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The Affects of Turmeric as an Anti-Inflammatory on Endurance Athletes

*Alia Shafi, Lia Keyser, Graham Ryan**

Undergraduate Students at Brown University: Chemistry, and Health & Human Biology

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ABSTRACT

Objective: To investigate the correlation of the oral intake of Synchro Gold, a turmeric supplement, and its affects as an anti-inflammatory to aid muscle recovery on endurance athletes.
Design: We designed a sample pool of 7 elite rowers and observed their perceived fatigue and soreness levels before and after the oral intake of Synchro Gold. With a myriad amount of research and study, we discussed the results on a molecular level.
Results: Control Group-The difference in the average for the perceived level of soreness for Easy level workouts was -0.0625, for Medium level workouts was -0.188, and for Hard level workouts was 0.250. Treatment Group: The difference in the average for the perceived level of soreness for Easy level workouts was -0.494, for Medium level workouts was -0.202, and for Hard level workouts was -0.178.
Conclusion: The findings of this study conclude that the use of Synchro Gold decreases the level of perceived soreness and fatigue level in endurance athletes and may infer that turmeric aids myogenisis post workout.

1. INTRODUCTION

The name 'Turmeric' originates from sanskrit and is defined as 'yellow'. It takes similar meaning in Mundari, Santali and the Dravidian languages. It is inferred that turmeric was a common possession amongst the Indonesian [1] people during the early development of Southeast Asia [1]. This popular yellow-color spice has a long medicinal history, dating back 4000 years. In the Indian Ayurveda system, it was used to treat respiratory conditions (eg, asthma, bronchial hyper reactivity and allergy), liver disorders, anorexia, rheumatism, diabetic wounds, runny nose, cough, and sinusitis.[2] In traditional Chinese medicine it was used to treat abdominal pain and in ancient hindu medicine it was used for the treatment of sprains and swelling.[2] Through research, turmeric has been found to have antioxidant, anti inflammatory, anticarcinogenic and antimicrobial effects.[12] It has also been used as a hepatoprotective, thrombo suppressive and has been prescribed to improve cardiac health.

The active constituent in turmeric has been identified as curcumin or, 1,6-heptadiene-3,5-dione-1,7-bis(4-hydroxy-3-methoxyphenyl)-(1E,6E). The three main curcuminoids identified in turmeric are demethoxy curcumin (curcumin II), bisdemethoxycurcumin (curcumin III) and the recently identified cyclocurcumin. Curcumin has very low solubility in water and the Stability of curcumin in aqueous solution improves with higher pH.[2] It is soluble in 0.1 M sodium hydroxide for a duration of 1-2 hours.

Curcumin is highly pleiotropic and interacts with numerous molecular targets. These targets include transcription factors, growth factors and their receptors, cytokines, enzymes and genes regulating cell proliferation and apoptosis.[2,7] Curcumin has been shown to inhibit the activity of enzymes, growth factor receptors, metals, albumin, and other molecules.[2] Research has found that Curcumin binds to P-glycoprotein, multidrug resistance proteins 1 and 2, glutathione, protein kinase C, ATPase,

ErbB2 and alpha1-acid glucoprotein.[1] Suppressing the p-glycoproteins can increase the bioavailability of many therapeutic agents including chemotherapy drugs. [1]Curcumin has been found to irreversibly binds CD13/aminopeptidase N, which inhibits tumor invasion and angiogenesis, or the formation of new blood vessels in the growing tumor.[2] curcumin inhibits activation of various transcription factors, including nuclear factor activated proteins, signal transducer and activator of transcription proteins and beta catenin, which regulate the expression of genes that contribute to tumorigenesis, inflammation, cell survival, cell proliferation, invasion and angiogenesis.[2,3] Curcumin also regulates the activity of a variety of tyrosine kinases activated by mutations that contribute to the malignant transformation, growth and metastasis of human cancers, which could be a great target for cancer prevention. Curcumin has also been shown to inhibit the expression of multiple genes and pathways involved in apoptosis, cell invasion, and adhesion, as well as regulating activities of several enzymes that mediate tumor growth.[2,3]

Curcumin has been found to have an extremely good safety profile. No studies in either animals or humans have discovered any toxicity associated with the use of curcumin, even in high doses. This is very different from most NSAIDs that have been linked to the formation of gastroduodenal ulcers.[8] One study creades a model to quantify the frequency of death or severe injury from bleeding or perforated gastroduodenal ulcers in chronic NSAID users. After analyzing thousands of cases, researchers found on average that 1 in 1200 of chronic NSAID users, or those taking them for at least two months, "will die from gastroduodenal complications who would not have died had they not taken NSAIDs. This extrapolates to about 2000 deaths each year in the UK."[8] Unfortunately, stopping the use of said prescribed NSAIDs is not an option. Therefore, having Turmeric is as safer alternative would be beneficial to patients.

