Quantum Dysgenic Theory

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Abstract

The utilisation of quantum theories within social science and biology is often reasonably met with dubiety. It would be even more controversial should such theories be applied to concepts under the domain of eugenics. Nonetheless, this can open up a fresh and unique understanding of theories that are usually understood by their classical structure. We will provide quantum interpretations of dysgenics and dysgenic traits from different scopes and procedures. The way dysgenic traits are in a flux with the environment that they interact will be analysed as well as how they interact with each other under quantum conditions. We will also take into account of factors such as intelligence, genetic heritability, and other biological and cognitive factors and try to study their frameworks in non-classical ways. Using what we have theorised, we will also attempt to create numerical and empirical analyses of some of the theories that we have proposed.

1 Introduction

"*What we observe is not nature itself, but nature exposed to our method of questioning.*" - Werner Heisenberg (1901 - 1976)

Eugenics is quite often regarded as a pseudoscience; the history of it has been filled with trouble. Many studies have tried to test the idea of whether or not there is a rise in dysgenic traits in populations as well as trying to see what the devastating consequences for a society as a whole are because of dysgenic populations. As the author, it is not my job to persuade whomever that reads this to be in favour of or in opposition of eugenics. That is simply not my task. However, it is in my hopes that the reader will understand how we can apply what we know about quantum physics to topics that are encapsulated in theories of genetics and biology. We will go through this rigorously. Much of this seems unconventional, most people would think, but regardless this will set in stone the potential for future theories of a similar nature. Some with hopefully even more predictive power. None of this has ever been attempted before, at least specifically regarding theories under eugenics, until now. Nevertheless, it is in the nature of interest for the quantum social scientist such as myself to revolutionise these fields with intriguing and meaningful comprehensions of the fields of social science and biology.

Theories about dysgenics are of course perceived classically, by which genes are discrete units. When we think about genetic inheritance, we usually think about it in the Mendelian way. So be it. This only works for traits that are simple, however. Some of the more *complex* genetic traits which are of high relevance to human behaviour and intelligence are held in control by a plethora of genes that interact in various ways with other genes and even the environment of which they are in. All of this *fails* to take in account of the role of quantum mechanics in biological processes. Even Schrödinger himself knew that there was a probable role of it in biology.

We will be studying dysgenics in various ways, such as under field theoretic frameworks and stochastic processes. We will seek to understand how dysgenic traits operate by due of their dynamism, which we will try to unveil the quantum properties of. Remember that we are working as *physicists*, and not as biologists or chemists. This means that whatever we do will not necessarily align with some of the common beliefs held by professionals in those areas, yet those professionals should thank us for at least trying to open their eyes from a different perspective.

2 Dysgenic Field Theory

What follows is a set of *different* yet closely related field theories that I have created in order to interpret dysgenics. We shall begin with the first field theory of dysgenics, which will approach dysgenics very generally. Some of these theories will be tested using computational mathematics software such as MATLab. Let us now begin.

2.1 Dysgenic Field Theory I

Dysgenes may be described by $\phi(x)$ which is a complex scalar field, x being a four-dimensional spacetime coordinate. Given a gauge field $A_\mu(X)$, dysgenes may also hold interaction with that gauge field. Note that $\mu = 0, 1, 2, 3, 4$. The gauge field is the representative of the environmental or social factors which the dysgenes are affected by. The action for the dysgene field is given by

$$S[\phi, A] = \int d^4x \left(-\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + |D_\mu \phi|^2 - V(|\phi|) \right), \tag{1}$$

where $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$ is the gauge field's field strength tensor while $D_\mu = \partial_\mu - ieA_\mu$ is the covariant derivative, e is the coupling constant between the gauge field and the dysgenes, and $V(|\phi\ |)$ is the potential function for the dysgene field. The potential that will be used for the dysgene field has been selected to be

$$V(|\phi|) = \frac{\lambda}{4}(|\phi|^2 - v^2)2, \tag{2}$$

where λ is a positive constant while v is also a constant albeit one that is non-zero. Two degenerate minima at $\phi = \pm v$ can be found in the potential. Due to this, the dysgene field is able to possess two possible vacuum states, both of which would correspond to two different phases of dysgenics.

The action $S[\phi, A]$ is invariant under local $U(1)$ gauge transformations of the form

$$\phi(x) \to e^{i\alpha(x)}\phi(x), \quad A_\mu(x) \to A_\mu(x) + \frac{1}{e}\partial_\mu \alpha(x), \tag{3}$$

where $a(x)$ is an arbitrary function of spacetime. The very fact that the phase of the dysgene field can not be physically observed and yet can be transformed by a local change of reference frame is reflected by this symmetry.

We still have to obtain the equations of motion for the dysgene field and the gauge field. We may do so by varying the action with respect to ϕ^* and A_μ, respectively. Thus we may write the equations of motion as

$$D_\mu D^\mu \phi + \frac{\partial V}{\partial \phi^*} = 0, \ \partial_\nu F^{\nu\mu} + ej^\mu = 0. \tag{4}$$

