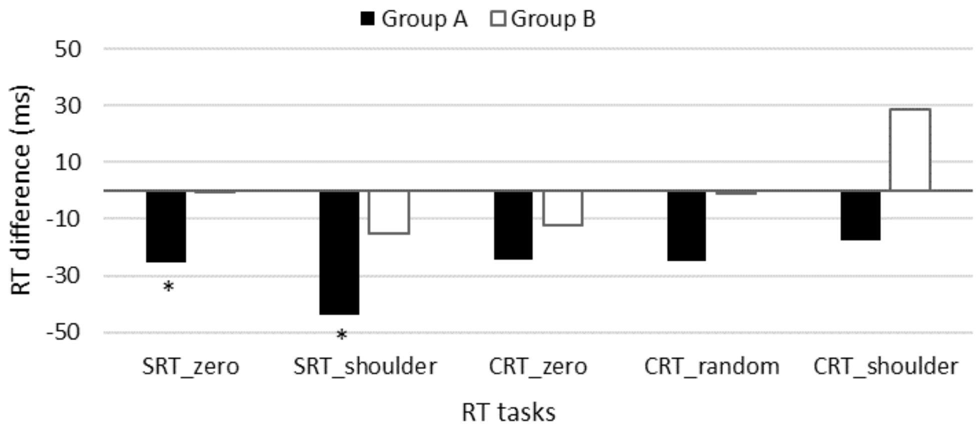

Figure 9. RT difference (before-after) for dominant hand of group A and group B.

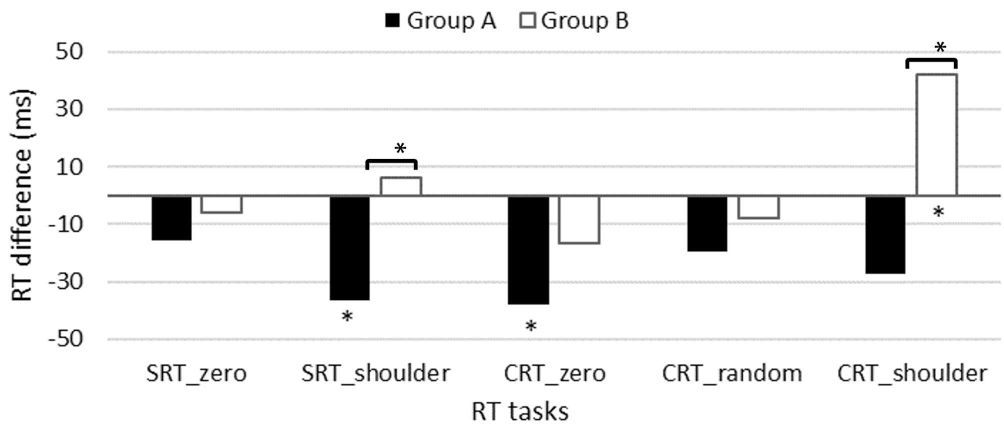

Figure 10. RT difference (before-after) for non-dominant hand of group A and group B.

⌐*¬ significant difference between group A and B; * significant difference within group A or B; **SRT** simple response time; **CRT** choice response time; **SRT_zero** simple response time at zero distance; **SRT_shoulder** simple response time at shoulder distance; **CRT_zero** choice response time at zero distance; **CRT_shoulder** choice response time at shoulder distance; **CRT_random** choice response time at random distance.

used the difference of RT before and after training, rather than the RT after training, as the outcome measures.

RT measurements

Shorter RT indicates better response. In this study, the karate kumite athletes (n = 24) averagely spent 315ms to 350ms for simple tasks; and 400ms to 450ms for choice tasks using dominant hands and generally took approximately 20ms more for the same task when using non-dominant hands. In other words, eye-hand RT increased from simple to choice tasks and from zero to random followed by shoulder distance. Under all conditions, all participants generally performed fastest at zero distance. Under simple conditions, longer duration needed for SRT_shoulder compared to SRT_zero was observed. Under choice conditions, there were longer RT from CRT_zero to random to shoulder distance. These results fulfilled the Hick's law as reported in year 1952 [17]. Our result showed that dominant hands were consistently faster than non-dominant hands in both simple and choice RT task. This is in accordance with previous studies [18, 19]. A transcranial magnetic stimulation (TMS) study showed that non-dominant hands had a different motor-pathway excitability during RT task compared to dominant hands [19]. Iglesias-Soler et al. [20] trained 30 young judo practitioners and reported that practices of non-dominant side improved judo skills.

