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Gene-Centered Evolutionary Standpoints: Extrication of the Role of Selfish Genes in Contemporary Genetics and Beyond

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Abstract

Richard Dawkins first introduced the Selfish Gene Theory in 1976, which contends that genes, not individuals, constitute the fundamental building block of evolution. This theory has been influential in understanding eukaryotic genome evolution, but it has also been criticized for being misleading. The theory has been applied in various fields, including evolutionary games and the study of memes. Selfish genes are correlated with increased promiscuity in eukaryotes, and they have been viewed as a potent evolutionary force. However, it is important to note that "selfish genes" do not necessarily connote selfish and egocentric people. This theory has been further developed and refined over the years, leading to a better understanding of the role of genes in evolution. The purpose of this study is to adapt the paradigm shift brought about by the theory of the selfish gene to the field of algorithmic optimization and to create a new method for using evolutionary algorithms.

Keywords*:* Gene, Selfish gene theory, Neo-Darwinism, Altruism, gene memes, CRISPR

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1. INTRODUCTION

Richard Dawkins is a British evolutionary biologist, author, and science communicator who is best known for his contributions to the field of evolutionary biology. In 1976, Dawkins published his book "The Selfish Gene," which introduced the concept of the selfish gene theory. The theory suggests that genes are the fundamental unit of natural selection and that they are the driving force behind the evolution of species [1].

1.1. Selfish Gene Theory:

The selfish gene theory proposes that "Genes are self-centered in that they solely care about their survival and reproduction" According to Richard Dawkins Genes are immortal [2]. "We are survival machines — self-serving robot vehicles engineered to preserve the selfish molecules known as genes [3]. According to Dawkins, genes are the basic unit of evolution, and they are responsible for the development of traits that are beneficial to their survival and replication. This theory has been influential in understanding eukaryotic genome evolution, but it has also been criticized for being misleading. The concept of gene selection is one of the major components of the selfish gene theory [4].

Gene selection is the mechanism through which genes that are advantageous to their survival and replication are more likely to be transmitted to subsequent generations. A crucial aspect of the selfish gene hypothesis is the concept of the expanded phenotype[5]. The extended phenotype refers to the idea that genes can influence not only an organism's physical traits but also its behavior and environment. For example, a bird's nest can be seen as an extension of its genes, as it is a product of the bird's genetic programming [6].

1.2. Selfish Gene theory and Zero-sum games:

According to Richard Dawkins' selfish gene theory, genes are the basic unit of natural selection and act in their own best interests to maintain their survival and replication. This theory has been applied to various aspects of biology, including the concept of zero-sum games [7]. Zero-sum games are situations where one person's gain is another person's loss, and the total sum of gains and losses is zero, Dawkins' selfish gene theory is based on the idea of the "struggle for existence" in nature, where the survival of the fittest is celebrated. This concept can be applied to zero-sum games, where individuals compete for limited resources, and one person's gain comes at the expense of another's loss. [5]

According to the selfish gene idea, individuals would act selfishly to guarantee their survival and reproduction, even if it meant depriving others of resources. However, more recent empirical data has added to the conceptual underpinnings of prosocial biological effects and emotions, particularly in response to notions of "selfish genes." [7]. This suggests that while genes may act in their self-interest, individuals may also exhibit prosocial behavior and cooperate with others to achieve mutual benefits. Radzvilavicius et al (2021) argue that although theories about selfish genes have provided invaluable insight into the evolution of eukaryotic genomes, they can also be deceptive. The author suggests that a unified theory based on mutational variance redistribution may provide a more accurate understanding of uniparental inheritance [8].

1.3. Selfish Genetic Memes:

Memes were first introduced by Richard Dawkins in 1976 in his book "The Selfish Gene." "Cultural units of information that spread from person to person through imitation" is how Dawkins described memes. According to Dawkins, any organism possessing gene-like traits like replication, variety, and competition is a "selfish replicator" that can spread through populations by a process similar to natural selection.[9]. The concept of memes has been widely used in the study of cultural evolution and has recently been applied to the study of biological evolution. The relationship between biological memes and the selfish gene theory is an interesting area of research. The selfish gene theory, which was also put forth by Dawkins, contends that genes serve as the main basis for evolutionary selection. According to the hypothesis, genes are self-centered and only concerned with their survival and procreation. The concept of biological memes fits well with the selfish gene theory as it suggests that cultural units of information can also be selfish and compete for survival and reproduction. Recent empirical evidence has shown that prosocial biological effects and emotions can be related to the spread of memes [9].

