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Original Article

Effects of matcha extract on simple and complex reaction times

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Abstract
This study analysed the effect of a food supplement, matcha tea extract, on simple and complex reaction time. The main objective was to verify the positive effect of this product on the speed of reaction to a visual stimuli after the extract was given. After the extract was given, selected individuals (n=31) were tested for simple and complex reaction time performance. A double blind experiment method with an added placebo was used to obtain the results. Statistical analysis included the Wilcoxon test to analyse the effect of the extract. The majority of study participants showed a statistical significant difference for the measured variables of both complex and simple reaction times. The results confirmed the positive influence of matcha extract on the reaction time of the studied individuals. This suggests that this nutritional supplement is suitable for lowering either the simple or complex response time after a visual stimuli is presented.
Keywords: Simple reaction, complex reaction, matcha, Wilcoxon test.

Introduction

The matcha (抹茶 in jap.) extract has been known for more than a millennium, and its use was first recorded in 12th century China and Japan. In Japan, this type of extract is called *Tencha* (てんちゃ, 点茶) and is commonly used during traditional tea ceremonies. *Matt* (抹) in Japanese means crushed into a powder, which preserves all the active substances (Thoma, 2014). Depending on the batch, the amount of the active compounds can differ by up to 10%. The main reason for this is the method of collection of the tea during harvest. Matcha contains twice as much caffeine and four times more L-theanine (amino acid) than any other green tea known to mankind (Standard Tables of Food Composition, 2012). Negative effects of matcha have not yet been described; however, there are 35 mg of the active compound. One gram of tea is the daily recommended dose, and it should not exceed 400 mg of the active compound, which is equal to 12 cups of tea (Haskell, Kennedy, Milne, Wesnes, & Scholey, 2008; Weiss & Anderton, 2003).

Haskell (Haskell et al., 2008) stated that L-theanine and caffeine are the primary components in the tea. In their study, they analysed the cognitive effects of this amino acid in combination with caffeine. The results showed that caffeine leads to faster reaction in terms of number perception with better RVIP (rapid visual information processing) and a reduction in fatigue. The combination of RVIP and decrease in psychological fatigue leads to a faster reaction time, faster working memory and better sentence verification accuracy. According to Haskell's study, the intensity of headaches also decreased. This suggest that beverages containing both caffeine and L-theanine can have different pharmacological profiles than beverages that contain only caffeine. Caffeine itself helped increase the reaction speed, information processing accuracy, simple reaction time, and reaction time for delayed word recognition. Sentence recognition was also more accurate when both compounds were used simultaneously.

One study on the catechin amounts in green tea used electronic chromatography to show that green tea contains high amounts of epigallocatechin gallate (EGCG). This catechin is one of the most effective antioxidants, and its effects can prevent cancer. EGCG levels in matcha exceed several times those in ordinary green tea (Weiss & Anderton, 2003). Quinlan, King, Hanna and Ghazziudin (1997) found that tea containing 100 mg of caffeine had significantly stronger effects than coffee with the same amount of caffeine. Steptoe, Hamer and Chida (2007) found that the tea can decrease platelet activation and cortisol levels during a stress reaction and that the tea increases the feeling of relaxation and body control.

Kakuda (2000) used animal testing to confirm that it is capable of inhibiting the stimulation caused by caffeine during an EEG scan of spontaneous animal activity.

Lu, Guarnieri and Simon (2004) studied the subjective mood effects of L-theanine and found that 200 mg can increase the feeling of "peace of mind". Kobayashi, Heck, Nomura, and Horiuchi (1998) found that 200 mg of L-theanine leads to an increase in alpha brain waves, which suggests that this amino acid promotes relaxation without fatigue and may decrease reaction time. Based on the available literature, matcha tea is believed to contain beneficial compounds that may have a positive effect on the human body. The beneficial compounds include amino acids, antioxidants, vitamins (C, B_1, B_2, etc.) and minerals (potassium, sodium,

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calcium, etc.). Matcha tea has many good effects on overall health, such as lowering the cholesterol and sugar levels in the bloodstream, supporting the structures of blood vessels, and heart and blood circulation. Matcha contains a high amount of the polyphenol, catechin, which is very effective against many diseases, and this effect does not only include EGCG. A study conducted by Weiss and Andertona (2003) found that matcha tea has several times the amount of EGCG than regular types of green tea. The study also showed that caffeine itself can lead to a decrease in reaction time; however, combined with L-thiamine, which supports a good mood, alpha waves and anxiety relief, the tea can possibly decrease the overall reaction time even more (Haskell et al., 2008).