The current density of the dysgene field is given by

$$j^\mu = i(\phi^* D^\mu \phi - \phi D^\mu \phi^*). \tag{5}$$

It is also crucial to add that the action that we are working with $S[\phi, A]$ has a global $U(1)$ symmetry, with that itself being a subgroup of the local $U(1)$ symmetry with $a(x)$ being a constant. In our case, this corresponds to a global phase rotation of the dysgene field. That would imply that the dysgenes have a conserved charge associated to them. This charge density is given by $p = j^0$. The total charge is given by

$$Q = \int d^3x\rho = \int d^3xi(\phi^* D^0 \phi - \phi D^0 \phi^*). \tag{6}$$

Now, since we are deciding that this system is going to be defined on a four-dimensional manifold with boundaries, the boundary conditions associated with the fields must be compatible with the gauge symmetry and variational principle. Thus, we must select a boundary condition that is appropriate, otherwise we will run into trouble. If we wanted to, we could impose Dirchlet boundary conditions on both fields, which be

$$\phi|\partial M = 0, \quad A\mu|\partial M = 0, \tag{7}$$

in which ∂M is the boundary condition of the manifold M. We could even impose Neumann boundary conditions on those two fields, thus

$$n^\mu D\mu\phi|\partial M = 0, \quad n^\nu F\nu\mu|_{\partial M} = 0, \tag{8}$$

where n^μ is the outward-pointing normal vector to the boundary. Such boundary conditions are important because can indeed ensure that the fields have zero normal derivatives at the boundary or vanish, respectively speaking.

2.1.1 Quantisation

We have to quantise the gauge and dysgene field. In order to do this, we are going to have use the canonical quantisation method. This is formed by imposing commutation relations on the conjugate momenta of the fields and the fields themselves at equal times. We define the conjugate momenta as

$$\Pi(x) = \frac{\delta S}{\delta \dot{\phi}(x)} = D_0 \phi^*(x), \;\; E^\mu(x) = \frac{\delta S}{\delta \dot{A}\mu(x)} = F^{0\mu}(x). \tag{9}$$

The commutation relations are given by

$$[\phi(x), \Pi(y)] = i\delta^3(\mathbf{x} - \mathbf{y}) \tag{10}$$

$$[A\mu(x), E^\nu(y)] = i\delta^\nu_\mu \delta^3(\mathbf{x} - \mathbf{y}) \tag{11}$$

$$[\phi(x), \phi(y)] = [\Pi(x), \Pi(y)] = [A_\mu(x), A_\nu(y)] = [E\mu(x), E\nu(y)] = 0. \tag{12}$$

These commutation relations give the implication to us that the conjugate momenta and the fields that they associate with are indeed operators that act on a Hilbert space of quantum states.

We now have to solve the equations of motions that we were dealing with for the fields. We will have to use the mode expansion method. Assuming that the manifold M is a four-dimensional box with sides L (so that periodicity can be satisfied by the boundary conditions) and that the gauge field is in the temporal gauge, that is, $A_0(X) = 0$, then the mode expansions for the fields are given by

$$\phi(x) = \frac{1}{L^{3/2}} \sum_{\mathbf{k}} \frac{1}{\sqrt{2\omega_{\mathbf{k}}}} \left(a_{\mathbf{k}} e^{-ikx} + a^\dagger_{-\mathbf{k}} e^{ikx} \right) \tag{13}$$

$$A_i(x) = \frac{1}{L^{3/2}} \sum_{\mathbf{k}} \frac{1}{\sqrt{2|\mathbf{k}|}} \left(b_{i,\mathbf{k}} e^{-ikx} + b^\dagger_{i,-\mathbf{k}} e^{ikx} \right) \tag{14}$$

Additionally, our reason for choosing that particular gauge $A_0(X) = 0$ is that it would simplify the equations of motion whilst also eliminating the constrain equation that A_0 adheres to. The annihilation operators that reside within the mode expansions satisfy the following commutation relations:

$$[a_{\mathbf{k}}, a^\dagger_{\mathbf{k}'}] = [b_{i,\mathbf{k}}, b^\dagger_{j,\mathbf{k}'}] = \delta_{\mathbf{k},\mathbf{k}'} \delta_{ij} \tag{15}$$

$$[a_{\mathbf{k}}, a_{\mathbf{k}'}] = [b_{i,\mathbf{k}}, b_{j,\mathbf{k}'}] = [a_{\mathbf{k}}, b_{i,\mathbf{k}'}] = [a_{\mathbf{k}}\dagger, b_{i,\mathbf{k}'}\dagger] = 0. \tag{16}$$

The Hamiltonian for the system can be obtained by integrating the energy density over the spatial volume, so

$$H = \int d^3x \left(\frac{1}{2} E_i E^i + |D_i \phi|^2 + V(|\phi|) \right). \tag{17}$$

The time now comes in to use the field mode expansions that we previously derived. By the field mode expansions, we write the Hamiltonian as:

$$H = \sum_{\mathbf{k}} \left(\omega_{\mathbf{k}} a_{\mathbf{k}}^{\dagger} a_{\mathbf{k}} + |\mathbf{k}| b_{i,\mathbf{k}}^{\dagger} b_{i,\mathbf{k}} \right) + H_0, \tag{18}$$

in which H_0 is a constant term wherein it holds dependence to the potential parameters. The Hamiltonian is diagonal in terms of the annihilation and creation operators. It is also good to note that it has a simple spectrum of eigenvalues. Given the vacuum state $|0\rangle$, which is the system's ground state, the equation

$$a_{\mathbf{k}}|0\rangle = b_{i,\mathbf{k}}|0\rangle = 0, \quad \forall \mathbf{k}, i \tag{19}$$

is satisfied. Thence, we are able to obtain the excited states of the system by applying the creation operators to the vacuum state while having energies that are multiples of ω_k or $|k|$. We interpret the quantum states of the system as superpositions of different numbers and types of quanta or particles. These are the excitations of the gauge or dysgene fields.