Elite athletes are constantly searching for ways to improve muscle recovery in order to gain speed and train at a higher level. The constant pressure of gaining an edge over the competition leaves most sore, fatigued and frequently injured. In an effort to combat minor injuries and soreness, athletes are frequently advised to take over the counter NSAIDs to reduce inflammation and improve recovery. However chronic NSAID use has been shown to have highly toxic effects, particularly in the gastrointestinal tract, that can lead to ulcers and proliferation.[8] These potentially detrimental outcomes allow NSAIDs to only be used as a temporary solution, leaving athletes looking for a long term solution. As a powerful anti inflammatory with no known toxic effects, Turmeric could provide a safer solution for athletes.[2] Synchro Gold is a liquid-state turmeric concentrate that carries properties that can aid myogenesis in order to decrease recovery time and increase athletic performance.

In recent years, it has been discovered that curcumin has anti-inflammatory properties associated with its chemical composition and interactions with other enzymes in the body. Curcumin has been shown to reduce NF-kB activation, AP-1 binding to DNA, as well as to decrease the production of enzyme COX-2.[4-7] All these play an important role in the inflammatory cascade. This has created an influx of research on curcumin and its ability to aid myogenesis on eccentric exercise-induced muscle damage. Exercise increases in inflammatory cytokines, such as IL-1B, TNF-a and IL-6, that were thought to be expressed only in immune cells, but now are known to be expressed throughout the body.[5-7,8] Muscle damage, with the production of free radicals in response to unaccustomed exercise, can trigger these pathways that lead to increased inflammatory cytokine production, pain and performance deficits in muscle function.[5] Specifically for muscle damage in downhill running, curcumin reduces hydrogen peroxide concentration and NADPH-oxidase gene expression in skeletal muscle but did not reduce plasma CK and LDH activities, which are all markers for muscle damage.[6] The purpose of this study is to test if decreasing this inflammatory response by taking Synchro Gold immediately after exercising would aid muscle repair and overall recovery in endurance athletes.

Although there has been a plethora of research supporting the health benefits of supplemental turmeric, as well as medicinal properties, there have been very few treatments that have made it out of phase-1 clinical trials.[10] Curcumin in its pure form has low bioavailability, due to many factors including that it is insoluble in water.[2] Many of the research now surrounding the medicinal use of Turmeric is focused on discovering new ways to improve its systemic availability. When ingested in its most bioavailable form, curcumin is absorbed in its highest density in the intestinal tract and surrounding organs.[10] One study found that when ingested with piperine, the bioavailability of synchro gold increases by up to 2000%.[11] Synchro Gold combines piperine with a liposomal delivery system to maximise absorption and bioavailability of the curcuminoids. Although Synchro Gold is commonly used as a nutritional supplement, its effects have never been tested on endurance athletes. This study aims to see if the Synchro formula will be an effective in promoting the absorption of the curcuminoids in high enough concentrations to reach the necessary active sites to promote muscle recovery. Rather than focus on the supplements effects on the overall health of the athletes, the study focuses specifically on the efficacy of synchro gold in improving muscle recovery. Previously, curcumin concentrations in the blood and skeletal muscle have showed the highest levels three hours after oral administration of curcumin, and the large difference is maintained until after twenty-four hours.[6] They main hypothesis tested in the study was, If Synchro Gold is consumed immediately after exercise, it will promote muscle recovery in endurance athletes by increasing the activity of myocytes, thereby decreasing muscle soreness and fatigue.

2. METHODS

2.1 Participants

The participant pool consisted of seven elite college rowers whose ages ranged from nineteen to twenty-two years old. The rowing season beings in March and ends June, however this study took place during the off-season months of July and August. The rowers were randomly assigned to groups, one group receiving placebo, the other receiving Synchro Gold. None of the rowers were harmed in the making of this study, and all participants applied voluntarily.

