

Erik Seedhouse

PULLING G

***Human Responses
to High and Low
Gravity***

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Human Responses to High and Low Gravity



Published in association with
Praxis Publishing
Chichester, UK



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SPRINGER–PRAXIS BOOKS IN POPULAR SCIENCE

SUBJECT ADVISORY EDITOR: Stephen Webb, B.Sc., Ph.D., M.Inst.P., C.Phys.

ISBN 978-1-4614-3029-2 ISBN 978-1-4614-3030-8 (eBook)

DOI 10.1007/978-1-4614-3030-8

Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2012932172

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Cover design: [Jim Wilkie](#)

Photo credit: www.learning-to-fly.com

Project copy editor: Christine Cressy

Typesetting: BookEns, Royston, Herts., UK

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

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Preface



Deeper into the atmosphere the G-forces increased to the maximum of 2. In any other circumstances this would have been a trivial force. A modern fighter can subject its pilot to 9 Gs. But for an astronaut returning from days of weightlessness, the feel of the G-forces was significantly amplified. It seemed as if an elephant were on my shoulders. I was being crushed into my seat. The weight of my helmet made it difficult for me to hold up my head. My vision began to tunnel, as if I were looking through a straw. I knew from my fighter jet experiences tunnel vision was an indication of approaching blackout. The vision area of my brain wasn't getting enough oxygenated blood.

Extract from *Riding Rockets*, by astronaut, Mike Mullane

Ever wondered what it feels like to pull 7 G in a fighter plane or what it's like to get up close and personal with a Formula One (F1) car or other gravity-defying vehicles? Pulling G is not an easy task, as it's extremely demanding on the body. But what exactly is G? G refers to G-force – a term you've no doubt heard many times to describe the gravitational force on a person or object when it's accelerating. This G-force can refer to rocket launches, fighter aircraft, or any activity involving acceleration. But the way G affects the body is determined by several factors, including the magnitude of the G-force, the length of time the person has to withstand it, the direction from which the force is applied, and even body posture at the time of the G. For example, an instantaneous impact such as a high-speed F1 accident may prove lethal, whereas exposure to transient Gs during a rollercoaster ride will have no long-term effects.

To give you an idea of how G-forces feel, merely sitting in your chair is equivalent to 1 G. If you're lucky enough to catch a ride in a Bugatti Veyron and ask the driver to accelerate from 0 to 100 km/hr (which will take an impressive 2.4 seconds), you will experience a force of 1.18 G. If you're even luckier and manage to get a ride in an F1 car (there are some two-seaters used to entertain corporate sponsors) and ask the driver to demonstrate its performance envelope, you will experience about 1.45 G. Back in the day when the Space Shuttle was flying, astronauts were subjected to 3.2 G during launch. Take a ride on one of the big scream-machine roller coasters and you can expect to really feel your organs displace inside your ribcage. For example, the Desperado subjects riders to a downward force of negative 4.1 G in its first drop. Snapping back upward out of this drop, riders experience 2.8 G before being dropped again and slung around to face a negative 5.25-G rightward turn. In addition to the stomach-churning

twists and turns, the Desperado subjects riders to nine instances of weightlessness; no other roller coaster comes close. If the Desperado doesn't satisfy your G craving, you can ramp up the G level by taking a ride in an aerobatic aircraft, which routinely pull 7 or 8 positive and negative Gs.

These are just some of the examples used in this book to describe the risks of the high and low-G environment and the physiology of surviving G. *Pulling G* begins with an explanation of biodynamics and Colonel Stapp's pioneering research before describing the phenomenon of gravity-induced loss of consciousness (G-LOC) and the body's compensatory mechanisms. In the next chapter, the dangerous issue of "push-pull" is tackled before introducing the human centrifuge and how it is used as a training tool for astronauts and fighter pilots. Next is a description of the lateral G experienced in the F1 arena and how drivers train to tolerate high G-loads at right angles to the spine. The following chapter provides an insight into the experiences of pilots who have survived high-speed ejections. After describing the accelerative forces that are unleashed when punching out from a high-performance jet, the focus is directed at the stresses experienced during launch and re-entry before segueing to the subject of zero-G and how human physiology adapts to transient microgravity. Finally, staying on the subject of space, the final chapter describes how scientists are investigating using artificial gravity to research ways of reducing the effect of zero-G on astronauts' bodies.

