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ANCIENT GREEKS AND BODY/COGNITIVE ENHANCEMENT TECHNOLOGIES: AN ANTHROPOLOGICAL PERSPECTIVE

ABSTRACT: Greek mythology formed the basis of much of Greek philosophy, art and science. The Greeks conceptualised their universe as animated by forces and elements which they anthropomorphised as gods and other supernatural beings. However, only recently has there been increasing attention on Greek mythology as a source of advanced technological and biomedical concepts. The Greek myths are fascinating for their technological ideas pertaining to body/cognitive enhancement. This paper provides theoretical correlations between Greek mythological and socio-historic dimensions of human enhancement, and some of their current/future technological developments, hence, offering a cultural anthropological perspective.

KEY WORDS: Greek - Mythology - Anthropology - Body enhancement - Interpretation

INTRODUCTION

There is little doubt that Greek mythology formed the basis of much of Greek philosophy, art and science. Like in other cultures, myths provided ancient Greeks with a blueprint for human behaviour, worldview and cosmology. Moreover, the Greeks conceptualised their universe as animated by forces and elements which they anthropomorphised as gods and other supernatural beings. The supernatural world was a source of awe and ambiguity, inspiration and terror, creativity and fatalism.

The Greeks appeased the divine powers via ritual practices and other devotional behaviours. However, only recently has there been increasing attention on Greek mythology as a source of advanced technological and biomedical concepts. Although, the Greeks drew heavily upon the epics of Homer and Hesiod for their mythopoiesis, Greek playwrights such as Aeschylus, Sophocles, Euripides, and Aristophanes based their plays on Greek myths and brought them to the public sphere. Greek myths became sources of scientific speculation for the pre-Socratic philosophers who

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speculated on the constitution of the cosmos. The Greek myths are uncanny for their technological ideas in the areas of body/cognitive enhancement. Correlations between Greek mythological and socio-historic dimensions of body and cognitive enhancement are drawn and some of their current/future technological developments are considered. The idea that Greek myths alluded to various types of human enhancement and technological innovation has tended to be overlooked in historic literature. Consequently, this paper provides theoretical correlations between Greek mythological and socio-historic dimensions of human enhancement, and some of their current/future technological developments, hence offering a cultural anthropological perspective.

It should be emphasised that the Greek notion of augmentation was borne out of Greeks' curiosity to view the mythic heroes and other beings as part of a greater and mysterious tapestry of events and circumstances which even gods did not have privy to. Through the centuries, the myths also became the basis for speculating the inherent powers contained in the body (σῶμα – *sōma*) and mind (νοῦς – *nous*) and how by using bodily techniques, individuals could improve their physical and cognitive abilities.

PERSEUS: THE AUGMENTED DEMIGOD

Perseus was a demigod, the son of god Zeus and a mortal woman Danae. Zeus changed into a shower of gold, impregnating her (Trzaskoma *et al.* 2004). Hence, Perseus's virgin birth distinguished him from other mortals. Perseus and his mother lived on the island of Seriphos which was ruled by King Polydectes who had fallen in love with Danae. In order to save his mother, Perseus was ordered to kill the mortal gorgon Medusa and bring her head to Polydectes. However, Medusa was formidable and lethal, for whoever looked upon her face turned to stone (Ashrafiyan, Galassi 2015). What is important here is how even Perseus's demigod status is insufficient in slaying Medusa. Consequently, he was transformed as a super warrior via gifts bestowed on him by the Olympians. From Hades he received the helmet of invisibility (making Perseus undetected from Medusa and her gorgon sisters), from Hermes he was given winged sandals to enable him to fly swiftly to and from Medusa's cave. Athena presented him with a reflecting shield, while Zeus presented him with a sickle shaped sword (ἄρπη – *hárpe*) made of adamantine. For the Greeks adamantine referred to an

extremely hard and unbreakable substance. In Virgil's Aeneid [book VI l. 548ff (6.548–560)] the gates of Tartarus which imprisoned the Titans were composed of adamantine (Virgil 2006).

The Greek myths were amongst the first to discuss superior kinds of weapons in order to transform mortals with godly powers. In modern-day high-tech warfare the American Stealth bomber aptly combines the elements of the Hermes winged sandals (πτερόεντα πέδιλα – *pteróenta pédila*), Hades helmet of invisibility and Zeus's adamantine sword. As its name suggests, the Stealth Bomber is undetectable to radar and anti-aircraft defences, capable of supersonic speed and tremendous destruction capacity. While the present-day weaponry likely has little to do with the Ancient Greek myth in question, it is relevant to weigh the importance of such an idea being developed in a pre-industrial society.

