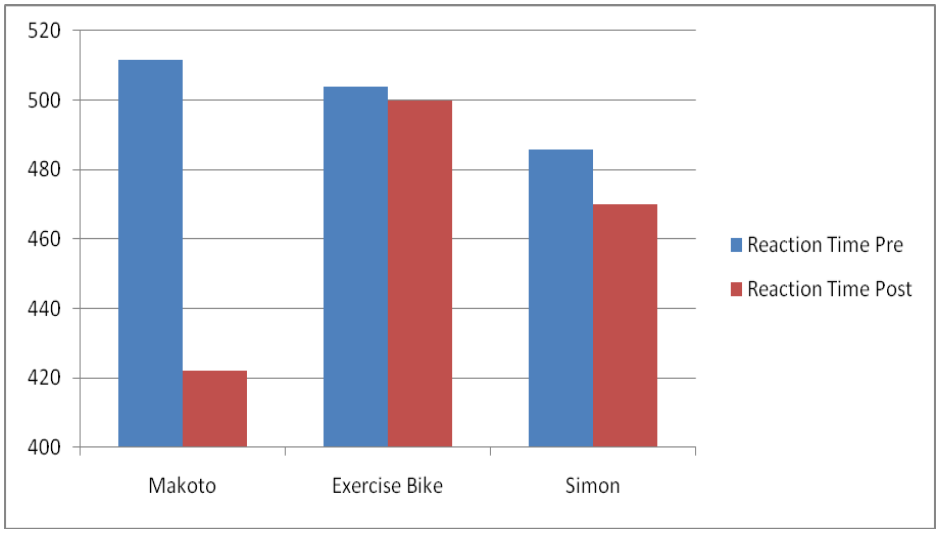
Comparison of Makoto Training to other Training Conditions:

A Preliminary study of Makoto Benefits

The decrease in reaction time for the Makoto students was statistically significant.



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Background

The present report summarizes a pilot study completed for Makoto USA. The Makoto training device was provided to Calvin College by the manufacturer with the understanding that an investigation into its training benefits would be completed. The present study was conducted by members of the Calvin College Psychology and HPERDS (Health Physical Education, Recreation, Dance, and Sport) departments to test some of the stated outcomes for the Makoto. The primary design of the study was to have volunteer participants complete six weeks of Makoto training and to compare their performance to two control groups. The first control group completed the same amount of training on a stationary bicycle to mimic the potential cardiovascular benefits, and a second control group completed the same amount of activity time using a game called "Simon" to mimic the mental and reaction time components of Makoto. Measures of fitness, reaction time and Neuropsychological performance were taken before and after the training sessions to assess potential changes.

The information contained in this report should be considered preliminary and any reader should keep in mind that no external review of the methods or results has been completed. No influence was exerted by Makoto USA on the researchers to produce any particular outcome.

The study focused on just some of the stated benefits of the Makoto. The Makoto Corporation, in its promotional information[1], suggests, *"While giving "players" a great cardio workout, the primary health benefit of makoto is the improvement of the neurological link between the brain and body. By improving this communication between the brain and body, dramatic improvements can be achieved in:"*

1. *Eye/Hand coordination*
2. *Quickness and reaction time*
3. *Focus and concentration*
4. *Mental Acuity*
5. *Stress reduction*
6. *"1st Step" speed*

In addition the Makoto, *"is used by professional and collegiate sports teams, health clubs, chiropractors, rehabilitation centers, hospitals, schools, martial arts studios, education institutions, community centers and more for a variety of "players." These people include:*

- *Competitive athletes*
- *Students with ADHD*
- *Youth*
- *People with depression*
- *People with memory concerns*
- *Neurological rehabilitation*
- *Cardiac rehabilitation"*

[1] http://www.makoto-nj.com/images/General%20Brochure.htm

Study Methods

Participants

Three physical education classes, meeting twice weekly, were selected for participation. Students in these classes were given the opportunity to volunteer for the study. A total of thirty three students volunteered. These participants were randomly assigned into three groups of eleven each. The first group completed six weeks of Makoto training, the second group was assigned to complete an identical amount of stationary bike training and the third group was assigned to practice on the game "Simon." The bike group served as an aerobic activity control. The goal of this control group was to determine if any changes – especially physical performance measures - seen with Makoto training are superior to, or different from, other forms of fitness training. Experience on the Simon game was designed to compare the effects of Makoto training to other forms of reaction time and cognitive (e.g., memory) training.