In particular, the conceptual underpinnings of prosocial biological effects and emotions have been developed in response to "selfish gene" conceptualizations. This suggests that the spread of memes can be influenced by biological factors, which supports the idea that memes can be considered as biological units of information.

2. Selfish gene theory and Neo-Darwinism:

Neo-Darwinism, according to Alfred Russel Wallace (1823–1913), is any integration of Mendelian genetics and Charles Darwin's theory of evolution by natural selection. Neo-Darwinism is a synthesis of Charles Darwin's theory of evolution through natural selection and Gregor Mendel's genetics theory. It suggests that evolution occurs through the gradual accumulation of small genetic changes, which are subject to natural selection. The selfish gene theory is an extension of Neo-Darwinism, which emphasizes the role of genes in evolution. It suggests that genes are the primary unit of selection, and they act selfishly to ensure their survival and replication. [10]

The relationship between the selfish gene theory and neo-Darwinism has been a subject of debate.[10] contends that the vocal human Darwinism of the previous 25 years—including human sociobiology and evolutionary psychology—directly refutes the selfish gene theory on which it is purportedly founded.[11] Suggests that selfish gene thinking is now commonly referred to as the gene's-eye view of evolution. [12]alludes to Dawkins, who said in The Selfish Gene that because of Darwin (and the neo-Darwinist synthesis of genetics and evolutionary theory), "we no longer have to recourse to superstition when faced with the deep problems: Is there an association to life?". This suggests that the selfish gene theory is an extension of neo-Darwinism and builds on its conceptual foundations.

3. Selfish Gene Elements:

On every occasion we're analyzing egocentric genes there are a few selfish genetic elements (SGEs) that should be in our issues. Genomes are defenseless against SGEs, which enhance their transmission in comparison to the rest of a person's genome but are indifferent to or harmful to the person as a whole. SGEs and various genetic elements in the genome, therefore, come into contact genetically. There may be mounting proof that SGEs and the associated genetic conflict serve as an essential driving force for evolution and innovation. [13]

If external conditions remain much the same as those that affected the humans who raised those offspring, organisms that have survived long enough to reproduce will at the very least endow their progeny with traits that increase their chances of surviving. However, behavior occasionally and occasionally appears to be inconsistent with this objective. That is especially consistent with behavior that prefers danger. Altruistic activity seems at odds with the altruist's need to survive because it costs the aided organism and benefits the organism being helped. Suicidal behavior also appears to be incompatible with survival on every level [14].

In the following content, the discussion on altruism and its relation with selfish gene theory is also mentioned for the readers to accurately understand the true meaning of life. Inside the following content material, the dialogue on altruism and its relation with the egocentric gene idea is likewise stated for the readers to appropriately understand the true means of existence. The selfish Gene theory is still argued fiercely by some evolutionary biologists because this principle handiest counts existence as an organic carrier for genes, this is just a little uncomfortable for scientists to accept as true that there's no different price or reason for lifestyles besides being a carrier. The issue also gets people irritated due to the fact Dawkins has by no means been a person to mince his words. The egocentric gene concept, which DARWIN describes as a cultural blob, is simply not evident. For Homo sapiens, achieving epic freedom isn't always a realistic goal. According to Darwin, earthly organisms are designed to interact with the complex ecosystems, of which we are a little part, continually. Inside the records of natural selection, we can see that the principal cause of natural selection is not to defend species or any network rather it secures a person's handiest to defend genes.