2.2 Protocol for Participants

All the participants were to be male rowers of similar age and physical capabilities and fitness levels. The participants were chosen from one single team, and therefore were expected to be following a specific training plan. Participants were given a set of expectation and directions for the collection period. Participants were shown how to log their data in an online spreadsheet. The measured data included the completed workout, perceived level of soreness, perceived level of fatigue, hours of sleep, estimated ounces of water consumed in the previous 24 hours and any other comments specific to that data point. They were also instructed to follow a consistent workout, sleep and hydration schedule throughout the collection period.

2.3 Choosing a Placebo

Out of the seven rowers, 4 received Synchro Gold, and 3 received a placebo. The placebo was made out of ginger, black pepper extract, and yellow food coloring. The mixture has a similar taste and coloring, but does not contain the active ingredient turmeric. Anyone previously unfamiliar with Synchro Gold would be unable to distinguish between the two.

Turmeric comes from the same ancestral background as Ginger does. Both are perennial plants found in Southern Asia, that are said to come from the Zingiberacaea family.[3] Like turmeric, ginger has chemical properties in its roots and rhizomes that create its medicinal properties.[1] For the purpose of this study, we used ginger because it is a plant similar to turmeric, has slightly different properties. Ginger has active constituents of gingerol, Shogaol and Zerumbone.[1] Turmeric has 3 major curcuminoids: curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Because of curcumins' unique structure, turmeric is an extremely powerful antioxidant.[1] Ginger has some antioxidant property, but it is not nearly as strong as those of turmeric. The ginger placebo will mimic the turmeric supplement, Synchro Gold, but will have negligible effects on the results.

2.4 Double Blinded

The experiment was double blinded by a third party, so neither the participants nor the researchers knew who had the supplement or the placebo. The supplement bottles were unlabeled in a dark, glass bottle. Each bottle was labeled with one of two expiration dates, which distinguished between the two groups. The bottles were distributed appropriately to each participant.

2.5 Collecting a Baseline

For two weeks, the seven rowers input data into the spreadsheets as instructed, without taking the supplement. In these fourteen days, they accomplished all the workouts that were completed throughout the experiment.

2.6 Measuring Muscle Recovery

Participants were tested at the beginning and end of the collection period in order to measure muscle recovery quantitatively. The test was conducted over a two day period on ergometers, a machine that mimics the rowing motion and is used as a tool for training off the water. The rowers completed their ergometer test at a pace relative to their individual abilities. Prior to the experiment, each rower completed a 2,000 meters test at max pressure. Theirs scores, recorded as time per 500 meters (splits), are used to determine their pace on the 60 minute test. This way, all rowers completed the workout at the same percentage of their max effort.

On the first day of the test, participants warmed up and then performed a one-minute test piece at maximum effort. The number of strokes per minute, or rate, can have a large effect on ergometer test scores. In an effort to control for error, a rate cap of a 40 was required for the test. After their average watts produced during the test were recorded, participants completed a 60 minute ergometer piece at 15 splits above their personal record over 2,000 meters while maintaining a stroke rating between 18 and 20 strokes per minute. This workout was intended to fatigue the rower's muscles. The next morning, the rowers completed a second one-minute maximum effort test identical to the first. The average watts for this test were recorded and then compared to the first test to see how the athletes were able to recover from the taxing workout the previous afternoon.

This test was completed twice, once in the first 2 weeks of the study and once at the end of the study. However, the second time this test was taken, the athletes took a dose of their assigned Synchro Gold or Placebo directly following their 60-minute ergometer test. The scores and therefore ability to recover with and without the supplement were then compared.

3. RESULTS

3.1 Data Collection

After the conclusion of the experiment, all participants perceived soreness and fatigue values were collected. These values were then organized and separated into categories based on the caliber of each individual workout. The categories were labeled "Easy", "Medium", and "Hard". Because all athletes were not following the same workout schedule, the protocol for Easy, Medium and Hard were

different for each athlete. In an effort to determine the definition of each category unique to each individual, every training plan was examined carefully taking into account level of fitness and athletic ability.
All values of each participant was collected and placed into two tables with labeling categories. One table for before supplementation and one for after supplementation. The average perceived soreness level and fatigue level was calculated for each table. The difference between the average value before and after supplementation was also calculated. This was determined using the initial value (no supplement) subtracted by the final value (with supplement).