2.1.2 Dysgenic Phase Transition and Symmetry Breaking

This quantum field theoretic dysgenic theory so far is quite interesting in that we may observe a symmetry breaking phenomenon along with a phase transition which it exhibits. We take the potential parameter v to be the control parameter for the field theory. The depth along with the shape of the potential well for the dysgene field is determined by that. The global $U(1)$ symmetry is the symmetry that is broken. This corresponds to the dysgene field's global phase rotation. When v crosses over some critical value v_c that is dependent on the other potential parameter λ and the coupling constant e, then the symmetry breaking occurs. Under that critical below is when the system happens to be in a symmetric phase. This results in the ground state of the dysgene field being $\phi = 0$ but having the global $U(1)$ symmetry preserved. However, when we start going above this critical value, then the state is in a broken phase. In that broken phase, the ground state of the dysgene field is $\phi = \pm v$, and the global $U(1)$ symmetry becomes spontaneously broken.

We should try to understand this symmetry breaking and phase transition better. We will have to take into account of an effective potential, which being a function that describes the system's energy as a function of the expectation value associated with the dysgene field. o obtain this, we have to integrate out the quantum fluctuations of the fields around their classical values. Methods like perturbation theory can be used to do that. For our case, the effective potential is given by

$$V_{\text{eff}}(\phi) = V(|\phi|) + \Delta V(|\phi|). \tag{20}$$

The quantum correction term $\Delta V(|\phi|)$ takes the form

$$\Delta V(|\phi|) = \frac{a}{2}|\phi|^2 - \frac{b}{4}|\phi|^4 + \frac{c}{6}|\phi|^6 + \cdots, \tag{21}$$

where a, b, and c are constants that are positive and also depend on our parameters. The form that has just been ascribed to the quantum correction term allows the apprehension of the primary characteristics that the quantum correction term has. These include

- The evenness under $\phi \to -\phi$
- The convexity at small values of $|\phi|$
- Non-analyticity at large values of $|\phi|$

and some others.

With the effective potential, the degeneracy and the stability of the system's ground state can be determined. The ground state corresponds to the minimum or in some other cases the minima of the effective potential. The energy gap that is in between the excited states and the ground state corresponds to the second derivative of the effective potential at the minimum (or minima). The shape and position of the minimum or minima of the effective potential depend on the value of v. If it happens to be case that $v \leq v_c$, then the effective potential has two degenerate minima at $\phi = \pm v'$, where $v' \leq v$, and the ground state is twofold degenerate and thus broken. The critical value v_c is determined by the condition that the second derivative of the effective potential at $\phi = 0$ vanishes:

$$V''_{\text{eff}}(0) = \lambda v^2 + a - bv^2 + cv^4 + \cdots = 0. \tag{22}$$

The transcendental equation for v_c is satisfied by that condition.

Due to the symmetry breaking and phase transitions that we have been analysing, we can come to understand a few yet important consequences. Two possible scenarios for dysgenics is implied, depending on whether $v \leq v_c$ or $v \geq v_c$ but we will not go further into this.

2.1.3 Quantum Fluctuations and Dissipation of Dysgenes

We will look into the dissipation and quantum fluctuations of dysgenes. We will employ the Langevin equation for this task. The Langevin equation is an SDE that describes the evolution of an open quantum system that is coupled to a reservoir or a bath. It takes the form

$$\dot{\hat{x}}(t) = \hat{f}(\hat{x}(t)) + \hat{\xi}(t). \tag{23}$$

The stochastic forces that are present in the form of the Langevin equation are related to the reservoir operators by

$$\langle R_\phi(s) \rangle = \langle R_{A_i}(s) \rangle = 0 \tag{24}$$

$$\langle R_\phi(s) R_\phi(s')^\dagger \rangle = N_\phi(s - s')\mathbb{I} \tag{25}$$

$$\langle R_\phi(s)^\dagger R_\phi(s') \rangle = M_\phi(s - s')\mathbb{I} \tag{26}$$

$$\langle R_{A_i}(s) R_{A_j}(s')^\dagger \rangle = N_{A_i}(s - s')\delta_{ij} \tag{27}$$

$$\langle R_{A_i}(s)^\dagger R_{A_j}(s') \rangle = M_{A_i}(s - s')\delta_{ij}. \tag{28}$$

These statistical properties imply that the stochastic forces hold to be Markovian, Gaussian, and zero-mean. Both the dysgene field and the gauge field are open quantum systems and they are coupled to different reservoirs. The reservoirs represent the social and environmental noise of which the fields are affected by. The reservoirs are in a thermal equilibrium at some temperature T and that the system-reservoir coupling is weak and linear. We can thus write

$$\dot{\phi}(x) = D_0\phi^*(x) + \xi_\phi(x) \tag{29}$$

$$\dot{A}i(x) = -E_i(x) + \xi A_i(x) \tag{30}$$

The stochastic forces for the dysgene field and the gauge field (respectively) $\xi_\phi(x)$ and $\xi_{A_i}(x)$ are related to the reservoir operators by

$$\xi_\phi(x) = \int_0^t dsK_\phi(t-s)R_\phi(s) \tag{31}$$

$$\xi_{A_i}(x) = \int_0^t dsK_{A_i}(t-s)R_{A_i}(s), \tag{32}$$

where $K_\phi(t-s)$ and $K_{A_i}(t-s)$ are respectively the kernel functions for the dysgene field and the gauge field. $R_\phi(s)$ and $R_{A_i}(s)$ are also respectively the reservoir operators for the dysgene field and the gauge field. Quantum effects such as tunneling and diffusion can induce transitions between different states or phases of dysgenics, and affect the stability and robustness of dysgenic patterns.

