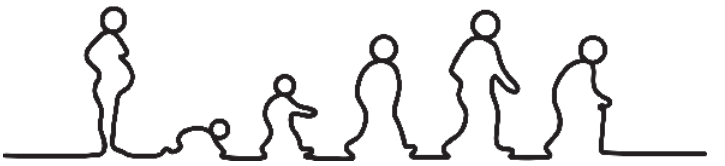
GRAVITY

a missing link in child development

Melodie de Jager • Oleg Efimov • Victoria Efimova



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- Throughout this book the parent has been referred to as the parent, you or she.
- Throughout this book the child has been referred to as the baby, the child and he.
- This has been done to add clarity to the roles played by each participant in the Gravity program.

INTRODUCTION

How did this book come about?

It all started when a neurologist and a speech therapist from Russia found an article written on the internet. This article was about the vestibular system and how it affects child development and learning. The neurologist and the speech therapist, a novel team to co-author a book in the field of education, had each also written numerous articles and books about the vestibular system for parents and teachers, so there was clearly a common interest.

The neurologist, Dr Oleg Efimov and the speech therapist, Victoria Efimova are the owners of an innovative private pediatric neurological clinic called Prognosis, in St. Petersburg, Russia. The author of the article was Dr Melodie de Jager from South Africa, the founder of the BabyGym and Mind Moves Institutes. Melodie, a developmental specialist with a keen interest in neuroscience, has written books for parents and teachers on a groundbreaking approach to child development, disabilities, developmental delays and barriers to learning.

Thus began a relationship in which Oleg and Victoria invited Melodie to St. Petersburg to present a seminar on her approach to development and learning. Melodie reciprocated by inviting Victoria and Oleg to Johannesburg to present a paper at the annual Mind Moves conference. After the conference, they spent some time at the Black Rhino Game Reserve exploring their common interests and the possibility of writing a book together. Would that be possible with the authors living in different hemispheres, on different continents and speaking different languages?

Of course it was possible because this book is about a common interest in understanding how the development of all children, in all countries, whether in South Africa, Russia, China, the United States or in fact anywhere in the world, are impacted by the force of gravity of our planet Earth.

CHAPTER 1

GRAVITY

THE IMPACT OF GRAVITY

Everything on planet Earth has changed many times: the climate has become colder and warmer, many species of animals and plants have disappeared and new ones have emerged, and continents and seas have changed their positions and coastlines. The only thing that has always remained constant is **the force of gravity** on the Earth. Gravity is a magical force that always acts consistently on all living things, even though we do not feel it.

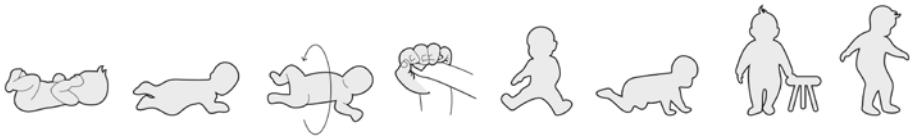
Gravity is the force that attracts a body towards the centre of the Earth.

Have you ever wondered if the weight of your suitcase remains the same, or if it changes, when you fly in an airplane?

If there was no gravity on Earth, animals and even plants would look quite different. All life on our planet is compelled to resist the force of gravity, using compensatory mechanisms:

- some animals have strong skeletons or shells to resist the force of gravity
- other animals and humans have muscles to resist gravity and help to maintain the position of the body
- the mammalian circulatory system also works with gravity, but most importantly
- gravity has affected the development of our brain.

If we observe how an infant develops, it starts as a floppy baby that develops into a standing and walking toddler. Infant development is, in fact, the story of the human struggle against gravity. Firstly the baby learns to raise his head, then roll over, grasp with his hands, sit, crawl, get up and finally walk.



It all seems so simple, but in fact it is not. Unlike other mammals, humans walk on two legs, instead of four. There is a theory that the development of a large brain was because our ancestors began to stand on two legs when they wanted to free their hands to work. To do that, they had to resist gravity. The result was a new, larger brain and the ability to use tools, develop language and other cognitive abilities.

