

Reaction speed exercises and eye-hand coordination on the *gyaku zuki chudan* punch speed

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Published online: April 30, 2023

(Accepted for publication April 15, 2023)

DOI:10.7752/jpes.2023.04108

Abstract

An Athletes thought process in coordinating the sensory system and motor system can be assessed by reaction time. At hand reaction time, good visual and motor hand coordination will provide a quick response to hand movements, Good reaction time is very important in karate, as it allows early identification of an opponent's body movement or attack which allows decisive or evasive action to be taken if necessary. The aim of this study is to examine how two types of reaction speed exercises, modified directional hand movement and ball release with eye-hand coordination as an attribute variable, affect *gyaku zuki chudan* punch speed. The method utilized in this study was an experiment with a treatment design by level 2 x 2 on 111 junior karate athletes aged 16-17 years in Bekasi, Indonesia. This study used a random selection approach to choose 60 persons, who were then separated into four groups. This study's device for measuring *gyaku zuki chudan* punch speed was punching speed test. Meanwhile, the ball-catching was used as an eye-hand coordination test tool. The results show that the modified directional hand movement exercise has a greater effect than ball release on the *gyaku zuki chudan* punch speed. There is an interaction between reaction speed and eye-hand coordination exercises on the *gyaku zuki chudan* punch speed. That athletes who have high eye-hand coordination are better if they are trained with modified directional hand, and athletes who have low eye-hand coordination are better if they are trained with ball release. So that the *gyaku zuki chudan* punch technique training program determined by the modified directional hand movement and ball release exercise.

Key words: reaction speed, *gyaku zuki chudan*, punch speed, eye-hand coordination, karate

Introduction

Karate is a martial arts sport that competes in two numbers, namely kata and kumite. Kata numbers match a person's ability to master karate martial arts with the harmonization of movements that reflect strength, speed and beauty. Meanwhile, the kumite number competes one's ability in a one-on-one fight in accordance with applicable regulations. In competition, kumite is divided into individual kumite with class divisions based on weight and team kumite without weight class division (specifically for men). The match system used is a reperchance or round of opportunities to return to athletes who have been defeated by the champion. Matches are played in one round (net two to three minutes) and one extra round in case of a draw, except in team matches there is no extra time. In addition, if in the extra round there is still a draw, then the selection of the most offensive and aggressive karateka will be held as the winner.

There are three levels of scores, namely *ippon* (three points), *waza-ari* (two points) and *yuko* (one point). If a kick hits the head (*jodan* kick), it has score of three, while a kick hits the back or body (*chudan* kick), it has score of two, and all types of punch have score (*ippon*) of one, the World Karate Federation (WKF) version of the karate competition rules. Kumite match points are divided into three levels, namely *yuko* (one), *waza-ari* (two), and *ippon* (three). Punches are one of the dominant techniques in karate martial arts. Even though in a karate match, a punch is only worth one point, but punches can be used to attack, cut or counter attack the opponent. Based on the documentation data issued by the 2017 Karate Championship Organizing Committee, an average of 81.94% athletes used the *gyaku zuki chudan* punch technique (Muhamad & Haqiyah, 2019).

The *gyaku zuki chudan* punch technique is a basic punch that an athlete must master from the first time an athlete or karateka practices (Hofmann et al., 2008). Disability in the skills of the *gyaku zuki chudan* punch technique will affect all other forms of punch or variations of the punch. This technique is very efficient for gaining points, and this is recognized by national karate athletes as they feel more confident using the *gyaku zuki chudan* technique than other techniques, especially when they have not obtained a score or are in a draw. 70% of all karate techniques use a lot of punches as a weapon that is quite powerful, therefore a karateka must have really good punches to be able to get points/scores when they are in a fight or kumite” (Purba, 2016).