Training effects

After training, the light signal training group (group A) simple tasks for dominant hands significantly improved after 6 weeks of training. Average SRT_zero improved from 307.5 ±32.93ms to 282.4 ±30.23ms; average SRT_shoulder improved from 322.8 ±37.19ms to 279 ±27.79ms. Our previous study, Liu et al. [15] reported that SRT_zero and SRT_shoulder for elite karate was 292.33 ±45.4ms and 316.95 ±37.54ms, respectively. This shows that a light signal training with a duration of 6 weeks is sufficient to promote kumite athletes' simple RT to elite level.

On the other hand, the human signal training group (group B) somehow did not show any improvement in either simple or choice RT tasks, but deteriorated in CRT_shoulder after training. Group B was not trained to complete the Go/NoGo task in limited time, resulting in the deterioration.

Whether the training effects are able to transfer beyond the trained task or to real world conditions is inconclusive as shown in published studies. Although using light to substitute human as the signal in training seems to give promising result in improving the both simple and choice RT, we are uncertain whether the results in laboratory are able to transfer to the field. Deveau et al. [21] and Rylander et al. [22] reported that general task training significantly influence the sports performance. In contrary, Ellision et al. [23] and Giboin et al. [24] reported weak correlation between laboratory and field task and no transfer to similar tasks was observed.

Comparison of the two programs

Training in karate kumite requires more than practice and physical preparation [25], quick sensory and motor reaction are significant to kumite athletes [26, 27]. Our training specifically aimed the visual response and explored two methods in carrying out the training: light signal and human signal. Main finding is a significant improvement in simple and choice task measured in zero-width distance (CRT_zero) for light signal groups. This is in accordance with recent studies which also showed positive impact of training on athlete's response time [10, 14, 28, 29]. Petri et al. showed promising improvement in response time but not response quality after training 15 young karate kumite athletes using virtual reality [29]. Balkó et al.[28] trained 19 adolescent fencers using light as a stimulus and reported a significant improvement of choice response task after 9 weeks of training. Our study suggested a 6-week visual training program using light signal could improve the choice RT which involves Go/NoGo decision making capacity. Nevertheless, we could not be sure for the sustaining period of this improvement.

Comparing the training effect between the light signal and human signal groups, light signal group had better RT at simple task measured in shoulder-width distance (SRT_shoulder) after training but not the human signal group. The difference of RT before and after training between two groups was significantly different too. Using light as a stimulus is capable to improve both simple and choice tasks; while human signal showed none of the tasks. Therefore, we suggest light signal is potentially an effective training tool. Our study indeed designed the human signal as close as possible to the light signal where the teammates wore blue and red gloves as signal.

There were a few limitations to our study. Sample size is relatively small. The training program was carried out at different universities with intention to avoid cross-information between groups, but also potentially affect the training style as it was given by different coaches. The colors of light and gloves may not simulate the real situation of karate competition. We did not restrict the karate technique in response to the signal during training, the athletes were allowed to used either punches or kicks. However, only eye-hand RT was tested without involving lower limbs or agility. Future study would have to recruit more participants, design a training program that could simulate the real contest situation, evaluate the contest performance after training and include more physical performance such as eye-foot RT and agility.

CONCLUSIONS

Six weeks of visual response training using light signals improved simple RT in collegiate karate athletes and have better result than human signal. Thus, the visuomotor training method can also be used in health-related training, in improving human motor safety, especially developing self-defense capabilities.