This study focused on the possible increase of individual reaction skills upon using the nutritional supplement, matcha extract. The main objective was to determine if its consumption improved reaction skills, as prior studies have suggested. This study provides an additional contribution to the existing nutritional supplement literature, and verifies that matcha extract functions as a stimulant, which can provides humans with faster response times to a selected stimulus. However, the effects of matcha tea have been verified using weak hypotheses that have been based on specific analyses, methods and factors that in some cases assured the positive or negative effects of this extract. Thus, we decided to contribute to the canon of research to determine in detail the effect of the extract.

Methods

Test subject groups

The study included 31 participants (15 women and 16 men) who were 20 to 45 years of age (Table 1). Two measurements were performed during one week. All participants were in good physical shape and healthy during testing and did not have any health issues. However, a kinesiology analysis of the test subjects was not included in this study. The overall data sample was achieved via purposeful selection.

Table 1. *Basic description of the test subjects*

Characteristics	Age/SD (years)	Height/SD (cm)	Weight/SD (kg)
	34.4/15	171.1/10	69.7/10

Legend: SD - standard deviation

Testing procedure

The tests were performed twice, and each were separated by one week. Each individual abstained from drinking or using any substances that may have caused any cognitive arousal (e.g., caffeine, etc.) for 48 hours and were advised not to engage in any difficult physical activity before testing. The testing involved a double blind test. Each participant randomly consumed the prepared samples (capsule) of substances labelled as A or B. Sample A contained 35 mg.kg-1 of matcha, and sample B contained the same amount of placebo (starch). The amount of extract dose was adjusted according to the test subject's weight. Fifty minutes after swallowing the capsule, each subject was tested using a reactimeter to measure their simple and then their complex reaction times. After a week, a second test was performed in which the participants consumed a capsule that was labelled opposite to the one from the previous week. All measurements took place in a standard environment in the laboratory at department of physical education and sport at the University J. E. Purkyne in Usti nad Labem based on the recommendation of a study conducted by Balkó (Balkó, Wasik, Chytrý, Dunajová a Škopek, 2017).

To measure the simple reaction time to a visual stimulus, the subjects were seated in an immobile chair opposite to a chair (eyes positioned 60 cm horizontally from the computer screen). A plate for reaction time testing was placed under either the right or left hand depending on the preference of the test subject. The hand was placed 4 cm above the touch-sensitive plate. The test subjects faced the computer screen and observed a green circle symbol in the middle of the screen on a white background that appeared at different intervals. Each appearance of the symbol meant the test subject was supposed to react to it by touching the plate 20 times in row. For the complex reaction time measurement, we used four different plates and four symbols on the screen. The test subjects had to react to a specific symbol by pressing the related plate also 20 times in a row. The plates were positioned in a square setting with a 4-cm gap in between each plate. The first plate was for the red square, second plate was for the green circle dot, the third plate was for the blue triangle, and the fourth was for the yellow cross. As in the simple reaction time test, the stimulus always appeared in the centre of the screen. This test included the use of both hands with the default hand position at 4 cm above the workspace. The left hand was 3 cm away from the left plates, and the right hand was 3 cm away from the right plates.

For the reaction skill measurement, a special reactimeter and Fitro Agility Check & Reaction 2.0 (Fitronic, s. r. o.) software was used. The software can generate stimuli in a range between 500 and 3000 ms, project them on a computer screen, and record the reaction time of the test subject (plate press). Error attempts were not included in the analysis. The simple reaction time threshold range of the correct attempt was calculated between 100 and 1500 Ms, and complex reaction time had a threshold range of 150–2000 Ms. All participants were not disturbed by any external stimuli during testing.