The *Gyaku-zuki*, also known as the reverse punch, is a technique commonly used in karate kumite, a form of competitive fighting. The objective of a punch is to hit the opponent at a controlled distance in as little time as possible. Punching consists of the rapid execution of a sequence of body movements (Suwarganda et al., 2009). In performing the *gyaku zuki chudan* technique, reaction speed is required (Hakim, 2020; Suwarganda et al., 2009) as well as eye-hand coordination (Camomilla et al., 2020; Mohammed Sayyd et al., 2019; Witte et al., 2008) so that the movement is efficient, obtains a score (*yuko*) and cannot be anticipated by the opponent. The form of speed exercise carried out in this case is speed in reacting to incoming stimuli, changing directions to a certain place quickly, timeliness and position in moving bodies, moving very quickly, making movements in a short time and answering or understanding something quickly (Andito et al., 2023). In karate, successful competition requires the realization of techniques in a short time. The role of attack techniques in kumite matches is very decisive, attack techniques that are carried out quickly and on target will be difficult for opponents to anticipate. Conversely, if the attack is carried out poorly, the attack will be easily anticipated by the opponent (Fendrian et al., 2016). Increasing the speed of the *gyaku zuki chudan* punch in karate is relevant for achieving points in competition, it can be assumed that the punch time is important for the total movement time of this karate technique (Emmermacher et al., 2005).

The problem that is often faced by junior karate athletes is that the *gyaku zuki chudan* punch technique is not effective and efficient because it is not fast and not on target, especially in estimating the distance of the attack. Based on these problems, it is necessary to use a variety of training methods to increase the *gyaku zuki chudan* punch speed, as stated in the karate competition regulations from WKF (World Karate Federation) article 6 regarding the assessment of kumite that there are 6 criteria: 1) the correct form, 2) sportsmanship, 3) displayed with a firm spirit, 4) the correct form (*zanshin*), 5) the right time, 6) the right distance.

In identifying factors that can influence and increase the *gyaku zuki chudan* punch speed, it is based on relevant studies. Based on the research results, a person's thought process in coordinating the sensory system and motor system can be assessed by reaction time. At hand reaction time, good visual and motor hand coordination will provide a quick response to hand movements. Hand reaction time can determine success in a match, so hand reaction time is an important component in sports (Syafitri et al., 2017). Good reaction time is very important in karate, as it allows early identification of an opponent's body movement or attack which allows decisive or evasive action to be taken if necessary (Syaquro & Badruzaman, 2018). Therefore, it is necessary to develop more varied exercises to increase the *gyaku zuki chudan* punch speed and the development of the instrument. The methods that have been used by other researchers are decline push-up exercises and stall bars hops exercises to increase power so that it is expected to increase the *gyaku zuki chudan* punch speed (Purba, 2016) as well as the application of weight training and exercise using rubber with manual punch speed test instruments (Saputra, 2017). It is interesting to study further about the effect of two forms of reaction speed exercises, modified directional hand movement and ball release with eye-hand coordination as attribute variable on the *gyaku zuki chudan* punch speed.

Methods

Study participants and organization

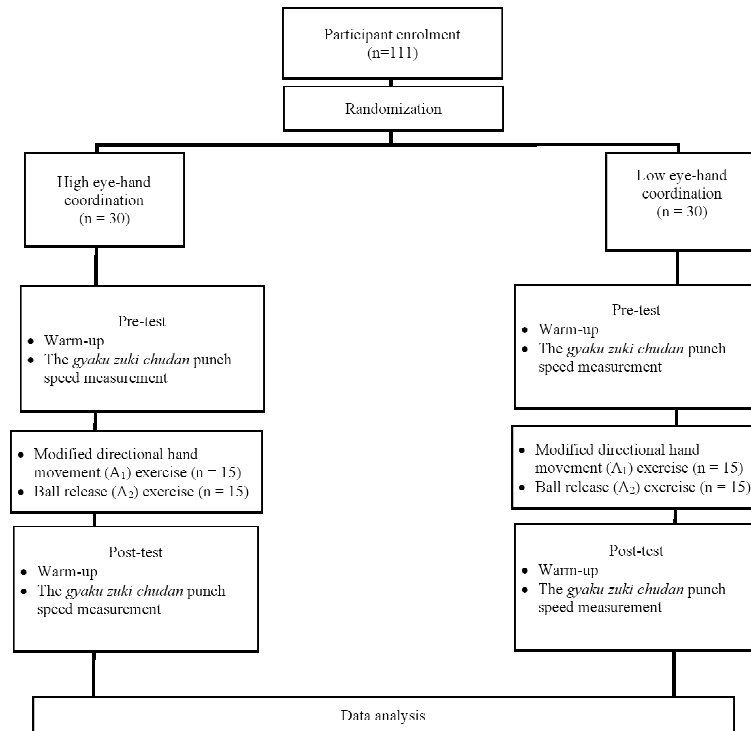
The research method used was an experiment with a treatment by level 2 x 2 design which is an action on one or more variables that are manipulated simultaneously in order to be able to study the effect of each variable on the dependent variable or the effect caused by the interaction between several variables (Tangkudung, 2018).