ACHILLES: THE ULTIMATE SOLDIER

Achilles was son of the sea nymph Thetis and the mortal Peleus. He is the central figure of the Iliad, formidable and effective, unalloyed by impending death (Armocida *et al.* 2021). Achilles epitomises the transhuman – superior in bodily speed and strength, overpowering his opponents and emboldening the Hellenes. When unleashed Achilles's anger is comparable to the Erinyes (furies). As a neonate Thetis took Achilles to the underworld and dipped him into the river Styx, which had magical powers. His body then became impervious to injury or death. However, only his ankle by which his mother held him remained vulnerable (Armocida *et al.* 2021). In another version, Thetis had burned the mortal elements of Achilles' body by night and anointed it in ambrosia (nectar of the gods) by day, making him immortal (Apollonius of Rhodes 2008).

The body of Achilles was further enhanced by being bestowed by Thetis with the wings of Arce (a wedding gift of Zeus), giving him unusual speed. Additionally, Thetis gave her son armour and sword, and immortal horses Balius and Xanthus, all wedding gifts from Hephaestus and Poseidon consecutively. Achilles also possessed a divine shield which had been forged by Haphaestus, the blacksmith of the Olympians. The "shield of Achilles" which had been forged during the Trojan War after Achilles' armour had been stolen by Hector, is described in the Iliad (XVIII.478–608) as being large, circular and heavy, consisting of 8 concentric circles depicting the cosmos and scenes of social and animal life.

During his short and eventful life Achilles killed many warriors, the greatest being the Trojan prince Hector. However, as foretold by his mother, Achilles was killed in the Trojan war by an arrow from Paris, guided by the god Apollo.

Achilles' indomitable combat prowess finds its modern-day homologue in the development of military technologies in the United States in order to enhance soldier performance. The United States Military Department has for several years been designing and constructing various human augmentation technologies. These technologies are classified according to three areas;

1. Human augmentation technologies: instruments based on AI, virtual reality and neurochemical agents for improving human senses and capabilities.
2. Augmented action: use of robotic exoskeletons and human operated machines for remote tracking and sensing.
3. Augmented cognition: use of technologies and nootropic and supplemental interventions for augmenting cognitive abilities in the war theatre.

Currently, the United States is in the process of advancing a lightweight armour exoskeleton from various materials. In the future such military exoskeletons may be fitted with multiple biotechnological interfaces/virtual display monitoring systems and robotics that will rely on verbal commands and gestures, and possibly telepathic signals (Zimet *et al.* 2003, U.S. Army Natick Soldier RD&E Center 2009).

The Defence Advanced Research Projects Agency (DARPA) is further developing other enhancement technologies incorporating brain-computer-interface technology (BCIT). For instance, three special types of helmets/headsets are under construction for the combat theatre. The first is a helmet which incorporates EEG sensors for monitoring stress and cognitive workload in military pilots (Mola 2017, Binnendijk *et al.* 2020). A second type of helmet currently being developed is titled, "Silent Talk" whereby soldiers on the battlefield may communicate via thought alone – EEG signals send thought based language (Kotchikov *et al.* 2010, Henneberg, Saniotis 2016). It has been suggested that "Silent Talk" is the latest technology that can be used by combatants and continues from age old non-verbal communication systems such as drumming, use of mirrors, smoke and pigeons (Henneberg, Saniotis 2016). A third type of helmet is the Integrated Visual Augmentation System (IVAS) has been in the developing process since 2018 via a collaboration

between the US Department of Defence and Microsoft. The headset incorporates sophisticated artificial intelligence and virtual reality capabilities such as 3D topographical maps, night vision and thermal sensors and holographic imagery for improving movement and tracking in a war theatre (Burt 2020). In the United Kingdom, the Defence and Security Accelerator (DASA) scheme is working on the 'Generation-after-next Wearable Technologies' project for creating devices which can recognise, detect and measure molecular biomarkers (i.e. metabolites, anti-bodies, enzymes and smaller particles) in various bodily fluids (Burt 2020). This technology would entail the wearing of artificial skin with implantable sensing devices. Given the increasing scientific/medical resources and funding in military based human augmentation in many countries, future soldiers will most probably be physically faster with quicker reaction time due to biotechnological endowments, making them worthy heirs of Achilles.