All pre- and post-training testing, as well as all training sessions, were conducted during class time and participants were allowed to substitute participation time as part of their class activities.

Tests and materials

Pre and post-training tests included: A finger tapping exercise, a computer based reaction time/decision making test, a vertical leap test , and an agility run. The finger tapping test required participants to alternate index finger taps, as quickly as possible, on a computer keyboard, and was designed measure reaction time as well as interhemispheric (e.g., left and right cerebral hemisphere) coordination. The computer reaction time task required participants to compare two briefly presented color diamonds. This test has been used in previously published studies to gauge the efficiency of interhemispheric transfer (Jeeves, Ludwig, Moes & Norman, 2001). The agility run and vertical leap test were designed to measure motor performance.

Testing procedures

All participants were tested on the first two tests in a computer lab. For the finger tapping task, participants were required to alternate tapping their index fingers as fast as possible for 30 seconds. The dependent measure for this test was the total number of j's and f's typed (using the left and right index fingers) over two 30 second time periods – subtracting for errors (i.e., two of the same letters in sequence).

The color matching task required the subject to match two targets displayed simultaneously for only 160 milliseconds. The position of each of the two targets was constrained to one of four locations forming an imaginary square centered around the fixation character ("+"), approximately 1 inch above and below fixation and 2 inches to the left and right of fixation at a viewing distance of 60 cm. Stimulus pairs were presented in one of four possible arrangements, left visual field (LVF), right visual field (RVF) – with one target above the other, bilateral-horizontal (Bi-Horiz) - with one target in each visual field and both targets arranged horizontally, and bilateral-diagonal (Bi-Diag) - with one target in each visual field and targets arranged diagonally with one target above fixation and one below fixation. The targets were two diamond-shaped figures of uniform visual texture. The target colors were yellow and light blue against a

black background. Participants were required to respond with a “match” or “no-match” response by pressing either the right or left shift key of the keyboard as quickly and accurately as possible. Dependent measures for this task are reaction time (RT) and percent error (PE). In addition to overall RT and PE, average responses for several separate conditions are taken including LVF, RVF, LVF & RVF combined (= Unilateral), Bilateral combined, and Unilateral minus Bilateral. This last measure creates a unique score called the Bilateral Field Advantage (BFA) score which measures the often found efficiency advantage of bilateral presentations over unilateral presentations. The larger the number the greater is the presumed interhemispheric efficiency. The primary comparison for the study was to compare pre-training and post-training overall RT and BFA. For similar matching tasks (i.e., letter matching, pattern matching) the BFA value is typically large (e.g., well above 0). However, because the color matching task is easier, the BFA value is smaller (i.e., close to or below 0). Despite this typical result, we have demonstrated that higher values (e.g., greater than 0) represent greater interhemispheric communication efficiency.

The vertical leap test (Texas Governors Commission on Physical Fitness, 1973) required participants to use a double-footed take-off to jump vertically as high as possible with maximum effort. Participants made a mark on the wall as high as possible while standing flat-footed with heels together next to the wall. To execute the jump, the participant squatted next to the wall, jumped as high as possible, and marked the wall with a piece of chalk. The participant was not allowed to walk or step into the jump. Each participant was given three trials, with the first as a warm-up at three-quarter effort. The next two trials were maximum jumps. The average of the last two jumps was recorded. The distance between the standing mark and the jump mark was measured and recorded as vertical jump height.

The Zigzag Run (Texas Governors Commission on Physical Fitness, 1973) required participants to jog to warm up for this activity, then to run through a short course that required turning as quickly and efficiently as possible. The run was timed with a stopwatch. Each participant completed a practice trial followed by a test trial after a short rest. Each participant’s elapsed time recorded to the nearest tenth of a second.