Table 1. Treatment by Level 2 X 2 Design

Eye-Hand Coordination (B)	Reaction Time (A) Exercise	
	Modified Directional Hand Movement (A ₁)	Ball Release (A ₂)
High Eye-Hand Coordination (B ₁)	A ₁ B ₁	A ₂ B ₁
Low Eye-Hand Coordination (B ₂)	A ₁ B ₂	A ₂ B ₂

The population in this study were Bekasi City Karate Junior Athletes aged 16-17 years, totaling 111 people. The sampling technique in this study was random sampling. Of the 111 athletes, eye-hand coordination tests were

carried out. The scores obtained from these measurements were then ranked from the highest to the lowest value. Furthermore, marching was done to determine the group that is trained with modified directional hand movement exercise (A_1) and the group that is trained with ball release exercise (A_2) based on the level of eye-hand coordination. The 60 athletes who met the requirements were divided into four groups using ordinal pairing, so that each group had 15 samples (Figure 1). This study's device for measuring *gyaku zuki chudan* punch speed was punching speed test (Putranto & Setyawati, 2018). Meanwhile, the ball-catching was used as an eye-hand coordination test tool (Widiastuti, 2015)



Treatment design

Modified directional hand movement exercise

Modified directional hand movement exercise was adapted from (Brown & Ferrigno, 2005). The goal of this exercise is to increase the speed and timing of upper body movements. The implementation procedure is to move the hand towards the stimulus (for example hand signals, shoulder signals, or the ball). More complex variations of movements can be done by doing leg movements (Figure 2).

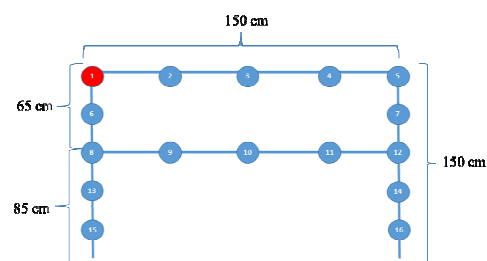
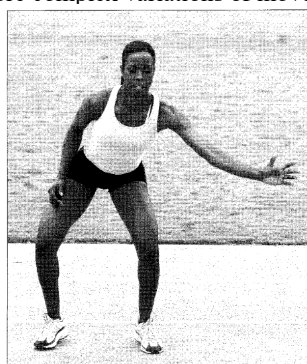


Figure 2. The Movement of Modified Directional Hand Movement Exercise

Ball release exercises

Ball release exercises aim to increase mental processing speed, upper body reaction time to visual stimuli. To do this exercise, hold two tennis balls at shoulder height. A partner practices standing in front in a ready position. Release one of the two tennis balls without prior notice; partner reacted and tried to catch it in the air. For a complex variation, have a partner practice using the contralateral hand to catch the tennis ball. Release both tennis balls at the same time (Figure 3).



Figure 3. The Movement of Ball Release Exercise

Data analysis

The SPSS version 25 (IBM Corp, 2017) was employed to perform descriptive statistics in performing participant demographic profiles. The data analysis techniques used are descriptive statistics and inferential statistics. Data analysis with descriptive statistics can be presented in form of frequency distribution tables, and histograms (Muhamad et al., 2021). In comparison, the inferential statistical analysis uses a two-way analysis of variance (ANOVA) at the significance level = 0.05 (Kadir, 2015). The requirements needed in the analysis of variance are the normality test and the homogeneity test. Then if there is an interaction, it will be continued with the Tukey test

Results

The calculation result of descriptive statistics:

Table 2. Descriptive Statistics

Group	Statistics	Reaction Speed Exercise	
		Modified Directional Hand Movement	Ball Release
High Eye-Hand Coordination	N	15	15
	M	0.2040	0.7487
	SD	0.12117	0.36750
Low Eye-Hand Coordination	N	15	15
	M	1.0233	0.2240
	SD	0.28299	0.15146
Total	N	30	30
	M	0.6337	0.4763
	SD	0.45476	0.38602

The *gyaku zuki chudan* punch speed in the modified directional hand movement exercise group with high eye-hand coordination is better ($n= 15$, $M_{A1B1}= 0.2040$, $SD_{A1B1}= 0.12117$). In the ball release exercise, group with low eye-hand coordination performs better ($n=15$, $M_{A2B2}=0.2240$, $SD_{A2B2}=0.15146$). Before testing the hypothesis using two-way analysis of variance (Anava), a requirements analysis test was first carried out. The results of the normality test show that the significance value of all variables is greater than 0.05, so it can be concluded that all research data is normally distributed. Likewise the test results of Levene's Test of Equality of Error Variances, it shows that the entire study group obtains scores of $F = 2.298$, $df_1 = 3$, $df_2 = 56$ with the $sig = 0.087 > 0.05$ value. Thus, the *gyaku zuki chudan* punch speed data is homogeneous and can be continued in hypothesis testing.