2.1.4 Entropic Uncertainty Relations and Entanglement Measures for Dysgenes

Using the Wehrl entropy, that being defined as

$$S_W(\rho) = -\int d^2\alpha\rho_W(\alpha)\log\rho_W(\alpha), \tag{33}$$

we may measure the uncertainty for the dysgene field. We drive the entropic uncertainty relation as

$$S_W(\rho_X) + S_W(\rho_P) \geq 2\log L, \tag{34}$$

which would mean that a trade-off exists between the precision of measuring the momentum and position of the dysgene field. That trade-off is dependent on the topology that constitutes the field space. The quantum mutual information for measuring of the quantum correlation and quantum non-classicality of the dysgene field is defined as

$$I(\rho_{AB}) = S(\rho_A) + S(\rho_B) - S(\rho_{AB}). \tag{35}$$

The von Neumann entropy $S(\rho)$ is defined as

$$S(\rho) = -\mathrm{Tr}(\rho\log\rho). \tag{36}$$

We will also make use of quantum discord, which we define as

$$D(\rho_{AB}) = I(\rho_{AB}) - C(\rho_{AB}), \tag{37}$$

where $C(\rho_{AB})$ is the classical correlation, that itself being defined as

$$C(\rho_{AB}) = \max_{M_i} \left(S(\rho_A) - \sum_i p_i S(\rho_A|i) \right). \tag{38}$$

The entropic uncertainty relations and entanglement measures respectively take the forms

$$S_W(\rho_X) + S_W(\rho_P) \geq 2 \log L + I(\rho_{AB}) \tag{39}$$

and

$$S_W(\rho_X) + S_W(\rho_P) \geq 2 \log L + D(\rho_{AB}). \tag{40}$$

2.2 Dysgenic Field Theory II

We will approach things with a different but related account, more so on genetic traits themselves and how they interact within populations. Given a quantum number n and a helicity λ_n , each trait may be represented. Note that these variables are discrete, so they take values that are within a finite set. Let $n = 1, 2, \ldots N$ and $\lambda_n = \pm 1$. Each individual within a population may be described by a quantum state $|\Psi(t)\rangle$. This is a superposition of particle and antiparticle states that have different quantum numbers and helicities. If it happens to be that one state with one particle with trait $n = 1$ and helicity $\lambda_1 = \pm 1$ along with one antiparticle with trait $n = 2$ and a helicity of $\lambda_2 = -1$, then we can write

$$|\Psi(t)\rangle = a_1^\dagger(t) b_2^\dagger(t) |0\rangle. \tag{41}$$

The creation operators satisfy

$$[a_n(t), a_m^\dagger(t)] = [b_n(t), b_m^\dagger(t)] = \delta_{nm} \tag{42}$$

$$[a_n(t), b_m^\dagger(t)] = [a_n(t), b_m(t)] = [a_n^\dagger(t), b_m^\dagger(t)] = 0. \tag{43}$$

The annihilation operators are to be defined as the Hermitian conjugates of the creation operators

$$a_n(t) = (a_n^\dagger(t)^\dagger \tag{44}$$

$$b_n(t) = (b_n^\dagger(t)^\dagger \tag{45}$$

Thus, we can define the number operator for particles and anti particles with a quantum number n and helicity λ_n as

$$N_{n,\lambda_n}(t) = a_n^\dagger(t) a_n(t) + b_n^\dagger(t) b_n(t), \tag{46}$$

which counts the amount of individuals with a trait n and helicity λ_n in the quantum state $|\Psi(t)\rangle$. Given the expectation value of the operator

$$\langle N_{n,\lambda_n}(t)\rangle = \langle \Psi(t)| N_{n,\lambda_n}(t) |\Psi(t)\rangle, \tag{47}$$

we are able to measure the average numbers of individuals with the trait n and its corresponding helicity. We then turn to the Hilbert space of quantum states for the population. We find it being given by the tensor product of Fock spaces for each trait

$$\mathcal{H} = \bigotimes_{n=1}^{N} \mathcal{F}n, \tag{48}$$

where $\mathcal{F}_n$ is the Fock space for trait n. This is then spanned by states that take the form

$$|n_1, n_2, \ldots, n_N\rangle = \frac{(a_1^\dagger)n_1(b_1^\dagger)n_1(a_2^\dagger)n_2(b_2^\dagger)n_2 \ldots (a_N^\dagger)n_N(b_N^\dagger)n_N}{\sqrt{n_1!n_2!\ldots n_N!}}|0\rangle, \tag{49}$$

We define the inner product on $\mathcal{H}$ as

$$\langle\Psi_1(t)|\Psi_2(t)\rangle = \prod n = 1^N \langle\psi_{1,n}(t)|\psi_{2,n}(t)\rangle, \tag{50}$$

and the norm of a state $|\Psi(t)\rangle$ as

$$\|\Psi(t)\| = \sqrt{\langle\Psi(t)|\Psi(t)\rangle}. \tag{51}$$

2.2.1 Propagation of Quantum States

The propagation of quantum states for each trait is described by the Weyl equation on a four-dimensional spacetime that is a product of two two-dimensional manifolds: $M = M_1 \times M_2$, where M_1 is a smooth orientable 2-dimensional manifold and M_2 is a complex curve endowed with a mereomorphic one-form ω. The metric on M can be give by

$$ds^2 = g_{00}dx^0dx^0 + g_{11}dx^1dx^1 + 2g_{01}dx^0dx^1 + dzd\bar{z}, \tag{52}$$

where g_{00}, g_{11}, g_{01} and g_{01} are functions of (x^0, x^1) only, with that being the coordinates on M_1. The one-form ω has poles at some points on M_2 which would correspond to singularities in the spacetime.

