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Caffeine Enhances Memory Performance in Young Adults during Their Non-optimal Time of Day

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Many college students struggle to perform well on exams in the early morning. Although students drink caffeinated beverages to feel more awake, it is unclear whether these actually improve performance. After consuming coffee (caffeinated or decaffeinated), college-age adults completed implicit and explicit memory tasks in the early morning and late afternoon (Experiment 1). During the morning, participants ingesting caffeine demonstrated a striking improvement in explicit memory, but not implicit memory. Caffeine did not alter memory performance in the afternoon. In Experiment 2, participants engaged in cardiovascular exercise in order to examine whether increases in physiological arousal similarly improved memory. Despite clear increases in physiological arousal, exercise did not improve memory performance compared to a stretching control condition. These results suggest that caffeine has a specific benefit for memory during students' non-optimal time of day – early morning. These findings have real-world implications for students taking morning exams.

Keywords: : explicit memory, implicit memory, caffeine, time of day, cardiovascular exercise

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INTRODUCTION

As any college student will tell you, the worst time to take a class is first thing in the morning. Unfortunately many classes and entrance exams are only offered during the time when most students are at their physiological low point of the day, as measured by body temperature, skin conductance, and heart rate (Horne and Ostberg, 1976; Bailey and Heitkemper, 2001). Importantly, this circadian slump comes with a cognitive cost. The majority of college students perform worse in the early morning compared to the afternoon on a variety of cognitive tasks that measure attention (Knight and Mather, 2013), learning (Anderson et al., 1991; Hidalgo et al., 2004), memory (Petros et al., 1990; May et al., 1993), and metamemory (Hourihan and Benjamin, 2013), skills that are critical for academic success. Many students rely on coffee – caffeine – to get them through those early morning exams. But does it actually help?

Caffeine is the most widely used stimulant, consumed daily by 80% of the world's population and 90% of the North American population (Heckman et al., 2010). Caffeine is an efficient drug, crossing the blood-brain barrier quickly to block adenosine receptors that are distributed widely throughout cortical regions. Even at low doses, caffeine results in significant increases in firing rates in regions mediating sleep and mood, such as the dorsal and medial raphe nuclei and the locus coeruleus (Nehlig and Boyet, 2000). This amplified cortical activity likely underlies the increase in subjective reports of alertness (Smith, 2005; Michael et al., 2008) as well as increases in sustained