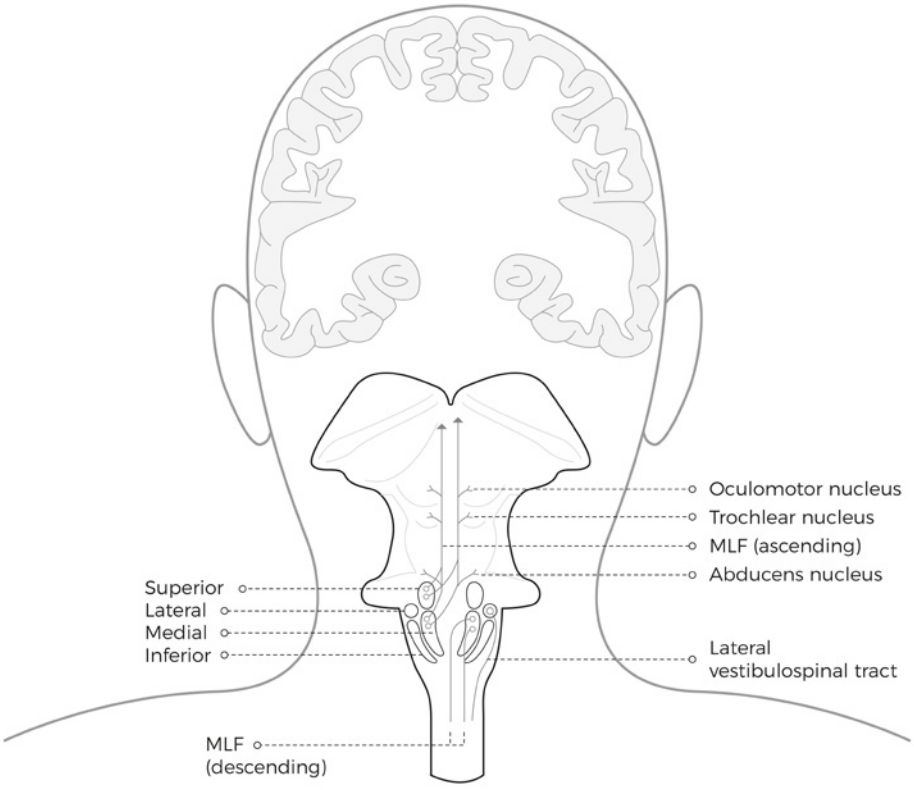
Gravity provides the baby with a starting point to develop physical, emotional and social skills, and most importantly, cognitive skills. From the moment he first puts his feet firmly on the ground, the baby has a physical starting point. In a similar way to using a GPS for maps, gravity provides a sense of current location for humans. For example, how does the brain know the baby's top from his 'tail'? He receives this information from receptors under his feet and the **vestibular system** in his brain stem and ears.

WHAT IS THE VESTIBULAR SYSTEM?

The vestibular system is found inside the head and it responds to changes in the position of the head. If the brain understands where the head is in relation to the feet, the child is able to navigate his position in space, and the vestibular system thus provides the brain with information about motion and spatial orientation. In addition, the vestibular system is involved with motor functions that allow the child to stabilise his head and body during movement, and to maintain his posture and balance in order to execute the skilful movements needed for skipping with a rope, writing and reading, etc.

The vestibular system consists of two parts, the central vestibular system and the peripheral vestibular system.

The central part of the vestibular system includes four pairs of vestibular nuclei to the left and right of the brainstem: the superior, lateral, medial and inferior nuclei.