REFERENCES

1. Tabben M, Chaouachi A, El Hadi MM et al. Physical and physiological characteristics of high-level combat sport athletes. J Combat Sports Martial Arts 2014; 5(1): 1-5
2. Chaabène H, Hachana Y, Franchini E et al. Physical and physiological profile of elite karate athletes. Sports Med 2012; 42(10): 829-843
3. Chaabène H, Franchini E, Miarka B et al. Time-motion analysis and physiological responses to karate official combat sessions: is there a difference between winners and defeated karatekas? Int J Sports Physiol Perform 2014; 9(2): 302-308
4. Zwierko T, Osinski W, Lubinski W et al. Speed of visual sensorimotor processes and conductivity of visual pathway in volleyball players. J Hum Kinet 2010; 23(1): 21-27
5. Teichner WH, Krebs MJ. Laws of visual choice reaction time. Psychol Rev 1974; 81(1): 75-98
6. Williams AM, Elliott D. Anxiety, expertise, and visual search strategy in karate. J Sport Exercise Psy 1999; 21(4): 362-375
7. Abernethy B, Wood JM. Do generalized visual training programmes for sport really work? An experimental investigation. J Sports Sci, 2001; 19(3): 203-222
8. Bressan ES. Effects of visual skills training, vision coaching and sports vision dynamics on the performance of a sport skill. Afr J Phys Act Health Sci 2003; 9(1): 20-31
9. Balasaheb T, Maman P, Sandhu J. The impact of visual skills training program on batting performance in cricketers. Serb J Sports Sci 2008; 2(1): 17-23
10. Vando S, Haddad M, Masala D et al. Visual feedback training in young karate athletes. Muscles Ligaments Tendons J 2014; 4(2): 137-140
11. Krzepota J, Zwierko T, Puchalska-Niedbał L et al. The efficiency of a visual skills training program on visual search performance. J Hum Kinet 2015; 46: 231-240
12. Spasic M, Krolo A, Zenic N et al. Reactive agility performance in handball: Development and evaluation of a sport-specific measurement protocol. J Sports Sci Med 2015; 14(3): 501-506
13. Paul DJ, Gabbett TJ, Nassis GP. Agility in team sports: Testing, training and factors affecting performance. Sports Med 2016; 46(3): 421-442
14. Liu YH, Chang ST, Chen SC et al. Training effect of a stationary preprogrammed target dummy on visual response time and contest performance of karate athletes. J Sports Med Phys Fitness 2017; 57(11): 1445-1455
15. Liu YH, See LC, Chang ST et al. Simple and choice response time elite and novice karate athletes and non-athletes. Arch Budo 2018; 14: 267-276
16. Bell PA, Loomis RJ, Cervone JC. Effects of heat, social facilitation, sex differences, and task difficulty on reaction time. Human Factors 1982; 24(1): 19-24
17. Hick WE. On the rate of gain of information. Q J Exp Psychol 1952; 4(1): 11-26
18. Gignac GE, Vernon PA. Reaction time and the dominant and non-dominant hands: An extension of Hick's Law. Pers Indiv Differ 2004; 36(3): 733-739
19. Poole BJ, Mather M, Livesey EJ et al. Motor-evoked potentials reveal functional differences between dominant and on-dominant motor cortices during response preparation. Cortex 2018; 103: 1-12
20. Iglesias-Soler E, Mayo X, Dopico X et al. Effects of bilateral and non-dominant practices on the ateral preference in judo atches. J Sports Sci 2018: 36(1): 111-115
21. Deveau J, Ozer DJ, Seitz AR. Improved vision and on-field performance in baseball through perceptual learning. Curr Biol 2014; 24(4): R146-R147
22. Rylander P, Karlsteen M, Kougioumtzis K et al. The specificity ersus generality of ball-andling skill – empirical vidence for a eneral all-andling bility. Hum Mov Sci 2019; 66: 477-486
23. Elliso PH, Kearney PE, Sparks SA et al. Further evidence against eye–hand coordination as a general ability. Int J Sports Sci Coa 2017; 13(5): 687-693
24. Giboin LS, Gruber M, Kramer A. Task-specificity of balance training. Hum Mov Sci 2015; 44: 22-31
25. Koropanovski N, Berjan B, Bozic PR et al. Anthropometric and hysical erformance rofiles of lite karate umite and ata ompetitors. J Hum Kinet 2011; 30(1): 107-114
26. Syaquro A, Rusdiana A, Sumardiyanto. Comparison of hole ody Reaction and nticipation reaction ime etween ata and umite in arate. IOP Conf Ser Mater Sci Eng 2017; 180: 012232
27. Nedeljkovic A, Mudric M, Cuk I et al. Does specialization in karate affect reaction time in specific karate kumite situations? 35th Conference of the International Society of Biomechanics in Sports; 2017 Jun 14-18; Cologne, Germany. Cologne: German Sport University Cologne; 2017
28. Balkó Š, Rous M, Balkó I et al. Influence of a 9-week training intervention on the reaction time of fencers aged 15 to 18 years. Phys Activ Rev 2017; 5: 146-154
29. Petri K, Emmermacher P, Danneberg M et al. Training using virtual reality improves response behavior in karate kumite. Sports Eng 2019; 22(1): 1-12
30. Dictionary of Sport and Exercise Science. Over 5,000 Terms Clearly Defined. London: A & B Black; 2006
31. Kalina RM, Barczyński BJ. EKO-AGRO-FITNESS© original author continuous program of health-oriented and ecological education in the family, among friends or individually implemented – the premises and assumptions. Arch Budo 2010; 6(4): 179-184

Cite this article as: Liu Y, See L et al. Effectiveness of visuomotor program via light signal on simple and choice static eye-hand response time among collegiate karate kumite athletes: pretest-posttest design with a control group. Arch Budo 2019; 15: 293-301