For our case, the Weyl equation is given by

$$(\gamma^\mu D_\mu - iq_nA_\mu)\psi_n = 0. \tag{53}$$

Select the Dirac matrices as

$$\gamma^0 = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \tag{54}$$

$$\gamma^1 = \begin{pmatrix} 0 & -i \\ -i & 0 \end{pmatrix} \tag{55}$$

$$\gamma^z = \begin{pmatrix} i & 0 \\ 0 & -i \end{pmatrix} \tag{56}$$

$$\gamma^{\bar{z}} = \begin{pmatrix} -i & 0 \\ 0 & i \end{pmatrix} \tag{57}$$

Define the chirality as

$$\gamma^5 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}. \tag{58}$$

We can then decompose the spinor field ψ_n into two components

$$\psi_n = (\psi_n^+, \psi_n^-). \tag{59}$$

Now it is possible to write the Weyl equation as a system of two coupled equations

$$(\partial_0 + \partial_1 - iq_n A_0 - iq_n A_1)\psi_n^+ + (\partial_z - iq_n A_z)\psi_n^- = 0 \tag{60}$$

$$(\partial_0 - \partial_1 - iq_n A_0 + iq_n A_1)\psi_n^- + (\partial_{\bar{z}} - iq_n A_{\bar{z}})\psi_n^+ = 0. \tag{61}$$

We can solve these equations by using the method of characteristics, which would involve finding curves on M along which the spinor components hold to be constant. In particular, such curves are called null geodesics. They satisfy

$$\frac{dx^0}{d\tau} = g_{00}^{-1/2} \tag{62}$$

$$\frac{dx^1}{d\tau} = \lambda_n g_{11}^{-1/2} \tag{63}$$

$$\frac{dz}{d\tau} = e^{i\lambda_n \theta}. \tag{64}$$

θ is a function of (x^0, x^1) defined by

$$e^{i\theta} = \frac{g_{00}^{1/4} + i g_{11}^{1/4}}{\sqrt{2}}. \tag{65}$$

Indeed we may now derive the solutions to the Weyl equation which are

$$\psi_n^+(x0, x^1, z, \bar{z}) = f_n^+(z - e^{i\lambda_n \theta}(x^0 + \lambda_n x^1) + iq_n \int A_z d\tau) \tag{66}$$

$$\psi_n^-(x0, x^1, z, \bar{z}) = f_n^-(\bar{z} - e^{-i\lambda_n \theta}(x^0 - \lambda_n x^1) + iq_n \int A_{\bar{z}} d\tau). \tag{67}$$

The initial conditions of the spinor field at some initial time $t = 0$ can be determined by using these functions that we have just derived. The spinor field ψ_n then may be expanded in terms of creation and annihilation operators

$$\psi_n(x^0, x^1, z, \bar{z}) = \sum_k \left(a_{n,k}(t) u_{n,k}(x^0, x^1, z, \bar{z}) + b_{n,k}^\dagger(t) v_{n,k}(x^0, x^1, z, \bar{z}) \right), \tag{68}$$

taking k to be the discrete index that labels the modes of the spinor field. The mode functions $u_{n,k}(x^0, x^1, z, \bar{z}) + b_{n,k}^\dagger(t)$ and $v_{n,k}(x^0, x^1, z, \bar{z})$ are solutions of the Weyl equation equation with specific normalisation factors and boundary conditions. The annihilation operators satisfy

$$[a_{n,k}(t), a^\dagger_{m,l}(t)] = [b_{n,k}(t), b^\dagger_{m,l}(t)] = \delta_{nm}\delta_{kl} \tag{69}$$

$$[a_{n,k}(t), b^\dagger_{m,l}(t)] = [a_{n,k}(t), b_{m,l}(t)] = [a^\dagger_{n,k}(t), b^\dagger_{m,l}(t)] = 0. \tag{70}$$

We previously defined a number operator and we will do so again but this time for particles and antiparticles with a quantum number n *and* mode k

$$N_{n,k}(t) = a^\dagger_{n,k}(t)a_{n,k}(t) + b^\dagger_{n,k}(t)b_{n,k}(t), \tag{71}$$

with the expectation value

$$\langle N_{n,k}(t)\rangle = \langle\Psi(t)|N_{n,k}(t)|\Psi(t)\rangle. \tag{72}$$

Using everything that we have derived, we can model the diversity and complexity of dysgenic traits that are present within a population of any size.

2.2.2 The Gauge Field and the Action

The gauge field A that couples different traits via four-dimensional Chern-Simons theory is a one-form on M that takes values in a Lie algebra g. This is a vector space with a bilinear operation called the Lie bracket. We take g to be equipped with a non-degenerate, invariant, and symmetric bilinear form. Choose g to be the Lie algebra of $U(N)$, the group of $N \times N$. This has a basis that is given by

$$T_a = \frac{1}{\sqrt{2N}}\delta_{a0}I + \frac{i}{\sqrt{2}}\lambda_a, \tag{73}$$

