

ARE WE ASTRONAUTS BEFORE BIRTH? A MIRACLE OF INTRAUTERINE LIFE

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SUMMARY

Although a life in the womb is often described as a miracle of nature, it is still a mystery connected with many controversies even though science has the means to follow fetal intrauterine development virtually from the conception. Fetal assessment is undertaken to determine its' development and well-being using different techniques. Assessment of fetal well-being can begin in early and late pregnancy, and during labor. An important ultrasound method for the evaluation of neurological well-being of the fetus is four-dimensional ultrasound (4D US) suitable for assessment of fetal behavior. While assessing behavior using 4D US examiner is trying to understand how fetus is adapted in intrauterine environment by observation of different movements of the body, extremities and the head including facial expressions. From the evolutionary point of view temperature (either cold, hot or thermoneutral) and gravity (microgravity, or 1G Earth gravity) belong to controlling mechanisms of the origin and evolution of life on Earth. Intrauterine milieu with microgravity is important for overall development of human beings. In this environment every individual is being prepared to be exposed to hostile extrauterine conditions characterized by cold and by Earth gravity (1G). Cold-induced activity and adaptation to cold can substitute 15 to 20% of the gravity and induce the activity of slow muscular fibers. After we were born or in other words while we landed from the universe and were exposed to cold, high oxygen concentrations and gravity, we stopped being astronauts and continued life as humans whose first year of development was marked by the tyranny of gravity.

The aim of the paper is to speculate about the significance of intrauterine environment in terms of development and preparation of the fetus to be exposed to hostile extrauterine milieu.

Key words: Baby Astronaut Hypothesis, gravity, microgravity, fetal behavior, four-dimensional ultrasound

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INTRODUCTION

Although a life in the womb is often described as a miracle of nature, it is still a mystery connected with many controversies even though science has the means to follow fetal intrauterine development virtually from the conception (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Fetal assessment is undertaken to determine its' development and well-being using different techniques (Jain & Acharya 2022). Assessment of fetal well-being can begin in early and late pregnancy, and during labor (Jain & Acharya 2022). Genetic check-ups and malformations are assessed in early and middle pregnancy, and they can be non-invasive and invasive (Jain & Acharya 2022). Non-invasive include cell-free fetal DNA assessment and fetal cell-based assessment, while invasive tests include chorionic villous sampling and amniocentesis followed by chromosomal microarray and next-generation sequencing (Jain & Acharya 2022). In late pregnancy, the most used test is biophysical profile showing increased fetal heart rate in conjugation with fetal movements (Jain & Acharya 2022). The next technology used for the assess-

ment of fetal well-being is Doppler used to detect fetal heart rate, vessel (arteries and veins) waveforms and valve timing intervals (Jain & Acharya 2022). Cardiotocography is also widely used both during pregnancy and during labor correlating fetal heart rate with uterine contractions (Jain & Acharya 2022). Another important ultrasound method for the evaluation of neurological well-being of the fetus is four-dimensional ultrasound (4D US) suitable for assessment of fetal behavior (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). While assessing behavior using 4D US examiner is trying to understand how fetus is adapted in intrauterine environment by observation of different movements of the body, extremities and the head including facial expressions (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Postnatal neurologists (either pediatric or adult) who do not use prenatal ultrasound do not have experience in observing movements in intrauterine watery milieu which is quite different than postnatal air environment. From the point of view of the general population intrauterine life is still mysterious and intriguing. This was the reason to ask Chat GPT to list the sayings about the life in the womb. Here are

cited some apt sayings about this fascinating and wondrous aspect of human life (Chat GPT 2023):

1. "Life begins in a moment of mystery, hidden within the womb."
2. "The womb is a sacred cocoon, where life unfolds in secrecy."
3. "Within the womb, a world of wonders silently takes shape."
4. "In the depths of the womb, a miracle of creation quietly unfolds."
5. "The womb holds the secrets of life, a realm of mystery and growth."
6. "Within the darkness of the womb, a symphony of life begins to play."
7. "The womb is a sanctuary of life, where the unknown becomes known."
8. "In the womb's embrace, a journey of transformation begins."
9. "Life in the womb is a whispered secret, waiting to be revealed."
10. "The womb is a cradle of existence, where miracles are nurtured."

At the end, Chat GPT warned: Please note that these sayings are metaphorical and not based on scientific facts (Chat GPT 2023).

