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BIO 143

THE EFFECTS OF LOCALIZED COLD ON THE REACTON TIME OF THE FEMALE ARM

INTRODUCTION

The physical reaction time in humans is affected by many factors. The most significant of these are gender, age, movement time, temperature, and the state of rest.

Gender has a very small but consistent effect on reaction time. Der and Deary (2006) found that the reaction times of women are slower and more varied than those found in men of similar ages. However, women were more accurate when asked to choose one of two options and react to it. They also showed a small improvement in speed with practice.

Age has a great affect on reaction time (Der and Deary 2006). Reaction time changes as people age. For adults, the time it takes to respond to a stimulus slowly increases until approximately age 50, at which point it drastically increases. As people age, not only does the time taken rise, but also the time taken becomes much more varied. The standard deviation increases as a group becomes older. In both simple (task oriented) and choice (decision oriented) reaction times, this decrease in the efficiency of reaction can be seen with increased age (Der and Deary 2006).

Whether or not the participant in a resting state may also have some bearing on reaction time. Eisdorfer and Lawton (1973) suggest that when a person is being asked to react to something, the heart rate slows just before the reaction and jumps directly after. Their research suggests a correlation between this jump in heart rate and the speed of reaction; the greater the difference between the slowed heart rate and the quickened heart rate, the faster the reaction seemed to be. Thus, if the person were in a resting state when they were tested, the heart rate would jump more making the reaction time quicker. They also suggest this could be a reason for the slowed reaction times in older adults, as the heart rates of the aging do not jump as sharply as the heart rates of younger people (Eisdorfer and Lawton 1973).

Mortimer (1982) states that movement time, another variable that can impact reaction time, only matters when the whole body or an entire limb is involved in the reaction and does not impact small reactions. It also shows that the speed of movement in nerves is only part of the total reaction time, even though they slow with age. Speed of nerve movement can be ignored as a cause of slowing with age. Also, the amount of action necessary may affect the movement time, and therefore the reaction time.

Temperature is one of the most influential factors with regards to reaction time. Cold temperatures slow the nerve signals from brain to hand, thus slowing the reaction (Ashcroft 2000). It also slows the muscles, causing stiffness and clumsiness. A study on how cold water affects swimmers stated that a water environment can cool the body rapidly. That cooling stresses the body’s ability to protect itself against such cooling, and increases heat production beyond its ability to cope (Folinsbee 1978). This is especially important in light of the fact that the body loses heat 25 times faster in water than in air (Ashcroft 2000). When the hand is immersed in cold water, the reduction in temperature stimulates blood vessels to constrict, also known as vasoconstriction (Thibodeau 1999). This occurs when the sensory receptor nerves in the skin feel that the temperature is decreasing. They send this information to the hypothalamus and the hypothalamus sends out signals for the body to perform heat-producing and heat-preserving tasks, such as shivering and vasoconstriction. While this conserves body heat, the lower blood supply to the muscles makes them work slower, and hence slows reaction times.

The purpose of this paper is to explore the effect that localized cold, specifically immersion in ice water, has on the body's reaction time focusing on the young female arm.

METHODS

We chose a sample size of 30 females between the ages of 18-22. We conducted our experiment in Hausser Hall, the freshmen girls' dorm of Taylor University Fort Wayne so that we could easily find females in this age range. First, we asked if they would be willing to participate in an experiment. If they agreed, we had them read and sign the informed consent form. None of our participants had to be disqualified on grounds of being outside our established age range, or on grounds of pre-existing injuries to their dominant arm. Once they agreed, we asked them to click a stopwatch on and off as fast as they could. We recorded the time on our datasheet, and then we asked them to submerge their arms in the bucket of ice water that was already prepared. We kept the water's temperature between 35° and 40° F. After 60 seconds, we wiped their arms and asked them to again click the stopwatch on and off as fast as they could. We recorded this number on the datasheet. We then compared the two columns of data and looked for differences in the participants' reaction time.

RESULTS

Figure 1 shows the two sets of reaction times compared to each other. The first set of times was faster, averaging about 0.22 seconds. The second set of times was slower, averaging about 0.28 seconds. The difference between the two was 0.06 with a standard deviation of 0.11 (Table 1).

The statistical analysis tool that we used was the t-test. Our hypothesis was that the reaction time before exposure would be greater than the reaction time after exposure. Our null hypothesis was that the reaction time before would be less than or equal to the reaction time after. After performing our test, we came up with $t=3.27$ and $p=0.0014$, (Table 1). Because our p value was less than 0.05 we rejected the null hypothesis, and our positive hypothesis was shown to be correct. Response time before exposure to cold is faster than response time after exposure.

DISCUSSION

The evidence shows that female reaction time increases as the local temperature decreases, and that cold temperatures slow the reaction speed. In this specific study, exposing the female arm to cold water led to a slower reaction time. The mean of the differences between pre- and post-exposure was .06 seconds, after immersing the lower arm in ice water (35-40° F) for 60 seconds. These results correlate with the results of Rammasayer & Bahner (1995) and with the results of Pilcher (2002).

Pilcher (2002) did a meta-analysis of 22 original studies. He found that cold temperatures negatively affect the performance of any task. This was especially true when applied to tasks that involved information processing, as the cold slows the action of the nervous system.