The Gell-Mann matrices λ_a are the generators of $SU(N)$. The Lie bracket and the bilinear form are given by

$$[T_a, T_b] = if_{abc}T_c \tag{74}$$

$$\langle T_a, T_b\rangle = \frac{1}{2}\delta_{ab} \tag{75}$$

Define the structure constants f_{abc} of $SU(N)$ as

$$[\lambda_a, \lambda_b] = 2if_{abc}\lambda_c. \tag{76}$$

Now we can write the gauge field A as

$$A = A_\mu dx^\mu = A^a_\mu T_a dx^\mu, \tag{77}$$

and the gauge field transformation under a gauge transformation as

$$A \mapsto A' = g^{-1}Ag + g^{-1}dg, \tag{78}$$

of which g is a smooth function on M that takes values in $U(N)$. The gauge transformation corresponds to a change of basis for the spinor field ψ_n which transforms as

$$\psi_n \mapsto \psi_n' = g^{-1}\psi_n. \tag{79}$$

From this account particularly, the action can be given by the sum of the Chern-Simons action for the gauge field and the spinor field's Dirac action

$$S = S_{CS} + S_D, \tag{80}$$

where

$$S_{CS} = \frac{k}{4\pi}\int_M \langle A \wedge dA + \frac{2}{3}A \wedge A \wedge A\rangle \tag{81}$$

$$S_D = -i\sum_{n=1}^{N}\int_M \bar{\psi} n(\gamma^\mu D\mu - iq_n A_\mu)\psi_n. \tag{82}$$

Obtain the equations of motion by varying the action with respect to both A and ψ_n. In respect to A, the variation with it gives

$$d_A \star F = j, \tag{83}$$

where

$$d_A = d + i[A] \tag{84}$$

and

$$F = d_A + iA \wedge A. \tag{85}$$

With respect to ψ_n, we get from the variation with it

$$(\gamma^\mu D_\mu - iq_n A_\mu)\psi_n = 0, \tag{86}$$

which is the Weyl equation. Now we have a descriptive account of how genetic traits interact and evolve in a population.

2.2.3 The Expectation Value of the Number Operator

It is crucial for our theory that we can calculate the expectation value of the number operator. This quantity is the measurement of the average number of individuals with trait n and helicity λ_n as you might recall but it is indeed the reflection of the effects of dysgenics on distribution of traits that reside in a population. Recall the expectation value of the number operator in (39). Writing the state $|\Psi(t)\rangle$ as

$$|\Psi(t)\rangle = \sum_{k_1,k_2,\ldots,k_N} c_{k_1,k_2,\ldots,k_N}(t)|k_1,k_2,\ldots,k_N\rangle, \tag{87}$$

we have that k_i is the mode index for a trait i. The basis states $|k_1,k_2,\ldots,k_N\rangle$ of the Hilbert space $\mathcal{H}$ are given by

$$|k_1,k_2,\ldots,k_N\rangle = a^\dagger_{1,k_1}(0)b^\dagger_{1,k_1}(0)a^\dagger_{2,k_2}(0)b^\dagger_{2,k_2}(0)\ldots a^\dagger_{N,k_N}(0)b^\dagger_{N,k_N}(0)|0\rangle. \tag{88}$$

The normalisation condition

$$\sum_{k_1,k_2,\dots,k_N} |c_{k_1,k_2,\dots,k_N}(t)|^2 = 1 \tag{89}$$

is satisfied by the coefficients $c_{k_1,k_2,\dots,k_N}(t)$ in (79). Wick's theorem will have to be utilised in order for us to calculate the expectation value. It states that

$$\prod_{i=1}^{m} a_i \prod_{j=1}^{n} b_j = \sum_P N(P) \prod_{i=1}^{m} a_i \prod_{j=1}^{n} b_j. \tag{90}$$

Suppose that $m = n = 2$. Then

$$a_1a_2b_1b_2 = N((1,3),(2,4))a_1a_2b_1b_2 + N((1,4),(2,3))a_1a_2b_1b_2 \; = a_1b_1a_2b_2 - a_1b_2a_2b_1. \tag{91}$$

The number operator can be written as

$$N_{n,\lambda_n}(t) =: N_{n,\lambda_n}(t) : + \sum_{k,l} \left(u_{n,k}(t)v_{n,l}(t) + v_{n,k}(t)u_{n,l}(t) \right), \tag{92}$$

with the normal ordered part being given by

$$: N_{n,\lambda_n}(t) := a_n^\dagger(t)a_n(t) + b_n^\dagger(t)b_n(t). \tag{93}$$

In (85), the second term is the vacuum expectation value of the number operator. This is the contributing factor of the vacuum fluctuations to the number of individuals. In our comprehension, this is the measure of quantum uncertainty in the distribution of traits. Using the Schrödinger equation given by

$$i\frac{d}{dt}|\Psi(t)\rangle = H|\Psi(t)\rangle, \tag{94}$$

we may calculate the expectation value. Take the Hamiltonian operator to be

$$H = -i\sum_{n=1}^{N} \int_M \bar{\psi} n(\gamma^\mu D\mu - iq_n A_\mu)\psi_n, \tag{95}$$

and express it in terms of creation and annihilation operators

$$H = \sum_{n,k,l} \Big(E_{n,k,l}a_{n,k}^\dagger(t)a_{n,l}(t) + E_{n,k,l}b_{n,k}^\dagger(t)b_{n,l}(t) + F_{n,k,l}a_{n,k}^\dagger(t)b_{n,l}(t) + F_{n,k,l}b_{n,k}^\dagger(t)a_{n,l}(t) \Big). \tag{96}$$

Then by the Schrödinger equation

$$i\frac{d}{dt}c_{k_1,k_2,\dots,k_N}(t) = \sum_{l_1,l_2,\dots,l_N} H_{k_1,k_2,\dots,k_N;l_1,l_2,\dots,l_N} c_{l_1,l_2,\dots,l_N}(t), \tag{97}$$

where the matrix elements are given by

$$H_{k_1,k_2,\ldots,k_N;l_1,l_2,\ldots,l_N} = \delta_{k_1l_1}\delta_{k_2l_2}\ldots\delta_{k_Nl_N}E_{n,k_n,l_n} + \delta_{k_1l_1}\delta_{k_2l_2}\ldots\delta_{k_{n-1}l_{n-1}}F_{n,k_n,l_n} + \delta_{k_{n+1}l_{n+1}}\delta_{k_{n+2}l_{n+2}}\ldots\delta_{k_Nl_N}F_{n,k_n,l_n} + O(F^2) \tag{98}$$