HERACLES AS IDEAL OF THE PHYSICAL STRENGTH AND HELLENIC BODY TRAINING

The ancient Greeks prized physical prowess since they believed that it reflected excellence (ἀρετή – areté). While a physically strong body was considered as the zenith of human aesthetics, an athlete lacking *areté* was considered in Platonic philosophy as one always lacking. This is why for the Greeks, physical training tended to be coupled with study of the literature and philosophy. The conjoint development of the body and mind embedded the Greek ideal of *areté*. This union between body and mind is exemplified in the Greek hero Heracles, son of Zeus, and strongest of mortals. He successfully completed twelve perilous labours which required tremendous mental and physical resources. Having realised that the skin of the Nemean lion was impervious to any object, Heracles figured that by blocking one of the two entrances of the cave where the Nemean lion dwelt, he could strangle it in the cave's darkness. Heracles' cognitive abilities were also depicted by his skill in archery and the flute that were taught to him by Eurytas and Linus (both sons of Apollo) consecutively (Evslin 1966).

The ancient Greeks developed the Olympic Games which had showcased the finest athletes among the Hellenic city states. Greek athletes developed various weight training methods, using body weight exercises, dumb bells made of rock, or carrying animals, to increase strength and muscle mass. Upon reaching 14

years of age Athenian boys attended gymnasia where they learnt wrestling, running, javelin, discus and other exercises. Their curricula also included academics (Ilic, Mijatovic 2006).

Both Plato and Aristotle wrote on the benefits of physical exercise in building a strong, disciplined and healthy body, essential for close combat (Plato 1971, Aristotle 1984).

The Heracleian ideal of the powerful warrior is embodied by the famed Greek runner Pheidippides (or Philippides) (530–490 BCE) who is reported to have run approximately 150 miles (241 kilometres) in 2 days (also running another 26 miles from Marathon to Sparta to alert the Athenians of the Persian defeat) before dying, probably from exhaustion.

The Spartans practiced their own form of augmentation, firstly via state sponsored eugenics. Neonates were inspected for any observable deformities or flaws. Those which were found to be 'weak' or having any kind of abnormality were left at Mount Taygetus to die. Secondly, from the age of seven, Spartan boys underwent *ἀγωγή* *agoge* – where they were placed in military style barracks and underwent intense military training and sports. This training which included various privations intended to physically and mentally toughen young males. Military training was complimented by learning of poetry, music and academic subjects (Cartledge 2004, Matyszak 2017). Clearly, both Spartan and Athenian training regimes emulated Heracles' training regime.

In the 21st century the Heracleian ideal of body enhancement is characterised in professional bodybuilding and modern athletics. Concomitantly, during this time we have witnessed an increase in performance enhancement substances such as anabolic steroids, human growth factor, erythropoietin and others. These have become widely available to millions of lay people. While these substances can lead to hyper-muscularity and increased performance they are precursors to possible nano-technologically based enhancement drugs (NTBED). In the future, (NTBED) will probably be much faster in promoting musculoskeletal hypertrophy and hyperplasia. Additionally, nano-technological based respiocytes (synthetic red blood cell) could be developed which would be injected into the body. It has been speculated that a respiocyte would be approximately 200 times more effective than an ordinary erythrocyte (Saniotis 2012). This would allow the recipient to run at full speed for several minutes or dive underwater for over an hour without oxygen. However, optimal enhancement performance would

need an injected dose of nanobots of $>10^{13}$ (Respiocytes 2019). It should be highlighted that the ancient notion of physical health and strength was achieved through exercise rather than owing to the administration of anabolic steroids or medicaments. Hence, another possible comparative scenario to consider, in light of the Heracleian myth, is the modern-day creation of robots with what could be defined "superhuman" characteristics.

MNEMOSYNE: PRECURSOR TO COSMETIC NEUROLOGY

Mnemosyne was a daughter of Gaea (Earth) and Uranus (Sky). She belonged to the second generation of twelve elemental beings known as the Titans from whom the Greek Olympians originated. Mnemosyne was associated with memory and was the mother of the nine Muses. Mnemosyne presided over Lethe (forgetfulness), a major river in the underworld where human souls were required to drink from in order to forget their former lives. According to the mystical school of Orphism, the human soul was immortal and underwent many incarnations in order to merge with the divine (Banwari 2015). The Pythagoreans also believed in transmigration of human souls, which they referred to as metempsychosis. Mnemosyne is also associated with mnemonic retrieval, renewal, and reasoning (Van Veldhuizen 2015).