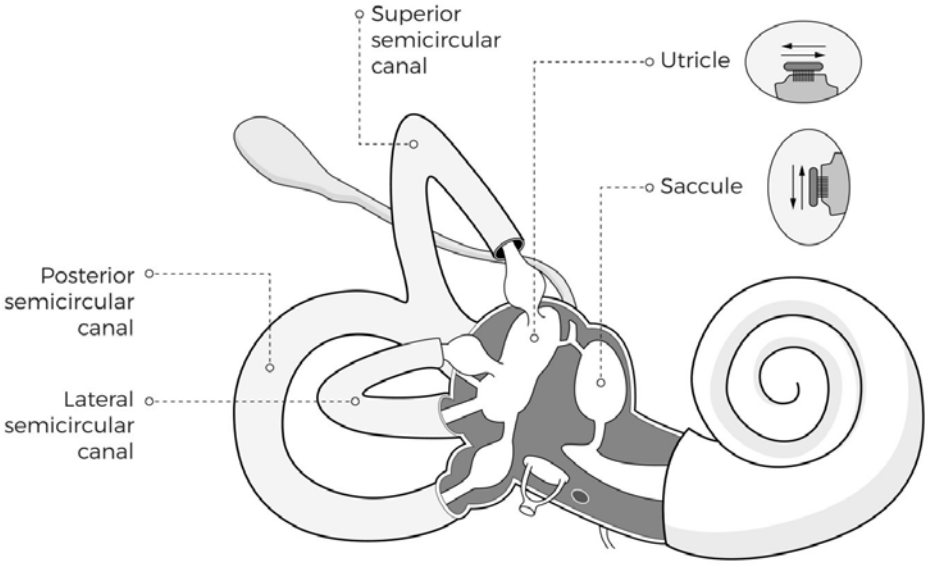
CENTRAL PART OF THE VESTIBULAR SYSTEM

The peripheral part of the vestibular system has ten organs, one set of five organs on each side of the head, located in the inner ears. These five organs comprise two different components: the three semi-circular canals which indicate rotational movements; and the two otolith organs which indicate linear accelerations. Different receptors respond to different kinds of head acceleration and gravity, so we need all of them.

Semi-circular canals responsible for rotational movements of the head.

Otolith organs responsible for linear movement:

- Utricle: forwards / backwards
- Saccule: up / down.



PERIPHERAL PARTS OF THE VESTIBULAR SYSTEM

It is important to understand that gravity is constant acceleration. Our brains must respond to gravity all the time. The vestibular system is switched on 24 hours a day, 7 days a week, thereby creating a foundation for our lives, and for the development of the brain and cognition.

The central part of the vestibular system is the structure that conducts and processes vestibular information in the brain. This process begins in the brain stem and ends in the cortex. Often when people refer to the *brain*, they really mean the cortex. But the cortex isn't everything. If you think of the brain as a mushroom, the cortex is the cap and the stem is the brain stem. Almost all information from the senses passes through the brain stem where there are centres that control all our important physiological functions. The brain stem is very important for processing vestibular information and for movement.

THE LINK BETWEEN GRAVITY AND THE VESTIBULAR SYSTEM

The vestibular system responds to gravity, but we don't feel it. We feel when we are touched; we pay attention to the sounds that register on the receptors of the inner ear; we see images that fall on the retina of the eye, but we do not notice gravity. That is why, for a long time, nobody realised how important gravity was for the functioning of the brain and its development. We can only really learn about the role of gravity when it is absent, which is very difficult on planet Earth.

WE ONLY LEARNED ABOUT THE ROLE OF GRAVITY WHEN IT WAS ABSENT.

Man can feel a lack of gravity when he is in the cosmos, or outer space. The Russian scientist Konstantin Tsiolkovsky (1889), in his work *Free Space,* described weightlessness and the sensations that a person experiences in **microgravity**.

Zero-gravity is the absence of gravity; a condition in which the effects of gravity are not felt; weightlessness.

Microgravity is a condition of very low gravity, approaching weightlessness.

In a spaceship, while in zero- or microgravity, objects would fall freely and float weightlessly[1].

He even foresaw that our perception in microgravity would change. In 1961, when the first Soviet cosmonaut Yuri Gagarin entered space, he confirmed that his experiences coincided with what Tsiolkovsky had described 70 years previously.

Although Tsiolkovsky couldn't foresee how microgravity would affect cognitive processes, he did understand how important gravity is to humans. He even proposed that we design homes in space in the shape of rings that constantly spin to artificially create the force of gravity.

1 (Exploration, n.d.)

KONSTANTIN TSIOLKOVSKY

He was born in 1857 in a small Russian town near Moscow. At the age of nine he was sledding, caught a cold, contracted scarlet fever and partially lost his hearing. As a result, he performed badly at school. When he failed for the second year, Tsiolkovsky was expelled from school. He never studied anywhere else, preferring to study independently, reading books from his father's library. He was interested in mathematics and physics. Over time, his father believed that the boy was able to learn and sent him to Moscow to enter a technical school. But Konstantin did not enter the school. Instead he spent three years studying in the Moscow library where he developed an interest in colonizing space. He went on to pass the exam to become a teacher and began to teach at a school.

He lived with his family in Kaluga where he engaged in science, made models of aircraft and dirigibles. He wrote books about the fact that, one day, a man would fly into space. When you visit Russia you will find the Tsiolkovsky Museum in Kaluga.