Makoto Training

The training period lasted for approximately six weeks during the spring semester of 2005 - following spring break and continuing through the end of the semester. Participants trained twice a week for eight minutes each session. The Makoto group completed three training sessions in this time including a three tower, two tower, and a sudden death protocol. Protocol one lasted 4 minutes, included all three towers, and required the participant to strike the targets with a large wand. Each participant began at speed level 1. Subsequent trials for this protocol proceeded to the next speed level when the strike accuracy ratio recorded by the Makoto machine reached 90% accuracy. Protocol two lasted 2 minutes, included only 2 towers, and required the participant to strike the targets with a small wand. Each participant was required to exchange the wand from hand to hand, striking the left tower with the right hand and the right tower with the left hand. Each participant began at level 1. Subsequent trials for this protocol proceeded to the next level when the strike accuracy ratio recorded by the Makoto machine reached 90% accuracy. The final protocol was called Sudden Death. Sudden

Death is a three tower protocol that begins as speed level 1 and increases in speed as the game continues. Each participant uses a large staff to strike the targets. When the first target is missed, the game is over. The total number of targets hit for each game was recorded.

The other two groups each participated for the same amount of time (8 minutes) either riding a stationary bike or playing Simon.

Results

Color matching task

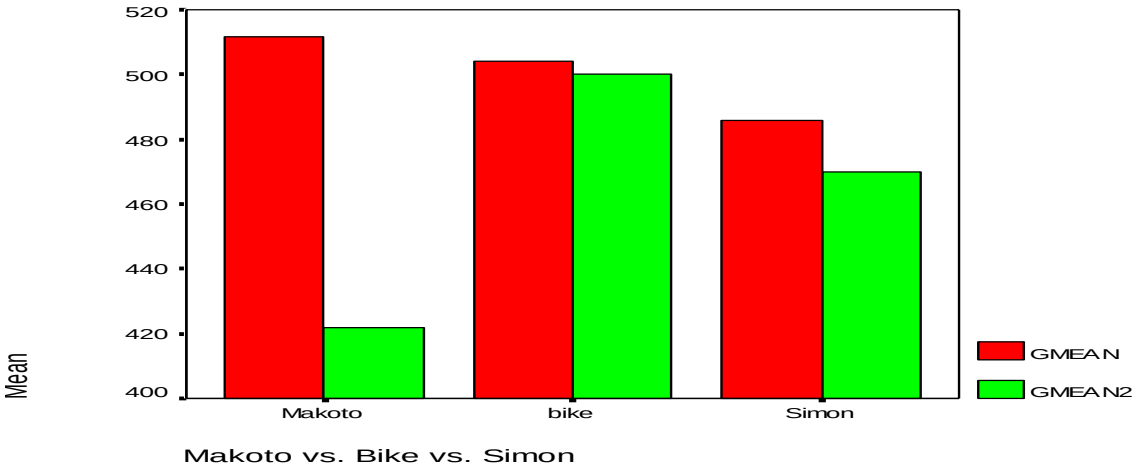
The grand mean of the reaction time (in milliseconds) as measured by the color matching program is shown in Table 1 and Figure 1. The improvement in RT shown by the Makoto test group was significantly greater than the other two groups.

Table 1. Average Overall Reaction Times (msecs.)

Group	Reaction Time Pre	Reaction Time Post
Makoto	511.6	*421.9
Exercise Bike	503.9	500.0
Simon	485.8	469.9

*Within-subject contrast F(2,30)= 4.86; **p = 0.015**.

Figure 1: Average RT (overall) levels pre-training and post-training by group. GMEAN & GMEAN2 represent the grand mean reaction time pre-training and post-training, respectively.



This improvement appears to be a genuine improvement and not due to an increase in speed at the cost of increased error rates. However, while there was not a statistically significant change in percent error, there was a trend in this direction for the Makoto training and the Exercise Bike training groups (see Table 2), raising the possibility that participants simply changed strategy rather than showing genuine

improvement. In other words, it's possible that participants lowered reaction time by simply allowing more errors.

Table 2: Average Percent Error (PE) by group

Group	Test time	Mean PE	Std. Error
Makoto	Pre-test	5.6	2.7
	Post-test	12.5	2.5
Exercise Bike	Pre-test	8.4	2.7
	Post-test	12.3	2.5
Simon	Pre-test	7.8	2.7
	Post-test	4.9	2.5

There was a slight improvement in the Bilateral Field Advantage following Makoto training (see Table 3) compared to the other groups. However, because the Simon training group also had some improvement, there was no statistically significant difference in improvement between groups ($F(2,30)=.975$; **p=.39**). It appears that an additional reason for the lack of significant difference is the amount of variance (standard deviation) within each group. This random variation in scores, combined with relatively small groups worked against finding statistically significant differences.

