Introduction

Researchers have extensively looked at the human dive response, where heart rate drops, and other physiological changes occur after a person immerses their face in cold water. Gooden (1994) described the mechanism that initiates bradycardia during the dive response. He claimed that the two requirements to elicit the dive response are the refex to stop breathing and water on the face (Gooden, 1994). The input gets processed, then, since the body is no longer breathing, the brain inhibits the respiratory center and cardiac muscle activity. This process activates parasympathetic nerves, which ultimately signal the heart to slow down, and the heart rate decreases (Gooden, 1994). Other research suggests that water on the face is not needed for the diving response and that holding one's breath can sufce (Schagatay and Anderson, 1988).

When analyzing the dive response, researchers found that the presence of water on the face and temperature of water infuenced the strength of the response (Schagatay and Holm, 1996). Specifcally, cold water had a stronger efect than warm water, which had a greater efect than breath-holding (Kawakami et al., 1967). Some research suggests that the heart rate initially increases (within the frst 12 seconds), then decreases based on the type of simulation (Furedy et al., 1983).

While this research shows consistent efects of temperature on the diving response, researchers have not looked at the efects of temperature and breath-holding on college students without previous dive training. If college students without previous dive training are like other populations, then they will experience the most pronounced diving response characterized by bradycardia with a cold-water dive simulation, followed by a warm water simulation, and a breath-hold will elicit the least pronounced diving response.

Discussion

Coldwater elicited a more pronounced diving response as measured by the greatest heart rate decrease than warm water. These results agree with a profound body of literature, suggesting that college students without dive training are similar enough to other populations for the temperature to affect the dive response similarly (Schagatay and Holm, 1996). Specifcally, the warm water decreased the heart rate by the same percentage (11%) as Gooden's (1994) experiment. However, the cold-water dive elicited a smaller decrease in heart rate than Gooden (1994) found (41% decrease).

Breath-holding did not elicit a diving response, as participants' heart rates increased throughout the breath-hold duration. These fndings contradict Schagatay & Anderson's (1988) fndings that breath-holding resulted in a 16-26% decrease in heart rate for young non-divers. However, these fndings support Kawakami and colleagues' (1967) fnding that holding one's breath at room temperature did not elicit the diving response, but holding one's breath at colder ambient temperatures did.

This study had few replications (Ncold=6, Nwarm=3), limiting our fndings' validity. Another possible limitation is the accuracy of the heart rate reader. The monitor displayed large heart rate fuctuations while recording, so we approximated that which looked like the average when determining the heart rate for the intervals.

Ultimately, this study suggests that college students experience similar diving responses as the population. In further studies, we would like to examine how diferent viscosities of liquid afect the dive response to examine if diferent types of liquids would elicit the response and to what extent.

Methods

Note: The team used the Neuro 301X – Neuroscience: Neuron to Brain Lab (Lab 4 – Mammalian Dive Response) Lab Manual as a guide for all methods. Please refer to this manual for more detail (Schwalbe, 2022).

PowerLab Setup

First, we set up PowerLab. We plugged in the Finger Pulse Transducer r to Inputs 1. We confgured the channels such that they lined up with the Lab Manual (2022). Next, we strapped the Finger Pulse Transducer and Respiratory Belt Transducer onto our group member who volunteered to do the dive simulation. We took a base measurement of the diver's heart rate to ensure it was being recorded correctly. We scaled the channel feedback to see the appropriate range (0-100 beats per minute)

Baseline Data Collection

The volunteer rested for fve minutes, to allow her heart rate to settle. After this fve-minute period, we measured her resting heart rate for one minute. Then, she held her breath for one minute. We recorded her heart rate during the 1st 15 seconds of her holding her breath, as well as the fnal 15 seconds. Subsequently, we recorded her heart rate immediately after she began breathing again. Then, we allowed her to rest for about 90 seconds before we yet again measured her heart rate.

Cold-Water Dive Simulation

We allowed the volunteer to rest again for about fve minutes. Meanwhile, the remaining group members prepared a bin to simulate a cold-water dive. We added ice and water to the bin and recorded its temperature. When the fve-minute rest period was done, the participant submerged her face in the cold water. During the 1st 15 seconds and fnal 15 seconds of her "dive" we recorded her heart rate. Then, immediately after she lifted her face, we recorded her heart rate, and once again after about 90 seconds of recovery.

Warm-Water Dive Simulation

warm water dive only decreased participants' heartrates by 11% (Figure 2).

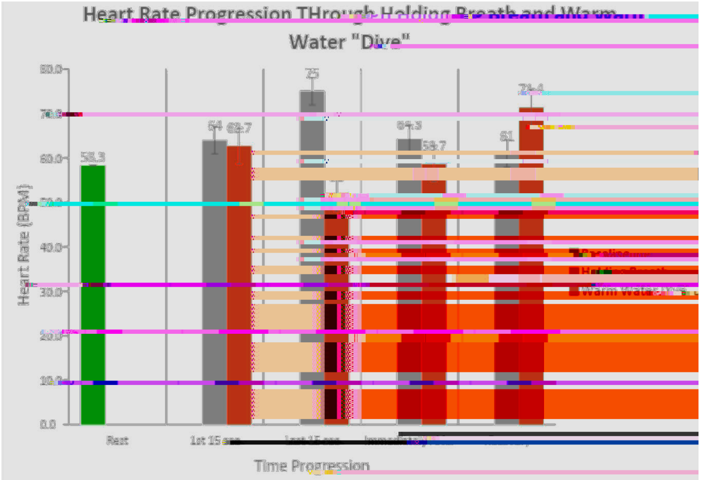

Figure 2. A warm-water dive simulation reduced heartrate, whereas breath holding increased heartrate throughout the simulation.

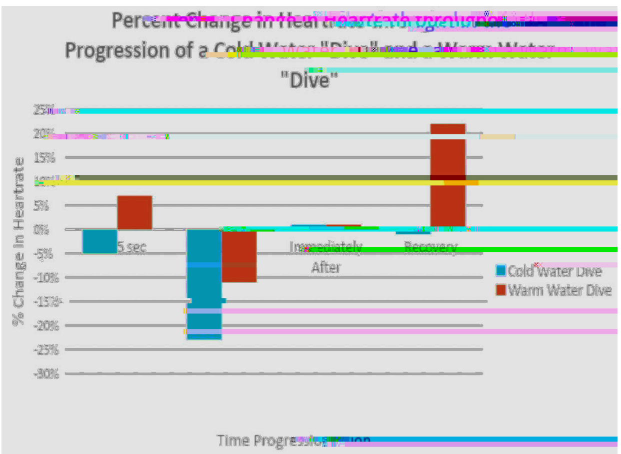

Figure 3. The cold-water dive elicits a more pronounced drop in heartrate than the warmwater dive.

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