Mnemosyne also refers to a river/lake in the underworld. Whoever drank of its water could recall their past and to access divine knowledge. In Pausanias's account, the water of Mnemosyne united mortal and divine aspects in humans so that they could attain perfection (Pausanias 1984).

From a neuroscientific viewpoint, the memory retrieving quality of the water of Mnemosyne gives us one of the first historic accounts of a cognitive brain enhancer. The Greeks had a long oral tradition predating and, to a certain extent, also including the Homeric period. Only with the advent of writing did this tradition wane, but it was never annulled. Greeks were expected to recite by memory the Iliad and Odyssey. Mnemonic skills played a central part in Greek rhetoric and informed political discourse. Orators such as Pericles were lauded for their rhetoric skills. According to tradition the poet Simonides of Ceos (circa 556–468 B.C.E.) developed a technique for remembering objects or places by forming mental maps and associating them to the visual images in the phenomenal world (Skoyles,

Sagan 2002, Kosslyn 1988). This mnemonic technique was later on called the *method of loci* (Loftus 1976, Williams 1986). Originally used to remember points during political debates, the method of loci influenced western intellectualism up until the European Renaissance (Spence 1986).

In the last generation there have been marked improvements in understanding neuro-cognitive processes. This has been mainly due to molecular biology and brain imaging which offer a window into human experience. Currently, scientists are engaged in creating various brain enhancement technologies (Henneberg, Saniotis 2016). These include the use of neural prosthetic devices, genetic engineering, and cosmetic neurology. Due to the wide scope of this area, I will focus here on cosmetic neurology. In the 1970's Corneliu Guirgea coined the name "nootropic" for any substance which had the ability to enhance cognitive abilities.

Cosmetic neurology refers to the use of pharmaceutical substances by healthy individuals in order to enhance cognitive abilities. Cosmetic neurology is presently being used throughout the developed world for non-therapeutic reasons. In a 2008 study approximately 20% of respondents were taking stimulants like modafinil, beta-blockers and methylphenidate (Stix 2009). Modafinil has been widely used by approximately 18% of American college students (Babcock, Byrne 2000), while methylphenidate is being widely prescribed for adolescents with ADHD. While the aforementioned are touted as "smart drugs" they have not been shown to improve intelligence. Rather they induce alertness, vigilance and ability to concentrate. Various neuropeptides are also being prescribed such as vasopressin the "cuddle hormone" for fostering trust (Walker, Toufexis 2003), and mood modulators (e.g. anti-depressants) for treating depressive and anxiety disorders. The global rise in depression (a five-fold increase in the last generation) has driven the idea that drugs can enhance mood (Pieters, Snelders 2009).

In the future, nano-technological drugs in concert with neuro-prosthetics may tinker neural transmissions to enhance memory recall and response time. For example, a novel neuroprosthetic called ELI (Endomyrrchorizae like interface) is being developed with the aim in treating people with neuro-degenerative disorders (Saniotis *et al.* 2018). Since ELI will be a nanobot to neuron symbiosis it may usher a new era of cognitive enhancements which will be befitting of Mnemosyne.

ANCIENT SHAPESHIFTERS AS PRECURSORS FOR TRANSGENIC TECHNOLOGIES

Many Greek myths focus on human/animal relationships, theriomorphs and shapeshifting gods which is beyond the scope of this analysis. This major mythological trope probably reflects the shamanic origins of ancient Greek religion. Ancient Greek interest in the natural world was a recognition of its power and indeterminacy. Many Olympians possessed both human and animal forms, while divine and semi-divine beings such as Pan, Nike, Medusa, Mermaids, Sirens, Harpies, Hypnos and Pegasus were distinct hybrids. Other immortals such as the centaur Chiron acted as healers and teachers to humans, emulating the role of spirit animal guides in many indigenous societies. The monstrous progeny of Typhon and Echidna (Chimera, Sphinx) are notable. The Sphinx is mentioned in Sophocles play *Oedipus Rex*, where it plays a lethal riddle maker. The Chimera, which was killed by Bellerophon, became a leitmotif of unnatural animal forms (Karpowicz *et al.* 2005).

In science a chimera is a genetically composite (transgenic) animal, an artefact of recombinant DNA genetic sequencing. Transgenic animals have been created in laboratories since the 1970s and serve various medical purposes (Saniotis 2007a, Saniotis 2007b).