Data normality was tested via the Shapiro–Wilks test. The results of the simple and complex reaction time did not have a normal data distribution. Thus, nonparametric

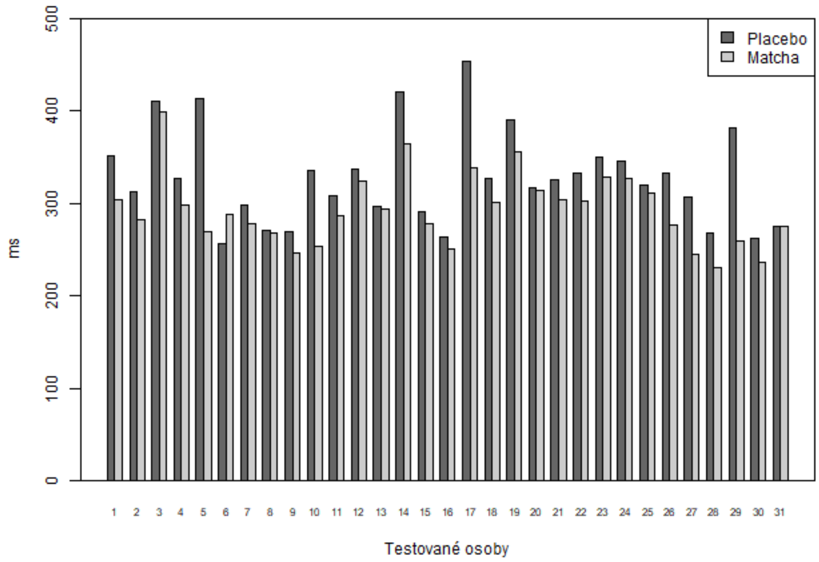

Figure 1. **Simple reaction time**

statistical methods were applied during the analysis. To statistically process the nonparametric data set, a Wilcoxon test was suitable because it compares dependent selections. The effect size threshold was set to $p < 0.05$. To calculate the size of the effect, the Rosenthal coefficient, r, (Rosenthal, 1994) was used. The effect intervals were as follows:

- Small effect ($r > 0.1$)
- Moderate effect ($r > 0.3$)
- Significant effect ($r > 0.5$)

Results

Figure 1 shows the simple reaction times (medians) of individual participants after matcha extract and placebo consumption. Figure 2 shows the individual reaction times of each test subject.

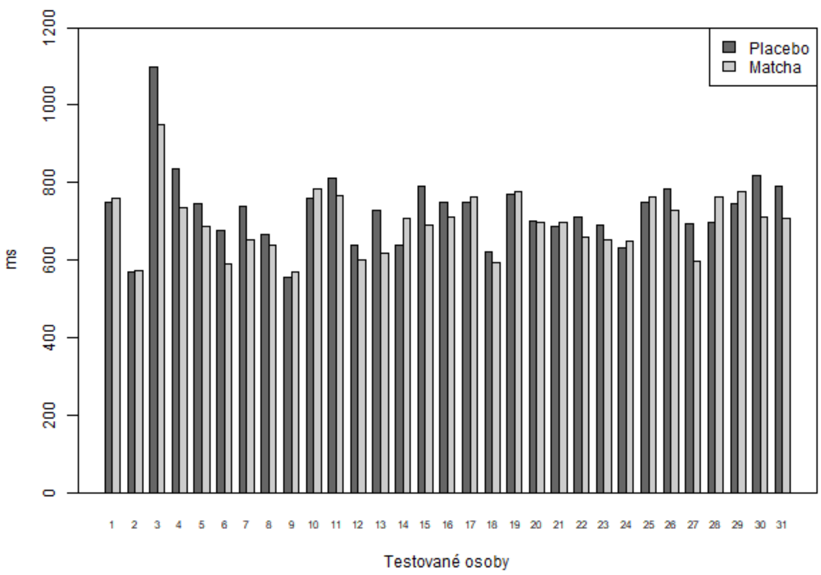

Figure 2. **Complex reaction time**

For the measured samples for SRT (simple reaction time) after matcha extract and placebo consumption, the analysis showed (Table 3) a significant difference ($p = 0.00$; $r = 0.56$). The CRT (complex reaction time) analysis showed that there is a significant difference between matcha tea extract and placebo ($p = 0.00$; $r = 0.34$). The SRT (56%) was improved more than the complex reaction time (34%).