Acknowledgments

In writing this book, the author has been fortunate to have had five reviewers who made such positive comments concerning the content of this publication. He is also grateful to Maury Solomon at Springer and to Clive Horwood and his team at Praxis for guiding this book through the publication process. The author also gratefully acknowledges all those who gave permission to use many of the images in this book, especially AMST and Mark Holderman.



From left to right: Warrant Officer Chris Kelly, the author, MCpl Allison Riddell, and Sgt Chris Townson seated in the control room of Canada's only human centrifuge located in Downsview, Ontario. This is a rather unique photo because these are the only certified current Acceleration Training Officers in Canada. When they're not spinning pilots in the centrifuge, Chris Kelly instructs Conduct after Capture training. Chris Townson indulges his penchant for motorbikes, and Allison earns a small fortune renovating houses. Image courtesy: David Brookes

The author also expresses his deep appreciation to Christine Cressy, whose attention to detail and patience greatly facilitated the publication of this book, to Jim Wilkie for creating the cover of this book, and to Stewart Harrison who sourced several of the references that appear in this book.

Once again, no acknowledgment would be complete without special mention of our rambunctious cats, Jasper, Mini-Mach, and Lava, who provided endless welcome (and occasionally unwelcome!) distraction and entertainment.

*This book is dedicated to my very good friend Capt Daniel “BOOYA”,
who assures me he can pull 2 G in his Sea King helicopter.*



About the author

Erik Seedhouse is a Norwegian–Canadian suborbital astronaut whose life-long ambition is to work in space. After completing his first degree in Sports Science at Northumbria University, the author joined the legendary 2nd Battalion the Parachute Regiment, the world’s most elite airborne regiment. During his time in the “Para’s”, Erik spent six months in Belize, where he was trained in the art of jungle warfare. Later, he spent several months learning the intricacies of desert warfare on the Akamas Range in Cyprus. He made more than 30 jumps from a Hercules C130 aircraft, performed more than 200 abseils from a helicopter, and fired more light anti-tank weapons than he cares to remember!

Upon returning to the comparatively mundane world of academia, the author embarked upon a master’s degree in Medical Science at Sheffield University. He supported his studies by winning prize money in 100-km running races. After placing third in the World 100-km Championships in 1992 and setting the North American 100-km record, the author turned to ultradistance triathlon, winning the World Endurance Triathlon Championships in 1995 and 1996. For good measure, he also won the inaugural World Double Ironman Championships in 1995 and the infamous Decatriathlon, an event requiring competitors to swim 38 km, cycle 1,800 km, and run 422 km. Non-stop!

Returning to academia in 1996, Erik pursued his Ph.D. at the German Space Agency’s Institute for Space Medicine. While conducting his Ph.D. studies, he still found time to win Ultraman Hawaii and the European Ultraman Championships as well as completing the Race Across America bike race. Due to his success as the world’s leading ultradistance triathlete, Erik was featured in dozens of magazines and television interviews. In 1997, *GQ* magazine nominated him as the “Fittest Man in the World”.

In 1999, Erik decided it was time to get a real job. He retired from being a professional triathlete and started his post-doctoral studies at Vancouver’s Simon Fraser University’s School of Kinesiology. In 2005, the author worked as an astronaut training consultant for Bigelow Aerospace and wrote *Tourists in Space*, a training manual for spaceflight participants. He is a Fellow of the British Interplanetary Society and a member of the Space Medical Association. Recently, he was one of the final 30 candidates in the Canadian Space Agency’s Astronaut Recruitment Campaign. Erik works as a manned spaceflight consultant, professional speaker, triathlon coach, and author. He is the Training Director for Astronauts for Hire (www.astronauts4hire.org) and completed his suborbital astronaut training in May 2011. He is also Canada’s only High Risk Acceleration

Training Officer, which is a long-winded way of saying he spins people in Canada's centrifuge.

In addition to being a suborbital astronaut, triathlete, sky-diver, pilot, and author, Erik is an avid mountaineer and is currently pursuing his goal of climbing the Seven Summits. *Pulling G* is his tenth book. When not writing, he spends as much time as possible in Kona on the Big Island of Hawaii and at his real home in Sandefjord, Norway. Erik and his wife, Doina, are owned by three rambunctious cats – Jasper, Mini-Mach, and Lava – none of whom has expressed any desire to travel into space but who nevertheless provided invaluable assistance in writing this book (!).

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