In this paper, we will try to show how the fetus moves in the uterus before birth and what conclusions we can reach by observing it with a 4D US. It seems that we managed to peek into the mysterious world before birth, which is enigmatic but at the same time very rich and dynamic, as well as interactive, which is confirmed by many mothers and scientific research (Stanojević et al. 2023).

The aim of the paper is to speculate about the significance of intrauterine environment in terms of development and preparation of the fetus to be exposed to extrauterine milieu.

INTRAUTERINE ENVIRONMENT: A GRAVITY AGE THERMOREGULATION OXYGENATION (GATO) HYPOTHESIS

The ancient Chinese believe that people are nine months older than what Western civilization advocates because the Chinese count the age of a person from conception. And it seems that they are right because the life begins much earlier before birth, which is scientifically still controversial (Kurjak et al. 2022). The development before birth takes place in a watery environment, with increased heat, relative lack of oxygen (hypoxia), and microgravity. This hypothesis about the environment before birth is called the "astronaut hypothesis" with the acronym Gravity Age Thermoregulation and Oxygenation (GATO) hypothesis, developed in 2013 (Sekulić et al. 2005, Meigal 2013, Meigal & Gerasimova-Meigal 2022). It seems that changing microgravity is important for proper motoric and overall

development in utero. In such conditions, it is much easier to move in the womb, but the closer the birth is, the more the amount of amniotic fluid in which the fetus is floating decreases, and gravity increases (Sekulić et al. 2005, Meigal 2013, Meigal & Gerasimova-Meigal 2022). When we are born, we are not quite ready to be exposed to gravity, which we struggle with till the end of the first year of life until we overcome it by standing up and starting walking.

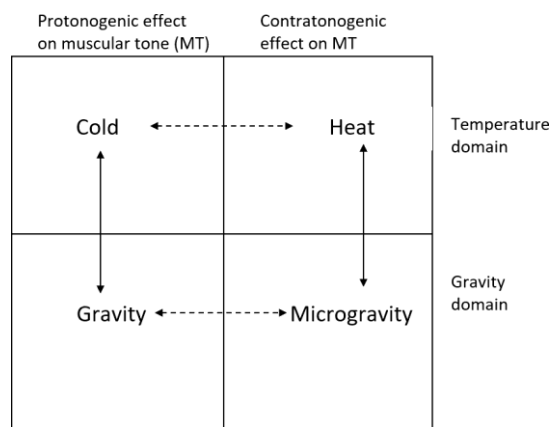


Figure 1. Interaction of cold, heat, gravity and microgravity on muscular tone (MT) solid lines showing agonistic effect and dashed line denotes antagonistic effect (Meigal & Gerasimova-Meigal 2022)

Relation of the temperature and the gravity on regulation of physiological functions

According to recent research, Meigal and Gerasimova-Meigal (2022) hypothesize that heat exerts similar effects on the neuromuscular system as microgravity, while the cold shares common effects on neuromuscular system as gravity (Meigal & Gerasimova-Meigal 2022). They claimed that relationship of the triad "microgravity, heat and hypoxia" and the dyad "cold and gravity" on neuromuscular system may have evolutionary origins and concluded that "synergistic adaptation of the motor system to different environments comes from their ontogenic synchronicity" (Meigal & Gerasimova-Meigal, 2022). They produced the so called "wet immersion model" of microgravity in utero affecting fetal behavior which is mirroring the phylogenetic development of neurologic and motoric systems (Meigal & Gerasimova-Meigal 2022). From the evolutionary point of view temperature (either cold, hot or thermoneutral) and gravity (microgravity, or 1G Earth gravity) belong to controlling mechanisms of the origin and evolution of life on Earth (Islas 2014, Nadezhdin et al. 2021). It seems that temperature and gravity exert similar effects as regulators of many physiological functions (Goswami 2017). It is not easy to investigate the influence of microgravity on human body after birth, but there is a model called dry immersion model when subject is immersed in thermoneutral water

separated from the water by an elastic waterproof fabric, which imitates absence of any supporting structure for the body, centralization of body fluids, immobilization and hypokinesia observed during spaceflight or in utero (Goswami 2017). However, little is known about the impact of microgravity on cerebral autoregulation and other physiological regulatory mechanisms ex utero, which is probably the reason why this model is still not used in the treatment of premature infants at the limits of viability (Kermorgant et al. 2020). Model proposed by Meigal & Gerasimova-Meigal (2022) which shows the influence of heat and microgravity and cold and gravity on muscular tone is shown in Figure 1 (Meigal & Gerasimova-Meigal 2022). Cold and gravity are increasing muscular tone (exerting protonogenic effect), while heat and microgravity are decreasing it (exerting contratonogenic effect), which means that cold and heat have antagonistic effect on muscular tone and motor system which is also the case when comparing normal gravity with microgravity (Meigal & Gerasimova-Meigal 2022).