4. Rudiments OF SELFISH GENE ELEMENTS:

4.1. Segregation distorters

The majority of the self-serving genetic elements regulate the genetic transmission technique for their very own gain, and as a result, they manifest as being overrepresented in the gametes (Fig. 1). Segregation distortion is an umbrella word that encompasses all of these distortions, which can occur in a variety of ways. During meiosis, a few factors can be transmitted preferentially in egg cells as opposed to polar bodies, with the former being the only one that can be fertilized and passed on to the next generation. Some genes that can influence the likelihood of ending up inside the egg rather than the polar frame may have a transmission gain and increase in frequency in a population. [15]

Different ways that segregation distortion can appear are possible. This mechanism, which takes place during meiosis, is known as meiotic drive. When a male gamete develops, there are many different types of segregation distortion that can occur because spermatid mortality might vary at different stages of sperm maturation or spermiogenesis. The Segregation Distorter (SD) in Drosophila melanogaster is a well-studied example, and it consists of the nuclear envelope protein Ran-gap and the X-related repeat array known as Responder (Rsp). The SD allele of Ran-gap favors its transmission only when there is a Rsp sensitive allele on the homologous chromosome[15].

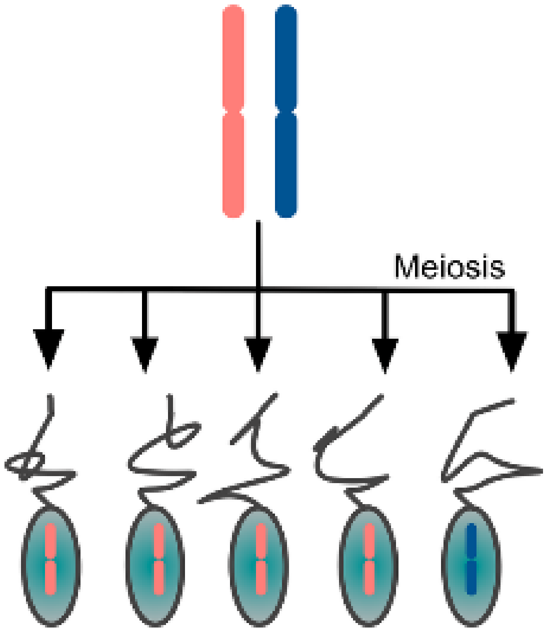

Figure 1. More than 50% of the gametes receive transmission from segregation distorters (seen below in red).

In a post-meiotic system, SD acts to kill RSP sperm (so it isn't always sternly meiotic force). This type of structure has intriguing rock-paper-scissors dynamics that oscillate between the SD-RSP, SD+-RSP, and SD+-RSP haplotypes[16]. Due to its inherent propensity for suicide, the SD-RSP haplotype is not always apparent. Segregation distortion can tilt the sex ratio while it affects the sex chromosomes. The Drosophila pseudoobscura SR device,

For instance, the X-chromosomal region is at the, and X / Y adult men produce the best daughters, but females go through regular meiosis with Mendelian genetic proportions of gametes [17, 18]. In addition to the fact that most of the situations wherein these systems were detected have the forced allele opposed utilizing another discriminating pressure, segregation distortion structures may push the popular allele to fixation. One example is the lethality of the mouse t-haplotype[19]. In addition, the intercourse ratio system in D. pseudoobscura has an effect on male fertility[18].

4.2. B chromosomes

B chromosomes are chromosomes that exist additionally to the typical (A) set but are not necessary forth the feasibility or fertility of the organism[20]. They accumulate and remain in the population because they may spread their transmission without the assistance of the A chromosomes (Fig. 2). Individuals of the same species frequently differ in the number of copies they contain.

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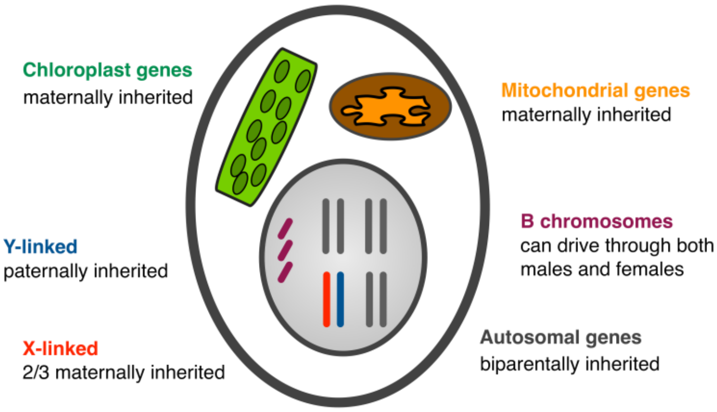