Table 2. **Reaction times after placebo and matcha tea extract consumption [ms]**

	Placebo (med)	Matcha (med)	p	r
SRT	327.2	293.0	0.00	0.56
CRT	729.1	696.2	0.00	0.34

SRT – simple reaction time, CRT – complex reaction time, p – error probability after zero hypothesis rejection, r – Rosenthal coefficient

Figure 3 shows the differences in SRT after matcha extract and placebo consumption. Differences in CRT are also shown after consumption of the matcha extract and the placebo (Figure 4.).

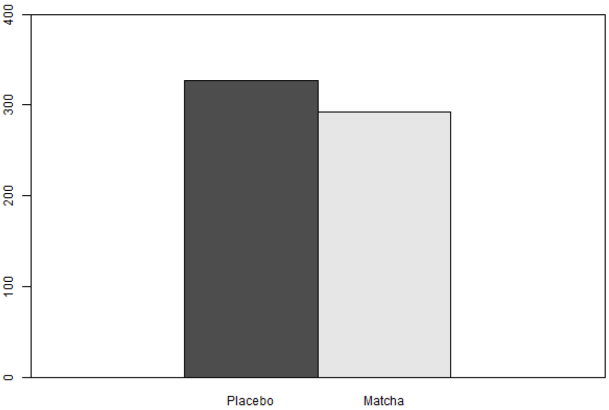

Figure 3. **Simple reaction time after matcha extract and placebo consumption**

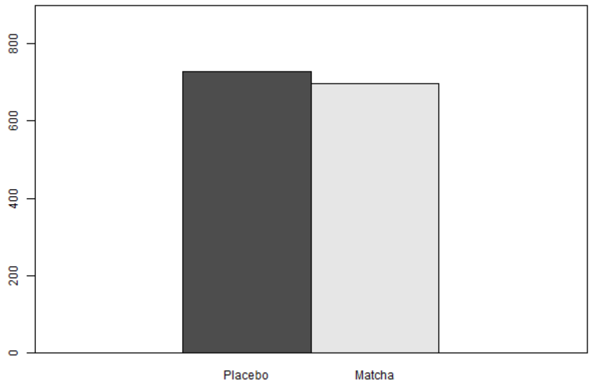

Figure 4. **Complex reaction time after matcha extract and placebo consumption**

The results shown above show the difference between SRT and CRT and the effect of the analysed extract, which confirm the significant differences in reaction times between the two groups.

Discussion

Analysis of the data showed that a statistically significant change was observed among both the reaction time variables. Thus, we conclude that both simple and complex reaction times were influenced; the speed of reaction was decreased to 56% for the simple reaction time and to 34% for the complex reaction time. Thus, matcha extract can decrease both the simple and complex response times to a visual stimuli. However, it is possible to compare similar studies with this study, e.g., a study conducted in 2003 that tested caffeine influence (Jensen et al., 2005), and another study written in 2010 that tested the effects of taurine on RT (Škopek, Hnízdil, 2010). Interestingly, these studies on different compounds also show no proven effects in contrast to the confirmed effect of matcha extract in our study,. Of course, our study results should be read with a certain amount of caution. The improved reaction times may have been caused by other variables that influence performance, such as individual psychological fitness. To verify the results of our study, additional control (repeated) testing on the same sample of participants would be required to increase the reliability and validity. Nevertheless, the findings of this study are significant..

Conclusion

The objective of this study was to determine whether it is possible to influence the reaction time of a person to a visual stimulus after matcha tea extract consumption. The analysis of the results showed that this nutrition supplement acted a stimulant during the testing of simple and complex reaction time. After consumption of the extract, for most of the participants, the predicted decrease in reaction time occurred. Thus, we recommend matcha extract as a suitable supplement for improved and faster reaction times to visual stimuli. It can be used for a wide range of sport activities and is suitable for providing improved reaction times in everyday life, e.g., driving a vehicle.

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