muscular fibers equally distributed, which means that gravity is not the only prerequisite for slow muscular fibers development (Meigal & Gerasimova-Meigal 2022). Besides environmental factors like temperature and gravity which are modeling development of neuromuscular system, body size might contribute to development of fast muscular fibers with smaller body size (Hesse et al. 2010). Although human newborns are small in size, this hypothesis does not apply, because Kumagai et al. (1984) proved that neonatal muscles had the same content of slow-type muscle fibers and undefined type muscular fibers, which is the reason why body size factor is not applicable to the Baby Astronaut hypothesis (Kumagai et al. 1984). A skeletal muscle maturation defect has been described in human fetuses with the fetal akinesia deformation sequence (FADS) (Vuopala et al. 1995). In utero fetus is exposed to decreased gravity due to the immersion producing buoyancy effect, higher temperature and hypoxia, while after birth the neonate is exposed to cold environment with 1G gravity which has

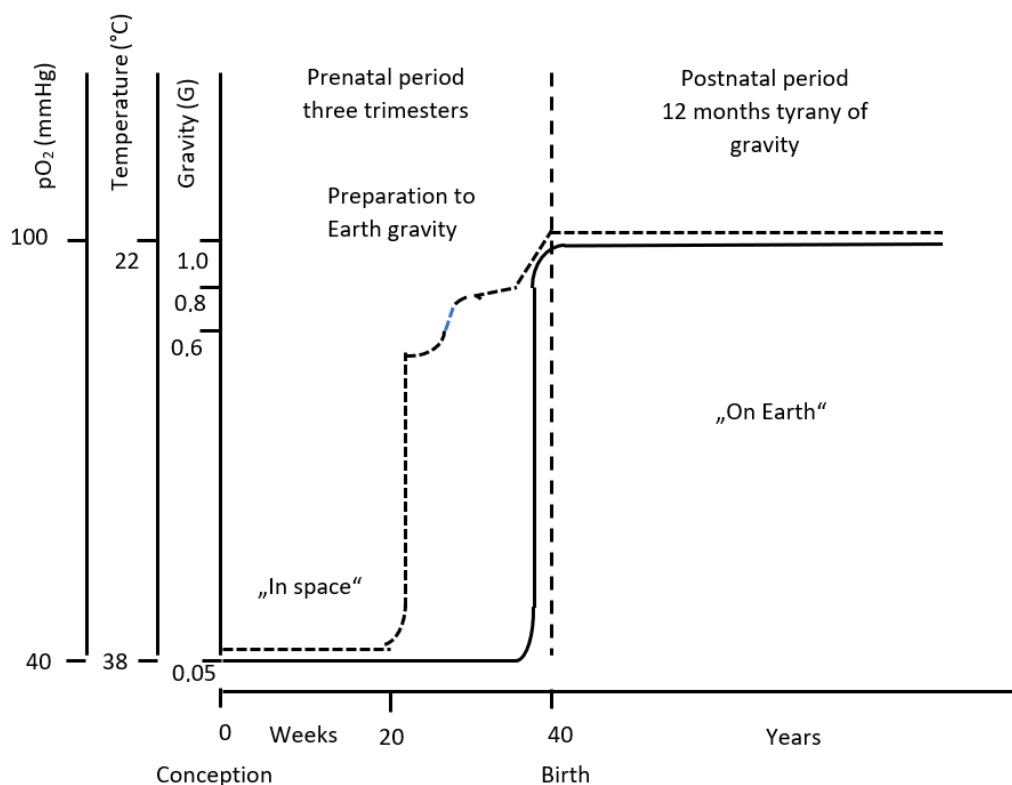


Figure 2. “Baby Astronaut Hypothesis” or scheme of gravity related events and confounding environmental factors on intrauterine and extrauterine life of human fetus comparing perinatal life with spaceflight events (solid line represents original events with changing gravity, while dotted line represents modified imagination of perceived gravity according to Sekulic et al. 2005 (Sekulic et al. 2005, Megal 2013, Zaripova & Meigal 2018, Meigal & Gerasimova-Meigal 2022).

