

SUBORBITAL SPACEFLIGHT PRE-LAUNCH PHYSIOLOGICAL PRIMING FOR ENHANCED G-TOLERANCE & (+G to 0-G) G-SWITCHING

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ABSTRACT

Suborbital spaceflight passengers will experience an extreme gravitational loading-unloading-reloading, here termed, *G-switching*, for which no on-Earth simulation can completely prepare them for. Put simply, down-gearing from 4-G to 0-G & then 0-G to 6-G is not merely a delta of 4-G & 6-G, respectively, because passing in & out of 0-G results in unique sensations that few experience, let alone have extensive experience of. As pointed-out by Anne Fisher, an astronaut-physician, *"Your first moments in space are not always your best. The switch from 3-Gs of acceleration to sudden weightlessness can be abrupt enough to induce vomiting. I could feel the blood rushing & in 30 seconds I was going 'uh oh', I am going to be one of the ones who is not going to feel good."* The real-world possibility that *"sudden"* G-switching, especially down into *0-G-land* &, moreover, from a significantly more aggressive position, i.e., from 4-Gx & 4-Gz may result in a higher-than-expected incidence of passengers actually becoming motion-sick & vomiting, &/or experiencing G-lock. It probably cannot be underestimated, especially given that most passenger are likely to be: passed their physical prime; under considerable psychological information stress-overload from being strapped to an actual *rocket* which could result in messing-up their anti-G straining manoeuvre. That aside passengers are in a shared & confined environment that could lead to a mass *bystander effect* of the above. Indeed, Fisher was a young, fit & trained professional pilot who experienced less than 2-Gz & about 3-Gx on her Shuttle flights & was yet still caught off-guard. The possibility that the entire experience could be completely ruined or at least not up to expectations, could result in a (serious) public-relations disaster. In response, outlined here, two new & novel anti-G countermeasures that might substantially mitigate such untoward ill-effects & possibly even allow expanding the passenger pool by enhancing G-tolerance. The pre-launch cardiovascular & metabolic techniques involves off-setting otherwise disadvantaged & unprepared body-systems by manipulating peripheral blood flow-volume & core-temperature to effect a more favorable, say, primed position to retard & offset G-related adverse effects. The on-demand strategy simply involves triggering & accentuating the diver's response, by a modified & judiciously executed & timed breath-hold manoeuvre to ensure advantageous physiological effects linger for some time prior to launch. The dive response involves a prompt, substantial & largely lingering: cephalo-thoracic blood-shift; extensive body-cooling, including brain & visceral cooling, which with experience can be on the order of degrees; cooling-induced peripheral vasoconstriction & increased blood pressure; sustained vertebral oxygenation & increased time-dose hypoxia tolerance; &, increased tolerance of *chest-crushing* Gx. And one notes that human +Gz tolerance, a poorly tolerated G-force, is decreased by as much as about 30-40% per degree increase in core-body temperature, so that the diver's response should offset this & expand the tolerable G-load, quite aside already pre-loading the brain with blood.¹⁻³ The technique requires less than 5 minutes to reap some benefit but a *warm-up* series of up to 30 minutes prior to launch will reap maximum & more clamped effects. Once learned, the

technique allows i-limited self-practice & a considerable conditioning-cope potential for improvement; faster improvements is possible via novel, off-the-shelf & non-invasive vitals monitoring biofeedback gadgetry. Although the specialized techniques require some training beyond what is taught in, say, a technical freediving course, they can be learned in a gradual, stepwise-personalized manner & do not involve extremely prolonged breath-holding nor deep-diving; the two priming techniques overlap in their effect but basically promote Gz- & Gx-priming via separate mechanisms. Considering the amount of money invested by the service-providers & spent by the customer, reducing the risk of untoward events seems warranted. The technique has yet to be tested under actual suborbital spaceflight conditions but has been chest-crush & motion sickness tested.

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