Figure 2. since not all genes are acquired in the same way, genetic interactions typically increase. Male cytoplasmic sterility (see 6.1) is one example. While B chromosomes can be advantageously transferred across both males and females, mitochondrial and chloroplast genes are often inherited from the mother. While mitochondrial and chloroplast genes are generally maternally inherited, B chromosomes can be preferentially transmitted through both males and females. https://doi.org/10.1371/journal.pgen.1007700.g005

B chromosomes were first discovered more than a century ago [21]. Their gene-deprived heterochromatin-opulent shape rendered them visible to basic cytogenetic techniques, despite being archetypically smaller than conventional chromosomes. B chromosomes are estimated to be present in 15% of all eukaryotic organisms after extensive research [22]. They appear to be primarily conjoint among eudicot plants, sporadic in mammals, and lacking in birds in general. They were the subject of Gunnar Stergren's seminal study "Parasitic nature of extra fragment chromosomes" from 1945, in which he argues that the parasitic characteristics of the Bs are what cause the variance in B chromosome abundance between and within species [23]. For the first time, genetic material was referred to be "parasitic" or "selfish" in this context. The number of B chromosomes is positively correlated with the size of the genome [24] and has also been linked to a decline in grasshopper egg production[25].

4.3. Green Beard

The name "green beard" came after the thought experiment performed by Bill Hamilton, and then further elaborated by R.Dawkins in his selfish gene theory. The Green-beard genes are known as those types of genes that can classify their replicas in other organisms and can make their carrier act cronyismically towards those species. In simple words, we can state that a green-beard gene can cause a phenotypic effect that allows the carrier of this gene to spot its copies in other organisms and causes that organism to comport itself differently towards other individuals depending on how much they possess the feature.

4.4. Green beards in the light of selfish gene:

According to Dawkins, a green-beard is habitually demarcated as a gene, or customary of meticulously related genes, that comprises three upshots:

1. A phenotypic marker is given to its carrier i.e. green beard.
2. The carriers of this gene can straightforwardly distinguish other organisms with the same marker.
3. The carrier then acts altruistically to the organism with the identical marker.
4. An organism with the green-beard allele particularly helps a fellow green-beard individual.

Any mutant alleles that create the boosting characteristic and want to supply the helping behavior will lead their carrier to have developed fitness and will, therefore, be selected as a result, according to a delinquent green-beard outcome [26]. It is anticipated that either the same gene or a group of closely related genes will effectively encode both the signaling and the altruistic feature to avoid this. As a result, it is expected that "green beards" will appear occasionally.

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4.5. Example of Green beard:

4.5.1. Yeast:

The term "green-beard situation" comes from yeast [27]. Flocculation is the growth of flocs of yeast flakes that help to protect them from chemical damage such as that caused by alcohol. A protein that is produced as a result of the gene FLO1 causes flocculation. The cost for cells that express this protein is that they divide more slowly than cells that do not. On the other hand, only cells that express FLO1 can stay inside the floc. The altruistic gene is passed on to the following generation even though some of these cells on the floc's outer side die. If exposed to severe chemicals, cells lacking the FLO1 gene cannot produce flocs and will perish. [27]

4.5.2. Types of green beards:

a. Facultative-helping

Includes the cell adhesion gene from the cooperative fruiting body-forming social amoeba Dictyostelium discoideum.

b. Obligate-helping

Includes the Agrobacterium tumefaciens plasmid Ti (tumor-inducing), responsible for the production of gall in plants.

c. Facultative-harming

It contains the Solenopsis invicta red fire ant's Gp-9 gene, which causes workers carrying the gene to kill non-carrier queens (Phototumefaciemma).

5. Application of selfish genetic elements in Plants and Animals

5.1. Cytoplasmic male sterility

Over 150 different plant species have been revealed to contain the selfish gene known as cytoplasmic male sterility (CMS), which is inherited from the mother[28]. A lot of research is done using CMS as a model system to examine selfish genetic factors that appear in nature [28]. The control of the expression of CMS-encoding genes has been studied, and a gene involved in this control has been isolated [29]. CMS has also been found to play an essential role in seminal outlines of hybrid discordancy and interspecific introgression in plants [30].