'Pharm' animals, for instance, have been used for organ harvesting, and replacement of collagen tubes, heart valves and cerebrospinal shunts (Glenn 2013). Milk from transgenic ungulate animals is now being used for anti-coagulant and growth hormone factors. Moreover, scientists have confirmed the feasibility of making "human proinsulin milk" of transgenic animals widely available in response to pandemic levels of type 2 diabetes (Qian *et al.* 2014).

Some scientists have been arguing for the future development of transgenic humans for enhancing the human species. It is argued that human/animal recombinant DNA may combat against genetic disorders, heart disease dementia and osteoporosis. Bioethicists like Oxford University's Julian Savulescu note that transgenic humans with tortoise DNA may increase longevity or ameliorate aging, while humans with owl DNA may have enhanced night vision which would decrease automobile accidents, improve night-time emergency services and pilot navigation (Savulescu 2003). For Savulescu, transgenic humans will be a defining evolutionary step for *Homo*.

Along this evolutionary line, some authors have hypothesised that transgenic humans will be able to

better adapt to future climate change in the next centuries. As a consequence of their enhanced senses, transgenic humans may also be able to instigate corrective environmental protection measures much earlier. As Saniotis points out: "Having enhanced sensory perceptions may actually promote more ecologically sound attitudes and practices" (Saniotis 2007b).

DAEDALUS, ICARUS AND THE BIRTH OF AUTOMATA

In Greek mythology Daedalus was a master craftsman who had created the Minoan labyrinth in order to contain the Minotaur — a human/bull hybrid. In order to safeguard the secret of the labyrinth, King Minos of Crete imprisoned Daedalus and his son Icarus. During his imprisonment Daedalus created two pairs of wings, for himself and his son. He glued bird's feathers together using wax. Before making their escape Daedalus instructed Icarus how to fly and warned him against flying too high lest the sun would melt the wax. Upon escaping their prison, Daedalus flew successfully to safety, whereas Icarus disregarded his father's caution and approached the sun. Consequently, the wax of Icarus's wings melted, and he fell to his death.

From a technological viewpoint, the myth of Daedalus is significant as it is one of the first myths which discusses the possibility of flight. Like other cultures, the Greeks were interested in birds and flight. Various divine beings and creatures in Greek mythology are depicted with wings. These include the Hermes, Nike, Pegasus, Gorgons, Harpies, Eros and Morpheus. For the Greeks, wings had multiple symbolism – lightness, freedom, swiftness, and transcendence of the material world. It also symbolised for the Greeks the notion of flight, a dream only made true in the 19th century AD.

However, Greek mimicry of birds was not restricted to the mythological realm. During the 6th and 5th centuries Greeks synthesised various mathematical ideas — precursors for gas *mechanics*, hydrostatics, and aerodynamics during the classical period (5th to 4th centuries BCE). This set the scene for the Pythagorean philosopher/mathematician Achytas of Tarentum (428–347BC) who is credited to have developed a self-propelled mechanised bird. The bird had a hollow cylindrical body with wings and was probably propelled by pressured steam made by an attached boiling device.

Achytas' flying bird is the first recorded experimental automaton created, predating Giovanni da Fontana's 1420 illustration of a rocket model avian by almost two millennia (Hallion 2003). Surprisingly, Achytas flying bird did not generate further scientific interest which may have led to the development of human flight at a much earlier stage. In any case, Achytas' automaton is indicative of Greek developments in aerodynamics and mechanical mathematics that were millennia ahead of their time.

The Homeric tales contain passages relating to various *autómata* (αὐτόματα) which had been created by Haphaestus, blacksmith of the Olympians. The god fashioned flying metallic tripods (*Iliad*, book VII). He also created a room of bellows which could operate automatically to his commands to melt metal – a precursor to industrial production line (Kalligeropoulos, Vasileiadou 2008).

Additionally, Homer gives us a vision of robotics, for Haphaestus created two "living maids" made of gold and endowed with speech, possessing strength and intelligence (Book XVIII, 410–420).

In the myth of the Argonauts the god Haphaestus constructed a bronze android called Talos to protect King Minos's realm. The sorceress Medea allured Talos and then removed a rivet from Talos's ankle, thereby draining the life-giving fluid from his body (Mayor 2018).