By using matrix exponentiation which involves finding the matrix $U(t)$ that satisfies

$$i\frac{d}{dt}U(t) = HU(t), \tag{99}$$

we can derive the solution as

$$U(t) = e^{-iHt}. \tag{100}$$

Using

$$\langle N_{n,\lambda_n}(t)\rangle = \sum_{k_1,k_2,\ldots,k_N} |c_{k_1,k_2,\ldots,k_N}(t)|^2\langle k_1,k_2,\ldots,k_N|N_{n,\lambda_n}(t)|k_1,k_2,\ldots,k_N\rangle, \tag{101}$$

the expectation value can be calculated. By orthogonality of the mode functions and using the normal ordered expression of the number operator, the matrix elements are computed to become

$$\langle k_1,k_2,\ldots,k_N|N_{n,\lambda_n}(t)|k_1,k_2,\ldots,k_N\rangle = (\delta_{k_nl_n} + |u_{n,k_n}(t)|^2 + |v_{n,k_n}(t)|^2), \tag{102}$$

where the first term represents the initial state of individuals and the second and third terms are the vacuum fluctuation contributions. By comparing this quantity with different initial states and different values of n and λ_n, we can observe how dysgenics affects different traits and different helicities in different cases.

2.2.4 The Rate of Change of the Number of Individuals

The rate of change of the number of individuals in a given population is given by the time derivative of the expectation value, which is

$$\frac{d}{dt}\langle N_{n,\lambda_n}(t)\rangle = \frac{d}{dt}\langle\Psi(t)|N_{n,\lambda_n}(t)|\Psi(t)\rangle. \tag{103}$$

The Heisenberg picture is to be employed in order to calculate that derivative. The Heisenberg picture is related to the Schrödinger picture by the following transformation:

$$N_{n,\lambda_n}(t) = U^\dagger(t)N_{n,\lambda_n}(0)U(t). \tag{104}$$

In the Heisenberg picture, the time derivative of the number operator is given by

$$\frac{d}{dt}N_{n,\lambda_n}(t) = i[H, N_{n,\lambda_n}(t)]. \tag{105}$$

Using the re-expression of the Hamiltonian and Wick's theorem, we calculate the commutator as

$$\frac{d}{dt}N_{n,\lambda_n}(t) = i\sum_{m,k,l}\left(E_{m,k,l}[a^\dagger_{m,k}(t)a_{m,l}(t), N_{n,\lambda_n}(t)] + E_{m,k,l}[b^\dagger_{m,k}(t)b_{m,l}(t), N_{n,\lambda_n}(t)] \quad + F_{m,k,l}[a^\dagger_{m,k}(t)b_{m,l}(t), N_{n,\lambda_n}(t)] + F_{m,k,l}[b^\dagger_{m,k}(t)a_{m,l}(t), N_{n,\lambda_n}(t)]\right). \tag{106}$$

Simplifying $[a, b]$ leads to

$$\frac{d}{dt}N_{n,\lambda_n}(t) = i\sum_{k,l}\left(E_{n,k,l}(a^\dagger_{n,k}(t)a_{n,l}(t) - a^\dagger_{n,l}(t)a_{n,k}(t)) + E_{n,k,l}(b^\dagger_{n,k}(t)b_{n,l}(t) - b^\dagger_{n,l}(t)b_{n,k}(t)) \quad + F_{n,k,l}(a^\dagger_{n,k}(t)b_{n,l}(t) - b^\dagger_{n,l}(t)a_{n,k}(t)) + F_{n,k,l}(b^\dagger_{n,k}(t)a_{n,l}(t) - a^\dagger_{n,l}(t)b_{n,k}(t))\right). \tag{107}$$

Now we have a description of how the number of individuals with a given trait and helicity change over time because of interactions with other traits. By solving the equation through a numerical or analytical method, we obtain a time evolution of the amount of individuals. in the population and then we can compare it afterwards with different initial conditions and values of n and λ_n.

2.3 Dysgenic Field Theory III

Consider a society as a collection of N individuals. Each individual will have a set of phenotypic traits that are influenced by their genotypes and also environmental factors. We will write the phenotypic trait vector of an individual i as

$$p_i = (p_{i1}, p_{i2}, \ldots, p_{im}), \tag{108}$$

where m is the number of traits that are considered. The traits will be continuous and normalised to $[0, 1]$. There exists a latent variable θ that represents the genetic quality of an individual. Denote the θ factor of an individual by

$$\theta_i \tag{109}$$

which is also normalised to $[0, 1]$. We hold that g is positively correlated with the phenotypic traits. Higher values of θ would imply that there are a higher values of the traits. Consider also that θ is heritable. Then we have a quantum field $\psi(x, t)$ that describes the state of the society at position x and time t. The quantum field is a complex-valued function and it satisfies the Weyl equation in the form

$$\sigma^\mu \partial_\mu \psi(x, t) = 0. \tag{110}$$

The left-handed and right-handed spinors of the quantum field are the states of the individuals in a society. $\psi_+(x, t)$ is the state of an individual with positive θ whereas $\psi_-(x, t)$ is the state of an individual with negative θ. Such a quantum field $\psi(x, t)$ is subjected to stochastic fluctuations because of the presence of arbitrary environmental influences. We could model this using the Weyl equation. To do that we would have to add a stochastic term, such that