3.2 Difference in precieved soreness

As seen in Figure 1, the participants that received the placebo had a sorness difference that was smaller than those who received the Synchro Gold.

Figure 1: Preceived Soreness Difference

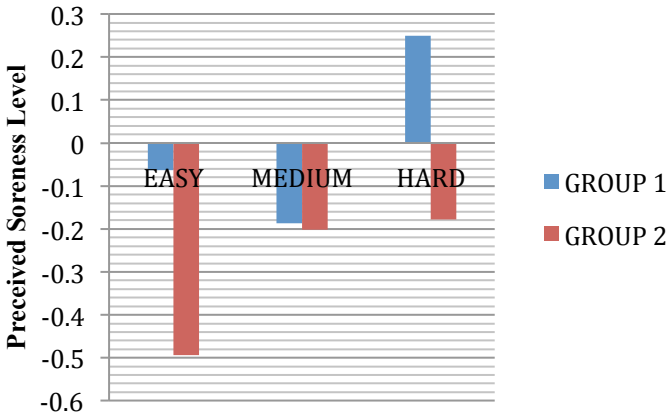

Fig. 1. This figure displays the difference between the perceived sorness value before and after supplementation with respect to each workout difficulty. Group 1 had the placebo, Group 2 had Synchro Gold. The table for this graoh can be found at Table 1.

3.3 Difference in Preceived Fatigue
As seen in Figure 2, the perceived Soreness difference was smalled for those with the placebo than those with the supplement. This was true for all except the Medium level workouts.

Figure 2: Preceived Fatigue Level

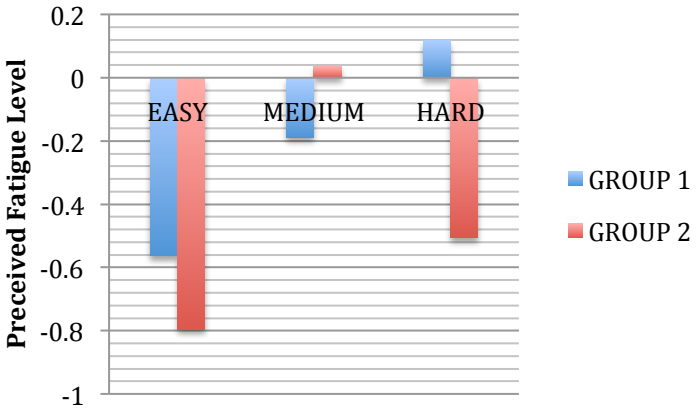

Fig. 2. This figure displays the difference between the perceived fatigue values before and after supplementation with respect to the difficulty of each workout. Group 1 had the placebo, Group 2 had Synchro Gold. The table for this graph can be found in Table 2.

3.4 Muscle Recovery

Two ergometer tests were assigned to measure muscle recovery. Both examinations followed the same protocol and all data was collected and analyzed. All athletes were to complete a 1-minute watt test followed by another ergometer test at a specific intensity unique to each athlete. The next morning, another 1-minute watt test was to be completed. In Figure 3, the bars display the difference in both watt scores. Test 1 portrays the test done prior to taking Synchro Gold. Test 2 was done at the end of the study and required all participants to take their dose of Synchro Gold between test day 1 and test day 2.

Figure 3: Difference in Testing Scores

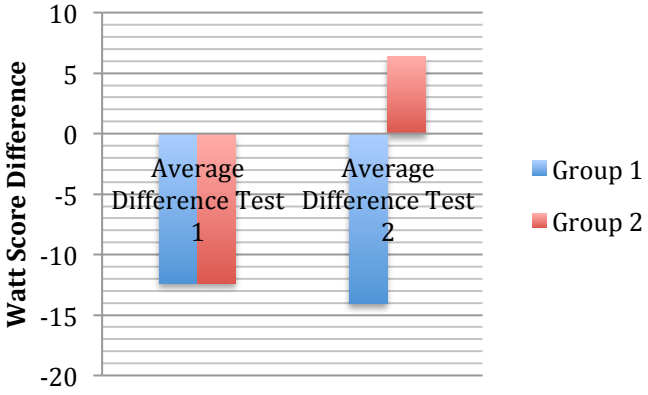

Fig. 3. This figure displays both tests on the graph. The bars graphed represent the watt score average difference between day 1 and 2 of testing. Group 1 had the placebo and Group 2 had the Synchro Gold. The table for this graph can be found at Table 3. P value= 3.90855E-06

4. DISCUSSION

4.1 Assumptions and Error

There are some errors that must be recognized prior to discussing the results.