In the *Odyssey*, Phaeacian ships were absent of pilots and oars and operated according to the commands of humans (Book VIII, 555–563). Allusions to various automata in *The Iliad* (Homer 1951), and *The Odyssey* (Homer 1919), are astounding and informed future Greeks in speculating and building of automata (Kalligeropoulos, Vasileiadou 2008). Influenced by the automata of Hephaestus and Daedalus, Aristotle states that automatic tools could be programmed to operate according to human commands (*Politics*, A2, 4) (Aristotle 1944).

During the Hellenistic period, Heron of Alexandria constructed many types of automata based on the naturalistic principles of the pre-Socratics. His inventions included automatic temple doors, mobile theatre, sound producing and self-bleeding statues, and an altar from which flowed milk and wine (Hopkins 1976).

Since the Industrial Revolution of the mid 19th century the human world has been increasingly dependent on automata. The recent development of the internet has enabled billions of minds to be connected in a global noosphere. Androids in the form of mobile phones and tablets have become central to modern human life. Japanese scientists have developed

a prototype female humanlike android named "Repliee R1" whose appearance matches a five-year-old girl. Repliee R1 embodies various motor actuators and sensory sensors, free joints and nine degrees of freedom (DOF) in its neck mouth and eyes (Minato *et al.* 2004).

Furthermore, the increasing use and effectiveness of military robots is consistent with the future objective of substantially reducing human military personnel in the war theatre and supplanting them with robots (Leonov *et al.* 2019). This has been evident in the widespread use of different types military drones by the Russian army in the continuing Russo-Ukrainian war. It is now assumed that over time robotic systems will supplant human combatants (Marcinek, Han 2023). Although, many military robots are currently dependent on humans in providing them with instructions (Sapaty 2015), the next decade will witness improved integration between robotic systems and artificial intelligence with the ultimate aim in achieving fully automated robots (Sapaty 2015, Marcinek, Han 2023). According to Sapaty (2015), military robotics will be enhanced via implementing "Spatial Grasp Ideology and Technology" (SGT) – that can be distributed in robotic systems by control modules that are universally inserted in vital points (i.e. electronic devices, sensors, humans); these points operate in a gestaltic manner in facilitating and interpreting operational settings based on "Spatial Grasp Language" (SGL). This language would enable to achieve the transmission of seamless directive initiatives and decision making capabilities by individual robots or robotic collectives Sapaty (2014, 2015). The probable development of such machines will be conterminous with the Iliadic vision of autonomous and intelligent androids of divine design.

BECOMING IMMORTAL

Generally speaking, Greeks feared getting old as it was associated with bodily decline (Richardson 1933). Although Greek social institutions accorded older people with great respect, Greeks revered the "youthful body" as is depicted in Greek art (Batrinos 2008). The Greek ideal of the body exemplified *areté* — young, strong, proportional and disciplined. Young athletes trained naked in gymnasia and in athletic competitions in order to parade their strong bodies. Consequently, many Greek myths interweave themes of youthfulness and absence of aging. The Titans, Olympians and many other supernatural creatures were considered to be

immortal. Immortality was a distinguishing factor between the immortals and humans. Immortality was sometimes conferred by the gods to mortals such as Heracles. While the gods were immortal they drank of a divine nectar called ambrosia which nourished their immortality. Ambrosia was poured into their cups by the Goddess Hebe who was forever young (Popoff 1921). On this theme, Ganymede, whom the Iliad writes as being the fairest of all mortals was taken up to Olympus by Zeus, conferred with youthful immortality, and also became a divine cupbearer (Homer 1951).

Another popular myth concerns golden apples located in the garden of Hesperides, located on an island at the edge of the world which was guarded by the hundred headed monster Ladon and the daughters of the Titan Atlas. Whoever ate of these golden apples was made immortal.

The myth of Tithonius melds themes of aging and immortality. Tithonius is a lover of Eos, goddess of dawn. She pleads to Zeus to make Tithonius immortal which Zeus agrees to do. However, she forgets to inform Zeus to make Tithonius immortally young. Consequently, he descends into a feeble and stricken old age. The myth aptly encapsulates the ancient Greek attitude towards aging and a desire to be forever young (Evelyn-White 1920).

Like the Greeks we live in a world fixated with youth, and equally disparaging about aging. From the 1960's scientists have been searching for ways for extending life. In the 21st century we have entered an anti-aging revolution which proffers different ways to maintain youthfulness and offset aging. Molecular biology is slowly understanding many genes which are responsible for aging.