Table 3: Average BFA values

Group	Test time	Mean BFA	Std. Error	Margin of Error (95%)	
				Lower Bound	Upper Bound
Makoto	Pre-test	-5.2	4.0	-13.7	3.1
	Post-test	.8	4.1	-7.6	9.3
Exercise Bike	Pre-test	-2.0	4.1	-10.4	6.3
	Post-test	-6.7	4.1	-15.1	1.8
Simon	Pre-test	.7	4.1	-7.6	9.1
	Post-test	1.8	4.1	-6.7	10.2

Finger tapping

The finger tapping exercise yielded a total number of taps (i.e., the sum of j's and f's typed during two thirty-second sessions) which did improve significantly from pre-test to post-test ($F(1, 30)=23.3$; **p<.001**) for all groups combined. The Makoto group did improve more than the other two groups (see Table 4) but there was not a significant difference in the amount of improvement between groups ($F(2,30)=1.93$; **p=.16**). Unfortunately, the number of errors committed (i.e., two or more of the same letter in a row) for all groups combined also increased between testing sessions. Therefore, it's possible that the increase in finger taps was due to a change in strategy of going faster, while making more errors. However, the Exercise Bike training group

had the largest increase in errors, so the Makoto training group's greater improvement in finger tapping cannot be accounted for completely with a possible change in strategy.

Table 4: Mean number of letters typed (total f and j letters typed) for finger tapping test.

Group	Test time	Mean Letters	Std. Error	Margin of Error (95%)	
				Lower Bound	Upper Bound
Makoto	Pre-test	159.7	4.8	149.8	169.5
	Post-test	171.1	5.9	158.9	183.2
Exercise Bike	Pre-test	150.5	4.8	140.6	160.3
	Post-test	167.8	5.9	155.6	179.9
Simon	Pre-test	152.7	4.8	142.9	162.5
	Post-test	158.5	5.9	146.3	170.7

Vertical Leap

There were no significant improvements for the three groups combined in vertical leap over the course of the training period (F(1,28)=.026; **p=.87**). As with some of the other measures, there was a slightly greater improvement with the Makoto training group (see Table 4), but this difference was not significant (F(2,28)=1.9; **p=.17**).

Table 5: Mean number Vertical Leap (inches) by group

Group	Test time	Mean Height	Std. Error	Margin of Error (95%)	
				Lower Bound	Upper Bound
Makoto	Pre-test	16.7	1.5	13.5	19.9
	Post-test	17.6	1.4	14.6	20.5
Exercise Bike	Pre-test	18.4	1.5	15.3	21.4
	Post-test	17.5	1.3	14.7	20.2
Simon	Pre-test	17.6	1.5	14.4	20.8
	Post-test	17.5	1.4	14.6	20.4

Agility Run

There were no significant improvements in the agility run over the course of the training period (F(1,28)=.66; **p=.42**). There were virtually no differences between groups in the level of improvement (see Table 5; F(2,28)=.048; **p=.95**).

Group	Test time	Mean	Std. Error	Margin of Error (95%)	
				Lower Bound	Upper Bound
Makoto	Pre-test	7.1	.19	6.7	7.4
	Post-test	7.1	.19	6.7	7.5
Exercise Bike	Pre-test	7.2	.18	6.8	7.6
	Post-test	7.3	.18	6.9	7.7
Simon	Pre-test	7.4	.19	7.0	7.8
	Post-test	7.4	.19	7.0	7.8

Conclusions

The primary findings were as follows:

- A significant improvement in overall reaction time for individuals completing the Makoto training in comparison to the control conditions. This difference cannot be attributed to changing strategy alone.
- Slight – but non-significant – improvements in BFA and alternating finger tapping (both measures of interhemispheric cooperation), and vertical leap, in comparison to the control groups.
- No impact of any of the training conditions on the agility run.

Reference:

Jeeves, M.A., Ludwig, T.E., Moes, P., Norman, W.D. (2001). Compromised Interhemispheric Processing in Callosal Dysgenesis and Partial Commisurotomy. Cortex, 37, 643-664.

Texas Governer's Commission on Physical Fitness (1973). Physical Fitness-Motor Ability Test. Austin, TX.