It has been speculated that under microgravity and heat conditions fast muscular fibers (type II) are produced, while under the cold and gravity condition slow muscular fibers (type I) prevail, with even slow fibers developing under hypergravity (Meigal & Gerasimova-Meigal 2022). Just before birth in human fetus there are fast and slow

been shown as “Baby Astronaut Hypothesis” in the Figure 2 according to the original scheme made by Sekulic et al. (2005), Megal (2013), Zaripova & Meigal (2018), and Meigal & Gerasimova-Meigal (2022). Following this concept, we can say that despite the discontinuity of environmental conditions from microgravity in utero and 1G gravity ex

utero there is a continuity of neurobehavioral development (Stanojevic et al. 2011, Stanojević et al. 2012).

FETAL BEHAVIOR ASSESSED BY 4D ULTRASOUND

By studying the fetal behavior using 4D US, we speculated about its consciousness and cognitive function, trying to get to know its emotional life and its readiness to be separated from the mother and protective intrauterine environment which can be considered as universe in which it is easier for the fetus to move like an astronaut, while starting independent extrauterine life is stressful for the newborn due to at least two important facts: separation from the placenta and exposure to 1G gravity. Assessment of fetal behavior with a 4D US gives the opportunity to possibly enter fetal emotional life, follow fetal mental status, consciousness, awareness, and other states related to the fetal mind and the ability of self-regulation (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Pregnancy lasts 280 days (40 weeks) with a range of 259 to 284 days (37 to 42 weeks). After 168 to 182 days (24-26 weeks), the fetus has all the necessary synapses in the brain to feel pain (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). As early as 203 days (29 weeks), brain waves can be registered from the surface of the head, which testifies and proves that the cerebral cortex registers pain (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). The response of the cerebral cortex to pain can be established even earlier as early as 175 days (25 weeks) with even more sensitive methods such as near-infrared spectroscopy (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). With 4D US, fetal facial expressions like those of children suffering pain were found. The fetus can change the frequency, pattern, and coordination of movements in response to sensory challenges, while the retention of information from motor experience and motor learning can contribute to normal motor development in utero (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). We learned from 4D US research that the fetus is capable of planning actions and learning, which means that it could have awareness and consciousness. It can be concluded from the previous research that the life of a fetus in the womb is dramatic and rich in different experiences, which probably would not be possible without the development of fetal consciousness and awareness (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Awareness is the ability to directly know and identify, feel, or become aware of events, which means that someone is aware of something, informing the environment about it through certain behavior (Kurjak et al. 2017, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Although many researchers think of awareness as consciousness, it is not entirely clear whether awareness

and consciousness are synonymous (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). According to some researchers, consciousness consists of two components: awareness, which is contained in consciousness, and arousal, which describes the level of consciousness (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). Consciousness and arousal are mostly positively correlated, which means that with reduced arousal, consciousness also decreases (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). A fetus before birth probably expresses emotions and motility that is targeted and planned (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). There are reflex movements called general movements (GMs) produced by brain activity in special centers that are not located in the cerebral cortex. These movements appear as early as 7 to 8 weeks of pregnancy, and last until the age of 50 to 60 weeks after birth (Stanojević et al. 2011, 2012, Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). These movements are a good exercise for the development of voluntary movements that arise thanks to the activity of the cerebral cortex (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023). The development of both movements is a parallel process that stimulates the development of the central nervous system which is responsible not only for the motoric function but also for the cognitive and emotional development (Kurjak et al. 2017, Salihagic-Kadic & Kurjak 2018, Kurjak et al. 2019, Kurjak et al. 2020, Kurjak et al. 2023).

CONCLUSION

Intrauterine milieu with microgravity is important for overall development of human beings. In this environment every individual is being prepared to be exposed to hostile extrauterine conditions characterized by cold and by Earth gravity (1G). Cold-induced activity and adaptation to cold can substitute 15 to 20% of the gravity and induce the activity of slow muscular fibers (type I) (Meigal & Gerasimova-Meigal 2022). After we were born or in other words while we landed from the universe and were exposed to cold, high oxygen concentrations and gravity, we stopped being astronauts and continued life as humans whose first year of development was marked by the tyranny of gravity and the replacement of fast muscle fibers by slow ones (Stanojevic et al. 2011, 2012, Meigal & Gerasimova-Meigal 2022). The question is whether the intrauterine environment is a sign that man, as part of the living world, originates from space.

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Conflict of interest:

Authors state no conflict of interest.

Contribution of individual authors:

Both authors have accepted responsibility for the entire content of this manuscript and approved its submission.

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