Several theories of aging have been developed, one which posits that aging is the accumulation of cellular damage over time so that regenerative processes are slowed down or annulled (Kirkwood 2008). Various factors contribute to cellular aging, such as chromatin instability, mitochondrial issues, and reactive oxygen species. Yang Li and colleagues propose that cellular aging can be seen as a fate-determination process, where cells either age towards silencing loss and nucleolar decline or heme depletion and mitochondrial decline. They created a model of the aging process and engineered a new long-lived state by manipulating interactions between chromatin silencing and mitochondrial pathways. This new state, marked by enhanced silencing and nucleolar function, leads to increased cell longevity through genetic modifications of certain pathway-related genes (Jiang *et al.* 2020).

Alternatively, the integration of biomaterials into the delivery system for CRISPR/Cas9 technology not only promises a transformative impact on gene therapy for infectious diseases but also presents a potential avenue for enhancing cellular longevity. These biomaterials, acting as protective agents for CRISPR/Cas9 components, have the capacity to extend the lifespan and effectiveness of the gene-editing capabilities. The synergy between biomaterials and CRISPR/Cas9 could not only address genetic illnesses and infectious diseases but also contribute to the pursuit of a long-lived state at the cellular level, thereby promoting overall health and quality of life (Dubey, Mostafavi 2023).

Another serious contender in life extension is caloric restriction (CR). Several studies have shown that CR in various animal species has significantly extended longevity, increased youthful vigour and prevented age related diseases (Yu *et al.* 2015, Houthoofd *et al.* 2007, Mercken *et al.* 2012). Although CR seems to have positive results on non-human species, it is unclear whether such results can be emulated in humans. It has been proposed that in order for humans to attain similar benefits of CR that they would need to severely restrict their calorie intake – a proposition which is unreasonable to most humans. Consequently, scientists are attempting to create an anti-aging pill, a modern version of the mythological ambrosia/golden apples which can mimic life extension benefits of CR without the discomfort. One such candidate is rapamycin – a protein compound and immunosuppressant. In the 2000s rapamycin was successful in increasing lifespan in mice (Harrison *et al.* 2009). Further studies on other animal species have verified the life extension properties of rapamycin (Leontieva *et al.* 2014, Anisimov *et al.* 2010, Anisimov *et al.* 2011).

Paradoxically, science has yet to understand how rapamycin works. A major reason for this could be due to it being involved in multiple biochemical processes. What is known is that the protein kinase TOR which is involved in cell transcription, proliferation and apoptosis can be inhibited with rapamycin, albeit, with side effects (i.e. insulin resistance). A significant finding. Possibly in the near future rapamycin's effect on TOR could be tweaked to prevent unwanted side effects (Connor 2018).

Various other life extension technologies have been used or are in a theoretical stage. While cryotherapy applications began in mid-19th century for treating cancer (Theodorescu 2004), cryogenic technologies have been widely used in the medical field for several

decades as they are relatively safe and cheap (Jain *et al.* 2021). Current cryogenic technologies include cryopreservation (long term storage of various types of human tissue) (Jain *et al.* 2021), which is routinely used in in vitro fertilisation for freezing oocytes, spermatozoa and embryos (Doyle 2018); cryosurgery for treating localised lesions (Cooper 2001) and cryogenics. The latter is a potential life extension technique where a human body or head is frozen (invariably a patient who has died from a terminal disease) at an extremely low temperature and then storing it in a special preservation facility for the future with the hope that the deceased will be restored to life by an innovative technology (Romain 2010, Jain *et al.* 2021). While cryonic preservation techniques are able to radically reduce the decaying process human cells, the promise of cryonics in restoring human life or providing immortality has yet to be achieved (Doyle 2018, Akpan 2022).

Nanotechnological applications are currently being designed in several areas (i.e. cosmetic neurology, neuroprosthetics, drug delivery, enhanced physical performance, gene therapy, dermatology, diagnostics and cell and tissue repair and regeneration; Saniotis 2012, Saniotis *et al.* 2018, 2020, Naqvi *et al.* 2020, Gao *et al.* 2013, Bheemidi *et al.* 2011, Aithal, Aithal 2018, Napagoda *et al.* 2023, Bilal *et al.* 2019, Gupta *et al.* 2020). It has been suggested that future nanobots will have the ability to regenerate or replicate damaged organs, leading to a restoration of the human body (Teoh 2015, Jain *et al.* 2021). Thus, human bodies could be continually repaired and restored at molecular and cellular levels indefinitely via the application of rejuvenating nanoparticles. Despite theoretical advances in nanotechnology there are potential risks using this technology such as cytotoxicity and unregulated cellular processes. Notwithstanding potential risk factors, it is expected that nanobased life enhancement and life rejuvenating systems will be feasible by the next generation.