Table 3. Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.151 ^a	3	2.384	37.725	.000
Intercept	18.481	1	18.481	292.476	.000
A	.371	1	.371	5.876	.019
B	.207	1	.207	3.268	.076
A * B	6.574	1	6.574	104.030	.000
Error	3.539	56	.063		
Total	29.172	60			
Corrected Total	10.690	59			

a. R Squared = ,669 (Adjusted R Squared = ,651)

The effect of the interaction is shown visually in the following figure:

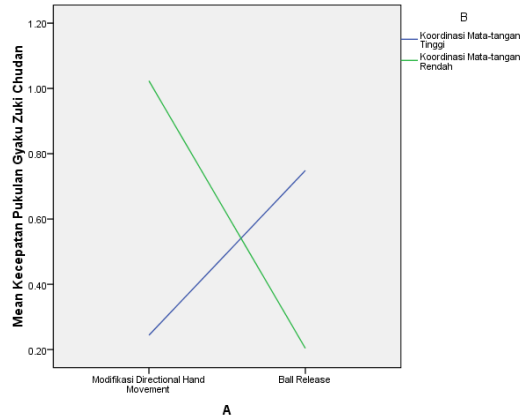


Figure 4. Interaction between reaction speed coordination exercises and eye-hand on the *gyaku zuki chudan* punch speed

The calculation results of the hypothesis test on the simple effect test for B_1 were carried out using the Tukey test. The results can be seen in the table below:

Table 4. The Result of Multiple Comparisons

Tukey HSD				
(I) fs	(J) fs	Mean Difference (I-J)	Std. Error	Sig.
A ₁ B ₁	A ₂ B ₁	-.50467*	.09179	.000
	A ₁ B ₂	-.77933*	.09179	.000
	A ₂ B ₂	.04000	.09179	.972
A ₂ B ₁	A ₁ B ₁	.50467*	.09179	.000
	A ₁ B ₂	-.27467*	.09179	.021
	A ₂ B ₂	.54467*	.09179	.000
A ₁ B ₂	A ₁ B ₁	.77933*	.09179	.000
	A ₂ B ₁	.27467*	.09179	.021
	A ₂ B ₂	.81933*	.09179	.000
A ₂ B ₂	A ₁ B ₁	-.04000	.09179	.972
	A ₂ B ₁	-.54467*	.09179	.000
	A ₁ B ₂	-.81933*	.09179	.000

*. The mean difference is significant at the 0.05 level.

Discussions

After analyzing the data on the four hypotheses proposed, all of them are accepted. The research findings are the results of statistical data analysis that need to be studied further in order to explain the hypotheses that are accepted or rejected. In carrying out the *gyaku zuki chudan* punch, reaction speed is highly needed (Suwarganda et al., 2009). Therefore, reaction speed exercise is needed to train it. Two forms of reaction speed exercise are modified directional hand movement (A₁) and ball release (A₂) with the aim of increasing the speed and timing of upper body movements. The advantage of A₁ is through the light signal given during the exercise, junior athletes will try to complete the exercise movement according to the number indicated by the light/light signal so that the athlete's speed and eye-hand coordination are trained rather than the A₂ exercise which only focuses on the stimulus in the form of throwing a ball. It is proven by the results of $M_{A_1} > M_{A_2}$ ($0.6337 > 0.4763$); $F_0(A) = 5.876$ with $p\text{-value} = 0.019 < 0.05$ (see Table 3).