OLEG COMMENTED:

Kaluga is a very small provincial town. My distant relatives lived there and told us about the local teacher Konstantin Tsiolkovsky. He was very poor, and often came to the neighbours to ask for kerosene in order to cook. He was considered an eccentric, almost a mentally ill person.

It was Tsiolkovsky who created the first drawings of a reusable space station that remained in orbit and would not return to Earth. His isolation and the lack of academic stature prevented anyone from knowing about this genius.

THE LINK BETWEEN GRAVITY AND THE BRAIN

Tsiolkovsky assumed that microgravity could be used for the treatment of many illnesses. However, the opposite happened when people began to spend a lot of time in space as they actually began suffering from health problems in microgravity. Their vision suffered and calcium, sodium and bone metabolism deteriorated, resulting in bone loss. Most importantly[2], their brain function began to deteriorate.

2 (Grimm, et al., 2016)

SYNONYMS USED FOR SPACE TRAVELERS IN DIFFERENT COUNTRIES:	
America	Astronauts
Britain	Aeronauts
Russia	Cosmonauts
China	Taikonauts

DYSLEXIA MIGHT RATHER BE VIEWED AS A FAULTY PROCESS THAN A CONDITION.

According to Goddard (2002)[3], educated and literate aeronauts start to write from right to left, reverse numbers and letters, and even produce mirror writing when in space. In the absence of a sense of gravity, these aeronauts seemed to have become 'dyslexic', which demonstrates the significance of gravity for spatial orientation and directional awareness. This phenomenon may point to the possibility that dyslexia might be viewed as a faulty process rather than a condition.

So, it turns out that cosmonauts and children with learning difficulties may have much in common. It appears that the brains of children with learning difficulties, for some reason, do not process information about the force of gravity very well. This can result in learning problems because, for the brain to work optimally, it has to give priority to the relationship between the body and gravity. If the brain does not know where the head is in relation to gravity, it will use most of its attention and resources to find it, to the exclusion of other abilities and skills.

The vestibular system works as an amplifier for information about gravity, and the functionality of this amplifier may be disrupted for a variety of reasons even before the child was born. Impaired functionality of the vestibular system has been found to delay milestones and have a negative impact on a child's overall development – physical, emotional, social and intellectual.

3 (Goddard, 2002)

DEVELOPMENTAL DIFFICULTIES ASSOCIATED WITH IMPAIRED VESTIBULAR FUNCTION

These difficulties can be observed, and parents should seek medical advice when three or more of these conditions are observed:

From conception to 12 months after full term:

- a quiet and passive foetus
- the foetus is not turned into the optimal position for delivery (breech position)
- the baby cries when picked up
- baby has problems feeding
- the baby's muscle tone is either high (spastic / hypertonia) or low (floppy baby / hypotonia)
- the developmental milestones are delayed
- starts walking after 12 months
- has problems with chewing solid food.

From one to three years

- is clumsy
- slow and messy eater
- prefers smooth food, no 'bits' with different textures in food
- insistently demands a pacifier, or mom, or a blanket
- can't determine the source of a sound and doesn't turn towards it
- has difficulty with perceiving depth and moving objects
- walks on tippy-toes
- has delayed speech development
- has problems with toilet training.

From 3 to 6 years

- has difficulty in holding a crayon or paint brush between the thumb and index finger
- has problem with speech development
- experience difficulty with perceiving sequences (instructions, tasks)
- finds it difficult to master self-reliant skills (washing, dressing, eating, etc.)
- still has trouble with using the toilet (enuresis / encopresis)

- has poor posture
- has a fear of the dark
- has a fear of heights
- can't ride a two-wheel bike at age six
- is slow to learn to build puzzles and play card games.

Children older than 6 years

- have difficulty in determining the leading or dominant hand
- lack self-organisation
- cannot sit still and sit up straight in class
- still have problems with speech development
- experience difficulty with perceiving sequences (numbers, letters, words)
- are slow to learn to write and read
- have poor / illegible writing
- cannot copy from the chalkboard or screens
- are unsuccessful in communicating with other children
- have difficulty in structuring learning material for studying purposes
- have difficulty in remembering tomorrow what they learned today.

An adult may demonstrate many of these problems too, and this may be associated with their vestibular system's inability to process information about gravity.

IN SUMMARY

It appears that the brains of children with learning difficulties, for some reason, do not process information about the force of gravity very well. Impaired functionality of the vestibular system has been found to delay milestones and have a negative impact on a child's overall development whether it be physical, emotional, social and intellectual.