CHANGES IN COGNITIVE FUNCTION AND SPORT-SPECIFIC REACTION TIME AFTER ACTIVE AND PASSIVE DEHYDRATION

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ABSTRACT

Dehydration has been shown to decrease sports performance. However, the exact cause of the decreased performance due to dehydration is still unclear. **PURPOSE:** Compare seated cognitive function performance to sport-specific reaction time values after a dehydrating protocol to approximately 2% body mass loss. **METHODS:** Seven women and thirteen men between the ages of eighteen and thirty-five participated in the study (27 +/- 4yr, 78.7 +/- 14.8 kg, 174.0 +/- 7.5 cm). Subjects reported to the lab in a fasted and normally hydrated state and completed a set of cognitive function tests followed by multiple sport-specific reaction time tests. Subjects then ran on a treadmill at 80% estimated max HR for 30 minutes, followed by multiple 15 minute sessions in a dry sauna at approximately 150 degrees F. After reaching a 2% (+/- 0.4%) reduction in dry body weight subjects completed the same procedures as pre-dehydration. **RESULTS:** Seven of the twenty-one cognitive function tests resulted in significant improvements after dehydration ($p < 0.029$). A multi-direction choice reaction time test where subjects selected targets with the upper body while moving the lower body was the only significant sport-specific test out of five that resulted in significantly decreased performance ($p = 0.026$). However, performance decreased in every sport-specific test, as demonstrated by an increase in reaction time (0.002 to 0.083 seconds). **CONCLUSIONS:** Sport-specific, total body reaction time performance and pure cognitive function appear to be influenced independently when athletic men and women are in a dehydrated state. The data suggest that pure cognitive performance is enhanced and the brain is functioning faster when dehydrated while total body sport-specific reaction time performance is decreased and the body reacts slower in a dehydrated state. The relationship between enhanced cognitive function and decreased sport-specific reaction time performance needs further investigation, but the current data suggest a peripheral mechanism may be the cause of decreased total body reaction time in athletic men and women.

INTRODUCTION

Dehydration is an important aspect of sports and exercise in general. In some cases, extreme dehydration has led to severe illness, or even death. Though the importance of hydrating while exercising for health and safety is well-known, another important factor is how mild or moderate dehydration may affect sports performance. Some of the more common issues related to exercise-induced dehydration are increased fatigue, body temperature, heart rate, and perceived exertion[1]. However, the focus of the present study was the effect of dehydration on cognitive function.

Results from past studies have been equivocal on the effect of dehydration on cognitive function. Dehydration has been demonstrated to affect certain measures of cognitive function[2], including pilots' performance and spatial cognition[3], yet other studies have failed to find a significant decrement in cognitive performance[4]. One confounding factor is that there are multiple ways to define and measure cognitive function.

In the present study, we were interested in how dehydration may affect an athlete in cognitive areas that would directly affect performance. Measurement tools involved both passive (or seated) tests and active tests of choice reaction time, where moving around the room and striking targets are required. Domains of cognitive function tested passively included: motor speed, information processing speed, executive function and reaction time. In this way, we sought to determine how mild dehydration (2% of body weight) may affect sport-specific aspects of cognitive function and reaction time.

METHODS

Cognitive Function Testing

Passive: CNS Vital Signs

Tests included:

- Finger Tapping
- Symbol Digit Coding
- Stroop Test
- Shifting Attention Test

Active: Makoto Arena II

Tests included:

- Single Step Audio
- Single Step Visual
- Towers Only (30s)
- Footplates Only (30s)
- Fatigue Test (2 min)

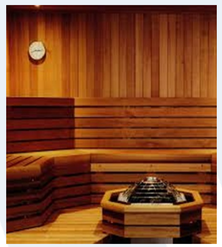
Dehydration Protocol

Treadmill:

- 30 minutes at 80% maximum heart rate (206.9 - (0.67 * Age))
- Subjects wore sweat clothes to enhance sweat rate

Sauna:

- 15 minute intervals in a sauna at 158 degrees Fahrenheit
- Naked body weight measured on a calibrated scale after every 15min session until 2% body weight loss is reached



Subject Characteristics

	n	Age (yrs)	Height (cm)	Weight (lbs)
Total	20	27 (4)	174.0 (7.5)	77.3 (14.3)
Men	13	26.4 (4.2)	176.9 (7.1)	84.6 (14.5)
Women	7	29.3 (4.6)	169.0 (6.1)	67.4 (6.0)

RESULTS

Table 2. CNS (N=20).