CONCLUSION

The paper has speculated a correlation between Greek mythological and socio-historic aspects of body and cognitive enhancement in relation to current/future technological developments. Greek mythology provides an extraordinary range of ideas alluding to body and cognitive enhancement technologies. It is no coincidence that the Greeks, revered the human body

for its apparent symmetry and beauty. As we have shown, the establishment of athletic games, gymnasia and public theatre were important ways in which mythic ideas of gods and heroes endowed with supernatural powers were embodied in Greek cultural practice. During the Greek classical period (550–320 BCE) the first automata were created. Philosophers such as Aristotle speculated on the possibility of automated machines to perform human labour. We are reminded of the thinker Gregory Bateson who suggests that stories infuse mental and biological systems (Bateson 2002). Myths embody unities. Likewise, the Greek myths fuse mental and biological themes that may influence modern developments in whose science is set on human enhancement. The paper examined seven themes of Greek myths in relation to various types of augmentation. For the Greeks, the mythical characters of Perseus, Achilles and Heracles embodied various physical and mental characteristics that were considered the pinnacle of *areté*. Arguably, these three characters give us insight regarding what can be achieved when the powers of the body and mind are unified towards accomplishing a specific goal. On this note, the unleashing of Achilles' unrestrained fury – which the Greeks referred to as *ménos* (μῆνος) has been argued as being the act of the gods weaponizing humans with unusual power beyond their physical abilities (Saniotis 2020). The fact that *ménos* derives from the 'supernatural' other can be considered as an endowed type of augmentation. The unrestrained blood lust asserted by Achilles *viaménos*, is synonymous with the non-discriminatory and colossal power of modern weapons of mass destruction.

The paper also gave an overview of ancient Greek themes alluding to cognitive enhancement, automata and life extension. Currently, these themes are receiving unprecedented amounts of scientific research and investment. Improvements in artificial intelligence combined with virtual reality technology and genetic engineering may enable the development of future bio-enhancements for optimising human health. However, to what extent will our current notions of medicine and the human body be transformed by the advent of novel bio-technologies? Saniotis and Henneberg (2011) have argued that since the second half of the 20th century western biomedicine has been shifting its direction from therapy to augmentation. Since the Second Epidemiological Transition (Industrial Revolution of the mid 19th century) there has been a drastic reduction in global premature death and increase in longevity due to improvements in public health sanitation, nutrition

and medical interventions. Many medical procedures are now more focussed on developing techniques for reconstructing a healthy individual's appearance instead of "saving lives" (Saniotis, Henneberg 2011). The growth of assisted reproductive technology (ART), albeit, catering for couples who cannot produce children via coitus is expensive (Saniotis, Henneberg 2021). Consequently, ART tends to favour more affluent couples (Hanevik *et al.* 2016). Second, in-vitro fertilisation (IVF) is less accessible in low-income countries (Ombelet *et al.* 2008).

The phenomenon of genetic load in extant *homo* should also be included in this discussion since its increase has been due relaxed natural selection, thereby, resulting in loss of fitness to various diseases (Stephan, Henneberg 2001). While increasing susceptibility to colour blindness, auto-immune diseases and cancers (You, Henneberg 2017), may be a result of continuing genetic load, medicine seems to be determined in developing bio-technological interventions for removing deleterious genes which can make us healthier and longer lived. Whether future medicine will succeed in its mission in providing viable augmentation interventions.

The Greek idea of augmentation differed from modern science as it derived from their mythology. As such, the Greeks always retold their caveat that "being better" or "superior" needed to be tempered so that it did not herald hubris. For the Greeks, the disciplined body was a manifestation of the unison of mind and body; via its performance such a body manifested the beauty of form and symmetry. To this end, Socrates famously stated: "No man has the right to be an amateur in the matter of physical training. It is a shame for a man to grow old without seeing the beauty and strength of which his body is capable." This is in stark contrast to the claims of transhumanists who envision a future world of post-humans who are products of genetic engineering – individuals who have transcended the limits of human biology. Even so, the Greek myths provide us a scope for imagining the body in accordance with the ideal of *areté*.

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