The study took place over a five-week period between the months of July and August. In the sport of collegiate rowing, these months are said to be the off-season. This meant that all athletes participating in the study were not following the same training plan. However, each athlete was held to the same athletic standard and expected to workout out at a consistent rate over the five-week period. All of them worked out enough to stay in minimal shape, but none was said to have reached their peak athletic potential.

Over the course of the experiment, each athlete was expected to gain fitness. The more fit an athlete got, the less sore and fatigued he would feel. Because of increasing fitness, all perceived soreness and fatigue levels should naturally go down. Two months before the study, all athletes had been working out at a constant rate and intensity. Over the five-week period each athlete focused on maintaining fitness rather than gaining. Each athlete was expected to gain some fitness, but the difference is said to be very minimal, if noticeable at all. The discussion focuses on how dramatic the drop in fatigue and soreness was rather than the appearance of a drop.

All data was gathered through each athletes' perceived level of soreness and fatigue. Naturally, this method of collecting data resulted in error because the data was qualitative rather than quantitative. Everyone perceives soreness and fatigue differently and comparing data between athletes would lead insignificant results. In an effort to solve this problem and reduce the error, the study asked for all athletes to record their perceived level of fatigue and soreness over a two-week period without supplementation. This allowed the study to compare participants with their own, personal observation of fatigue and soreness. The discussion and results are comparing each athletes fatigue before and after supplementation specific to the level of intensity of each workout.

The study occurred over a five-week period. During this time, each athlete is expected to gain fitness. The more fit an athlete gets, the less sore and fatigued he will feel. Because of increasing fitness, all perceived soreness and fatigue levels should naturally go down. However, each athlete had been working out prior to the study at a constant rate 2 months before the start of the study. Over the five-week period each athlete focused on maintaining fitness rather than gaining. Each athlete was expected to gain some fitness, but the difference is said to be very minimal, if noticeable at all. The discussion focuses on how dramatic the drop in fatigue and soreness was rather than the appearance of a drop.

The research asked for all participants to rate their soreness over a scale given to them. It was up to the participants to follow the directions we provided. A possible error is that these directions may have been interpreted differently, or participants may have not followed the directions as asked. For example, the instructions asked all participants to take a 1.5 Oz dosage of Synchro Gold within a 30-minuet window after exercise. Not all athletes may have followed this rule precisely.

We chose to follow the recommended dosage of Synchro Gold for each athlete, rather than altering the dosage based on BMI and body mass. This may have caused some increase in perceived soreness and fatigue for some over others.

When analyzing the results, all the above is taken into consideration.

4.2 Soreness Level

Based on the data collected over the 5 week study, Synchro Gold had a positive effect on the perceived level of soreness for the participants.
For the easy level workouts the average difference between the weeks without the supplement and those weeks with, was -0.5. For those who had the placebo, theey recorded little difference in their perceived level of fatigue, scoring a -0.063. For the medium level workouts, the placebo and the Synchro Gold had similar values. The placebo scored a -0.19 and the Synchro Gold scored a -0.20 (Fig. 1). The difference between the two scores is 0.01 favoring Synchro Gold. For the hard level workouts, the placebo scored a value of 0.25 and the Synchro Gold was -0.18 (Fig. 1).

Based on this data, one can assume that the Synchro Gold helped decrease the perceived level of soreness for the participants. The participants using the Synchro Gold felt better after taking the supplement for all level workouts. However, the Synchro Gold was most effective in easy level and hard level workouts.

All participants were required to take the supplement immediately after exercise followed by 16 oz. of water. This allowed the body to absorb the turmeric appropriately. From previous studies on the anti-inflammatory properties of turmerics main constituent, Curcumin, it is possible that the Synchro Gold helped to recover the muscles post workouts.

4.3 Fatigue Level

Based on the data, the Synchro Gold helped to decrease perceived fatigue level.