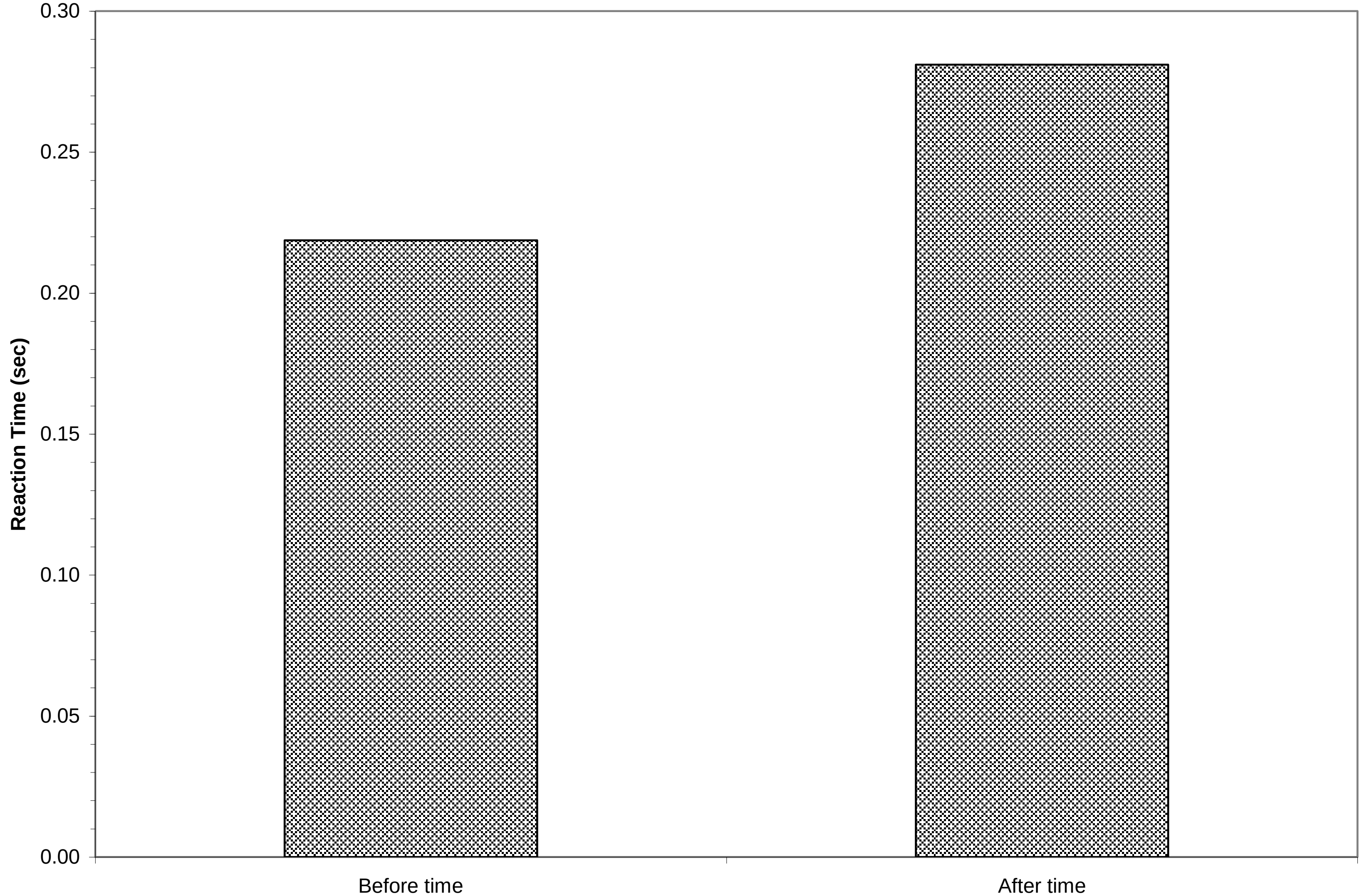

Figure 1- This graph presents the average reaction times before and after cold exposure for the participants. The results for each test are placed side by side in order to contrast the differences.

Table 1. This table shows the results of the paired t-test applied to the difference between the time before exposure to cold (in seconds) and the time after exposure to cold (in seconds).

	n	Mean	SE	SD
Time before exposure to cold (sec)	31	0.219	0.0105	0.058
Time after exposure to cold (sec)	31	0.281	0.0212	0.118
Difference (Time before exposure to cold (sec) - Time after exposure to cold (sec))	31	-0.062	0.0191	0.106

Mean difference	-0.062	
95% CI	-x	to -0.030
SE	0.0191	

t statistic	-3.27
DF	30
1-tailed p	0.0014

Rammasayer & Bahner (1995) experimented with the effects of lowered core body temperature on human information processing, using the human reaction time to measure this. They found that by lowering the body's core temperature just 1 degree Fahrenheit, reaction time and movement time both increased significantly. They also observed a general deterioration of condition and reaction time with progressively lower core body temperatures. Movement time was especially affected by cold temperatures, thereby increasing the time needed to react at these temperatures.

In light of these two studies, the small mean of the differences that we found between pre- and post-exposure (0.06 seconds) gains significance as the length of time increases, more of the body is submerged, and the temperature of the water drops (Ashcroft 2000). Should the body's core temperature drop even one degree, reaction time slows and judgment is impaired (Rammasayer & Bahner 1995). If a person's body temperature drops below 90° F, they lose consciousness (Ashcroft 2000). In the temperature range we tested (35-40° F), a person fully immersed in cold water has between 15 and 30 minutes before they will become unconscious, and only 30 to 90 minutes of expected survival time. So, the slowed reactions brought on by exposure to cold could kill a person, if that prevented him from getting himself out of the cold water.

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