CMS has been utilized in the development of wheat hybrids [31]. Mutations in genes associated with fertility are generally the cause of male sterility phenotypes in rice, such as CMS, by the interactions that are not compatible, between different allelic or non-allelic genes, or due to genetic differences among cytoplasmic and nuclear genomes [32]. CMS is often used in three-line hybrid systems, where A-lines represent female lines that carry male sterile cytoplasm and nuclear genes that cannot be restored. Male fertile plants (B-lines) are produced by maintainer lines, which have undistinguishable nuclear genomes to each A-line and attuned fertile cytoplasm and are capable of keeping the male sterility of A-line, and R lines are the pollinator/male lines that transmit dominant nuclear restorer of fertility gene(s)[15].

In conclusion, CMS is a maternally inherited selfish gene that has been widely studied in plants. It has been found to have a significant impact on plant's interspecific introgression and creating hybrid incompatibility patterns. CMS has also been utilized in the development of wheat and rice hybrids and is often used in three-line hybrid systems.

5.2. PiggyBac vectors

PiggyBac vectors are a promising tool for gene therapy and genome engineering due to their high efficiency and flexibility. It has been observed that the piggyBac transposon system is helpful in the preclinical development of transposon-based gene therapy [33]. The transposase of piggyBac can be molecularly engineered, allowing for site-specific targeting of therapeutic genes [34]. However, there are some limitations to the use of piggyBac vectors. Recuperation of the transposon catalyzed by piggyBac transposase ensues in 40-50% of cells, which can limit the efficiency of the system [35]. Additionally, the employment of piggyBac as a gene-drive technique to spread anti-malarial transgenes in populations of the malaria vector Anopheles Stephensi has sparked worries about the potential unintended consequences of releasing GMOs into the environment [36]. Despite these limitations, piggyBac vectors have been successfully used in diverse applications. For example, piggyBac transposon-mediated gene transfer has been used to establish stable cells expressing FRET biosensors[37]. Overall, piggyBac vectors are a promising tool for gene therapy and genome engineering, but further research is needed to address the shortcomings of the system and assure the safety of its applications.

5.3. C Homing endonuclease and CRISPR gene drive systems

Two effective technologies for genetic engineering and population management are CRISPR gene drive and homing endonuclease systems. Both approaches rely on the dissemination of a desired trait across a population through the employment of selfish genetic components.

Homing endonuclease genes (HEGs) are naturally occurring selfish genetic rudiments that have been studied extensively for their potential use in gene drive systems [38]. HEGs work by selectively disrupting specific gene sequences and rapidly spreading through homologous recombination repair events [39]. However, the use of HEGs as gene drive systems has prompted concerns regarding the potential negative effects of releasing genetically modified organisms into the environment [40].

CRISPR gene drive systems, on the other hand, rely on the use of the CRISPR-Cas9 system to create cleave at specific target sites and insert a desired gene. CRISPR gene drive systems are exceedingly efficient in spreading a desired trait throughout a population but also prompted concerns regarding the potential negative effects of releasing genetically modified organisms into the environment. [41].

Both CRISPR gene drive and homing endonuclease systems are examples of selfish genetic rudiments that use the activities of the host to facsimile themselves into a specific target DNA sequence [42].While these systems hold great promise for genetic engineering and population control, further research is needed to address the potential risks and ensure the safety of their applications.

6. NATURE vs. GENE

6.1. Altruism

The forebear of evolution, Charles Darwin was a leading protagonist of the concept that "factual altruism cannot last for generations". His theory of natural selection holds that organisms behave extravagantly in certain ways if doing so will increase their chances of survival. In this manner, selfishness necessarily be present in every behavior since species must be selfish to exist [43].

According to Darwin, altruism would not survive in nature over time because it would be damaging to a species and would result in its extinction. A gentleman will not, over time, give money to charity at the expense of his happiness and means of subsistence because doing so would result in his demise [43].

6.2. The assessment from selfish gene theory:

Dawkins and Smith are two well-known scientists to propose the selfish gene elucidation of altruistic behavior, but Darwin's explanation differs from Smith's. Both their views are different on the concept.