		Mean	SD	Mean Difference	P Value
Psychomotor speed domain raw	Pre	187.17	17.27	1.44	.488
	Post	188.61	17.75		
Reaction time domain raw	Pre	680.25	49.77	4.03	.776
	Post	684.28	59.20		
Cognitive flexibility domain raw	Pre	44.00	8.60	3.61	.018*
	Post	47.61	6.45		
Processing speed domain raw	Pre	63.00	6.09	2.61	.025*
	Post	65.61	7.33		
Executive functioning domain raw	Pre	44.94	8.36	3.89	.012*
	Post	48.83	6.10		
Motor speed domain raw	Pre	123.22	13.29	-1.78	.313
	Post	121.44	14.96		
Total test time	Pre	885.33	96.80	-105.28	.037
	Post	780.06	151.70		
Ftt right taps average	Pre	64.06	8.27	-1.28	.448
	Post	62.78	9.88		
Ftt left taps average	Pre	59.17	6.68	-0.50	.642
	Post	58.67	6.17		
Sdc correct	Pre	63.94	6.24	3.22	.004*
	Post	67.17	7.09		
Sdc errors	Pre	0.94	1.55	0.61	.052
	Post	1.56	1.38		

*P < 0.05

		Mean	SD	Mean Difference	P Value
Stroop simple reaction time	Pre	333.94	43.51	0.61	.958
	Post	334.56	40.26		
Stroop complex correct	Pre	12.00	0.00	-0.22	.104
	Post	11.78	0.55		
Stroop complex reaction time correct	Pre	646.83	60.28	-18.83	.339
	Post	628.00	56.09		
Stroop complex commission errors	Pre	0.39	0.70	-0.33	.029*
	Post	0.06	0.24		
Stroop correct	Pre	23.89	0.32	-0.33	.302
	Post	23.56	1.25		
Stroop reaction time correct	Pre	713.67	68.43	26.89	.140
	Post	740.56	85.65		
Stroop commission errors	Pre	0.94	1.35	0.28	.263
	Post	1.22	1.44		
Sat correct	Pre	50.06	5.59	2.78	.005*
	Post	52.83	4.40		
Sat errors	Pre	5.11	3.36	-1.11	.096
	Post	4.00	2.57		
Sat average correct rt	Pre	998.56	90.41	-47.33	.010*
	Post	951.22	83.64		

*P < 0.05

Table 3. Makoto (N=20)

		Mean	SD	Mean Difference	P Value
Audio single step	Pre	1.169	.101	0.082	.056
	Post	1.251	.193		
Visual single step	Pre	1.161	.211	0.002	.964
	Post	1.163	.220		
Footplates only on 3 towers	Pre	1.275	.179	0.008	.819
	Post	1.282	.190		
3 towers without footplates	Pre	1.239	.130	0.083	.026*
	Post	1.322	.198		
2 minute test with 3 towers and footplates	Pre	1.295	.136	0.079	.051
	Post	1.373	.230		

*P < 0.05

CONCLUSIONS

In pure cognition tests, dehydrated subjects performed the same or better than when they were hydrated at baseline, suggesting that the stress enabled their brains to work faster. However, in cognitive tests that involved body movement, the stress of dehydration resulted in decreased performance, suggesting more fatigue. Therefore, sport-specific cognitive function could decrease with dehydration, since physical movement is involved.

ACKNOWLEDGEMENTS

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