

## **Physiological influences on the rate of subjective time – the case of hypercapnia.**

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For short intervals, subjective time is a linear function of real time, and this is often explained by proposing the existence of a pacemaker in the brain that generates timing pulses. As a biological mechanism, the rate at which the pacemaker produces pulses is thought to be influenced by various physiological factors, such as arousal, the actions of various drugs, and body temperature. For example, a reduction of body temperature slows the rate of subjective time, which is thought to be due to a reduced rate of pulse production from the pacemaker. Likewise, an increase in body temperature increases the rate of subjective time due to an increase in the rate of pulse production. We present the first investigation of the effects of a hypercapnia on the rate of subjective time. Hypercapnia is a physiological change induced either by breathing air with a higher than normal percentage of CO<sub>2</sub> or by breath holding (used here). Hypercapnia changes the physiological environment of the brain by increasing the proportion of CO<sub>2</sub> in the blood, and by producing vasodilation leading to an increase in cerebral blood volume. In the experiment, participants made verbal estimates of auditory stimuli with durations in the range 150msec to 950msec. Auditory stimuli were either continuous filled tones, or two brief clicks defining an empty interval. Previous research has indicated that filled intervals appear longer than unfilled intervals (the so called “filled duration illusion”), and this has been explained by suggesting that the pacemaker runs faster for filled than unfilled intervals (Wearden et al., 2007). We replicated the filled duration illusion under conditions of normocapnia, and found that hypercapnia abolished the filled duration illusion by shortening estimates of filled intervals relative to normocapnia while leaving estimates of unfilled intervals unchanged relative to normocapnia. A plausible interpretation of this pattern of results is that hypercapnia prevents the pacemaker running at the higher rate it normally runs at for filled durations.