Smith's view of altruism is based on sociology according to him altruistic behavior is done to improve social standing. Dawkins's theory, in disparity, assents the concept that altruism endangers the altruist beheld as an organism, but it however views the altruistic act as enlightening survival forecasts for an altruist's genes. Richard Dawkins in his research on the Selfish gene wanted to hypothesize and confer the biology of selfishness and altruism, and at that juncture, he reinterpreted the origin of evolution and altruism. [43]

William D. Hamilton's genetic kinship hypothesis had a role in altruism. A gene might affect an organism by helping other organisms possess the ability of that gene: the gene has an advantage in this regard, even the ransom of a few individuals. For example, in social insects, the workers are sterile, impossible for them to pass on their genetic material. Simply by passing along copies of their gene, thus benefiting the queen. He stated that 'The organism is only just DNA'S way to make more DNA.' [44]

6.3. Altruism and selfishness:

Altruism and selfishness are two opposite beliefs, like free will and determinism. The apparent incompatibility may be challenged by various forms of compatibility. Altruism is a type of behavior that is conceived or adopted over the experiences of life while selfishness is the inner desire of an organism for the sake of survival.

6.4. Altruism in related and unrelated Organism:

Robert Trivers presented that mutual altruism can evolve among unrelated individuals of different species. The liaison of the involved individuals is similar to some circumstances of the Prisoner's Dilemma. William D. Hamilton explained that if two individuals of the same species contain the gene for transfer, then one individual will sacrifice himself to save the other this will benefit both individuals, moreover, both individuals can work mutually to benefit each other e.g. one individual collects food for survival and the other can protect the infants, etc. In this way individuals can benefit from the exchange of many altruistic acts, this relation is analogous and the key is IDP (iterated prisoner's Dilemma) where both individuals mutually act altruistically [43]. Table 1 list the scientists contributed to the selfish gene theory.

7. List of scientists that contributed to the Selfish Gene Theory:

Sr. no	Name	Occupation	Contribution	Publication
1.	**George.C.Williams** (1926-2010)	Professor of Biology, State University of New York at Stony Brook	Proposed that gene is the ultimate beneficiary of selection	Williams, G. C. (2018). Adaptation and natural selection: A critique of some current evolutionary thought (Vol. 61). Princeton university press.
2.	**Richard Dawkins** (1941), (aged 82)	Professor of Public Understanding of Science, University of Oxford	Stated that " Genes are in a sense of immortality and tend to conserve themselves throughout inheritance and evolution	Dawkins, R. (2016). The selfish gene. Oxford university press.
3.	**William.D.Hamilton** (1936-2000)	Professor of logics and metaphysics, University of Edinburgh	Proposed the relation of altruism and selfish gene theory and stated that the change in average trait value is a population is proportional to BR-C B = Benefit to others R = Relatedness C = Cost of Self	Williams GC, Williams DC, 1957. Natural selection of individually harmful social adaptations among sibs with special reference to social insects. Evolution 11: 32 -39.
4.	**John.M.Smith**	Founding Member and Dean at	Formalized the central concept of evolutionary	Maynard Smith, J., 1958c The Theory of Evolution. Penguin

	(1920-2004)	University of Sussex	game theory called the evolutionary stable strategy.	Books, London.
5.	**Robert Trivers** (1943) (aged 80)	Professor of Anthropology and Biological Sciences at Rutgers University also the professor of Psychology at University of Harvard	Concentrated on the biology of selfish genetic elements which leads to certain kinds of internal genetic conflicts.	Burt, A., & Trivers, R. (2006). Genes in conflict: the biology of selfish genetic elements. Harvard University Press.

8. CONCLUSION

In conclusion, the selfish gene theory and its elements have been the subject of extensive research and debate over the years. The theory proposes that genes are the central unit of selection, and selfish genetic elements can augment their transmission at the outlay of other genes in the genome. While some studies have supported this theory, others have challenged it, highlighting the need for a more nuanced understanding of the gene's-eye view of evolution. Nevertheless, the concept of selfish genetic elements has provided valuable insights into eukaryotic genome evolution and the transmission of genetic traits. As research in this field continues, it is essential to consider the broader implications of the selfish gene theory and its potential impact on our understanding of evolution and genetics.

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