The above statement was true for both the easy and hard workouts, but not for the medium level workouts. For the easy level workouts, the placebo scored a -0.56 and the Synchro Gold scored a -0.80. For the medium level workouts, the placebo scored a -0.19 and the Synchro Gold scored a 0.036. For the hard level workouts, the placebo

scored a value of 0.12 and the Synchro Gold scored a value of -0.51 (Fig. 2).

The values of the fatigue level for synchro gold was much less evident than those for the sorneness level. There are a few confounding factors in this experiment that can have an effect on the level of fatigue. The amount a participant slept each night could have had an effect on the level of fatigue for each participant. However, calculating the correlation coefficient for each participant over the 5 week study, the numbers of hours slept had no correlation between the level of fatigue that each athlete documented. All r^2 values were all below 0.030.

Another confounding factor could be the amount of water that each participant drank. Daily water intake can influence the level of fatigue that each athlete felt. Similar to the sleep versus fatigue level, there was not correlation between the amount of water an athlete drank to the level of fatigue he felt.

4.4 Muscle Recovery

All participants were required to complete two ergometer tests, one with the supplement and one without. Based on the data, the participants with the Synchro Gold, on average, did better on their second watt test, compared to their first, than those who took the placebo. The higher the watt score, the better. While analyzing the graph, if the difference between the first and second watt score is positive, the rower increased speed. Figure 3 shows that for the first test, both groups 1 and 2 yielded the same watt score difference. However, in test 2, group 2 increased speed and power output. Group 2 had the Synchro Gold. Synchro Gold may have helped aid muscle recovery, helping the athletes pull a better watt score the day after a physically taxing workout (Fig. 3). A p-value was calculated using the difference between the test at the beginning of the period and at the end of the testing period. It was calculated with five degrees of freedom, and came out to 3.9 x 10^-6 which is less than .05 and therefor statistically significant.

4.5 Conclusion

Overall, those who took Synchro Gold recovered faster and felt better. The participants who took the placebo had higher signs of soreness and fatigue compared to the experimental group.

The Synchro Gold helped more with the participants' perceived soreness level than fatigue level. Past experiments on turmeric indicate that curcumin has strong anti-inflammatory properties. This fact explains why the soreness levels decreased. When an athlete gets the feeling of being sore, he/she is said to have Delayed Onset Muscle Soreness (DOMS).[13] DOMS as muscle pain or soreness that occurs 12-48 hours after exercise. It is said to be the most intense at the beginning of an athletic season or for noivice athletes.[13] The proposed mechanisms of DOMS is often theorized as lactic acid, muscle damage, connective tissue damage and inflammation [13] Turmeric, like other common NSAIDS, have the power to reduce inflammation, explaining the reduction in perceived soreness in the experimental group [8]

Chronic fatigue syndrome (CFS) is an illness that is described as persistent fatigue involving various systmes in the body.[15] A number of studies indicate that oxidative stress may play a role in its pathogenesis.[15] Studies have shown that with the use of curcumin treatment, it is possible to reduce the symptoms of depression, namely the mechanisms associated with oxidative stress pathways.[14] Curcumin has the ability to reduce oxidative stress, therefore reducing the symptoms of CFS. The participants in the study who had the Synchro Gold recorded less fatigue than those who had the placebo.

If Synchro Gold was taken immediately after a hard workout, the workout the following day would yield a better result. Based on the data that was collected using ergometer tests, those who took Synchro Gold went a lot faster the next morning compared to those without the supplement. Synchro Gold showed to be not very effective for the medium level workouts. This may have been because the low/medium level workouts was not causing as much muscle damage as the hard level workouts. The Synchro Gold does not make a significant difference if used on low intensity workouts.

Table 1

Column1	GROUP 1	GROUP 2	SD 1	SD 2
EASY	-0.0625	-0.494047619	0.088388348	0.926709252
MEDIUM	-0.1875	-0.202380952	0.265165043	0.566747943
HARD	0.25	-0.177777778	0.353553391	0.754983444

Table 2

Column1	GROUP 1	GROUP 2	SD 1	SD 2
EASY	-0.5625	-0.795634921	2.032931996	0.895591053
MEDIUM	-0.1875	0.035714286	0.441941738	0.163338366
HARD	0.116666667	-0.505555556	0.542115199	0.231074056

Table 3

Column1	Average Difference Test 1	Average Difference Test 2
Group 1	-12.375	-14.05
Group 2	-12.375	6.366666667

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