A person's process of thinking and coordinating the sensory system and motor system can be assessed by measuring reaction time, at hand reaction time, good visual and motor hand coordination will provide a quick response to hand movements (Haqiyah et al., 2020; Santos et al., 2020). Eye-hand coordination is a complex psychomotor ability that plays an important role in adaptation (Saputra et al., 2022). It involves the synergistic action of sensory processes (exteroceptive and interoceptive) and motor function, resulting in the provision of informational and energetic parameters of the movement (Grigore et al., 2012). Performing *gyaku zuki chudan* punches requires eye-hand coordination (Witte et al., 2008) so that the movements are efficient, score (ippon), and cannot be anticipated by the opponent. Athletes who have high eye-hand coordination will have good punch timing. Hand reaction time also determines the success of an athlete in a match, so hand reaction time is an important component in sports (Syafitri et al., 2017). Based on the results of the hypothesis testing, there is an interaction between reaction speed and eye-hand coordination exercises on the *gyaku zuki chudan* punch speed by 65.1% (see Table 3 and Figure 4). $F_0(AB) = 104.030$; $p\text{-value} = 0.000 < 0.05$ (see Table 3).

In the group of athletes who have high eye-hand coordination (B_1), the effect of A_1 exercise is better than A_2 . Descriptively, $M_{A_1B_1}=0.2040 > M_{A_2B_1}=0.7487$ (Table 1); *mean difference* = -0.50467. The simple effect test for B_1 : ($A_1B_1-A_2B_1$); sig 0.000 < 0.05 (Table 4). The A_1 form of exercise can increase reaction speed (Haqiyah et al., 2020) and the *gyaku zuki chudan* punch speed (Riyadi, Dani Nur; Lubis, Johansyah; Rihatno, 2019). The A_1 exercise is more influential because it requires greater focus to see the stimuli/signals given from the PC according to the number indicated by the light/light signal. The A_2 form of exercise is more effective for the group of athletes with low eye-hand coordination compared to the A_2 exercise because the athletes only focus on the direction of the ball thrown so it can be caught. Descriptively, $M_{A_1B_2}=1.0233 < M_{A_2B_2}=0.2240$ (Table 1); *mean difference* = 0.81933. The simple effect testing for B_2 : ($A_1B_2-A_2B_2$); sig 0.000 < 0.05 (Table 4).

Reaction speed exercises and eye-hand coordination can have a significant impact on the *gyaku zuki chudan* punch speed in karate (Penov & Chalakov, 2021; Zayed & Aly, 2018). *Gyaku zuki chudan* is a rear-hand straight punch aimed at the torso-level, and it is one of the most commonly used punches in karate (Venkatraman & Nasiriavanaki, 2019; Venkatraman et al., 2019). To increase the force of this punch, coaches can use modern tools and methods, such as video-computerized systems and kinematics analysis software, to record and analyze the parameters of the punches performed by the athletes. Additionally, the relationship between lower limb and upper limb with punch *gyaku zuki* performance in karate has been studied in boxing, indicating an inverse relationship between the force in the lower limb and arm velocity (Zayed & Aly, 2018). Therefore, coaches can focus on developing the lower limb muscles to improve the arm velocity and punch speed. Moreover, reaction speed exercises and eye-hand coordination can be improved through various training methods, such as proprioceptive control, visual control, and computer games practice (Szabo et al., 2021; Perzov & Kozminsky, 1989). For instance, a study found that computer games practice can improve eye-hand coordination and reaction speed. Another study showed that push up and bench press exercises can significantly improve punch speed in *pencak silat*, a martial art similar to karate. Therefore, coaches can incorporate these exercises into their training programs to enhance the reaction speed and eye-hand coordination of their athletes, which can ultimately lead to an improvement in the *gyaku zuki chudan* punch speed. In conclusion, reaction speed exercises and eye-hand coordination are crucial factors that can affect the *gyaku zuki chudan* punch speed in karate. Coaches can use modern tools and methods to record and analyze the parameters of the punches performed by the athletes, focus on developing the lower limb muscles, and incorporate various training methods, such as proprioceptive control, visual control, and computer games practice, to improve the reaction speed and eye-hand coordination of their athletes.

Conclusions

According to the findings of this study, response of reaction speed exercises and eye-hand coordination are helpful for improving the *gyaku zuki chudan* punch speed in Karate. When developing the best training program for their athletes, coaches should consider the group differences observed in this study. So that the *gyaku zuki chudan* punch technique training program determined by the modified directional hand movement and ball release exercise. The limitations of this study are the limited population and sample, as well as other factors that are considered to influence the results of the study that cannot be controlled, for example the physical and psychological conditions of the athletes.

Acknowledgements

We are very grateful to our college who support this research

Conflict of interest

There is no conflict of interest in this study

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