$$\sigma^\mu \partial_\mu \psi(x, t) = \eta(x, t), \tag{111}$$

where D is the diffusion constant and δ is the Dirac delta function. The stochastic term $\eta(x,t)$ represents the random perturbations of the quantum field $\psi(x,t)$ because of factors that are external in nature, like epidemic or wars. The quantum field $\psi(x,t)$ holds interactions with itself. It does this by way of a nonlinear potential $V(\psi)$ which models the self-organisation and collective behaviour of the society. We can set $V(\psi)$ equal to the Chern-Simons theory. The gauge field A can be expressed in terms of the quantum field ψ as

$$A = \psi^\dagger \sigma^\mu d\psi. \tag{112}$$

The Chern-Simons potential $V(\psi)$ is a bit interesting in regards to its properties. Firstly, it has gauge invariance

$$\psi(x,t) \to U(x,t)\psi(x,t). \tag{113}$$

It also has a parity violation

$$V(\psi(x,t)) \to -V(\psi(-x,-t)). \tag{114}$$

The gauge A even features a topological quantisation condition

$$k = n, \tag{115}$$

where k is a coupling constant and n is an integer. We take $V(\psi)$ to be the diversity and complexity of a society. Values of $V(\psi)$ that are higher mean that there is a higher presence of collectivisation of the society. The gauge invariance implies that the society is robust to local changes of individual states while the parity violation means that the society is asymmetric and biased towards certain directions and conditions. The topological quantisation means would entail to us that the society can only exist in discrete phases or regimes. Combining the Weyl equation with $V(\psi)$ yields

$$\sigma^\mu \partial_\mu \psi(x,t) = \eta(x,t) - \frac{k}{4\pi}\psi^\dagger(x,t)\sigma^\mu d\psi(x,t) \wedge d\psi^\dagger(x,t)\sigma_\mu \psi(x,t). \tag{116}$$

For this field theoretic interpretation specifically, this equation is the master equation. It could be labelled as the "quantum dysgenics equation". This is a non-linear stochastic partial differential equation for $\psi(x,t)$. It will describe the evolution of the society under dysgenics. It captures the dynamics of the society under the influences of dysgenes, environmental fluctuations, and so forth.

2.3.1 The Quantum Dysgenics Equation I

In the case of a homogeneous and isotropic society, in which the quantum field $\psi(x,t)$ would not depend on the spatial coordinate x, we will analyse some of the properties of this equation. Due to these circumstances, (116) reduces to

$$\frac{\partial \psi(t)}{\partial t} = \eta(t) - \frac{k}{4\pi}\psi^\dagger(t)\frac{\partial \psi(t)}{\partial t} \wedge \frac{\partial \psi^\dagger(t)}{\partial t}\psi(t). \tag{117}$$

The evolution of a society under dysgenics is now described in *one*-dimension. We can then rewrite this equation in terms of the components of the quantum field $\psi(t) = (\psi_+(t), \psi_-(t))$. The equation (117) then becomes

$$\frac{\partial \psi_+(t)}{\partial t} = \eta_+(t) - \frac{k}{4\pi}|\psi_-(t)|^2 \frac{\partial \psi_+(t)}{\partial t} \tag{118}$$

$$\frac{\partial \psi_-(t)}{\partial t} = \eta_-(t) - \frac{k}{4\pi}|\psi_+(t)|^2 \frac{\partial \psi_-(t)}{\partial t}. \tag{119}$$

This set of equations show that the evolution of each component of the quantum field $\psi(t)$ has dependence on its own noise term and the square modulus that the other component possesses. What does this mean? There is a feedback mechanism between the positive and negative g in society, such that the fluctuations and growth rates of each factor are influenced by the presence and magnitude of the other factor. In order for us to solve the set of equations, we will use stochastic averaging. We have to make the assumption that there is a separation of time scales between the quantum field $\psi(t)$ and its own derivative $\frac{\partial \psi(t)}{\partial t}$ such that

$$\left|\frac{\partial \psi(t)}{\partial t}\right| \ll |\psi(t)|\,. \tag{120}$$

This means now that the quantum field $\psi(t)$ transforms much slower than its derivative, and thus we may neglect the higher order terms that are present in the equations. By applying stochastic averaging to these equations, we obtain the following approximate solutions for the quantum field components

$$\psi_+(t) \approx \psi_+(0)e^{\int_0 t\eta_+(\tau)d\tau - \frac{k}{8\pi}|\psi_-(0)|^2 t} \tag{121}$$

$$\psi_-(t) \approx \psi_-(0)e^{\int_0 t\eta_-(\tau)d\tau - \frac{k}{8\pi}|\psi_+(0)|^2 t} \tag{122}$$

Indeed we observe that because of this, the components of the quantum field grow or decay exponentially. This depends on the sign and magnitude of the noise terms. If $\eta_+(t)$ then we have exponential growth, but if we have $\eta_-(t)$ then we have exponential decay. Note also that this now shows that a negative feedback term proportional to the square modulus of the initial value of the other component affects the quantum field components. This represents the effect of dysgenics on the society that we are dealing with. The coupling constant k is the determinant of the strength of this particular feedback term. Higher values of k imply stronger dysgenic effects.

2.3.2 The Quantum Dysgenics Equation II

The equation (116) remains unchanged but the problem is that it is more challenging to solve analytically. To cope with this, we will have to solve the equation numerically. Let $\psi(x,t)$ be a smooth and continuous quantum field in the space-time domain $[0, L] \times [0, T]$ where L is the length or duration of the society and T is the duration of the simulation. We then proceed to discretise this domain into a grid of $N_x \times N_t$ points where N_x is the number of spatial points and N_t being temporal points. Denote the spatial step size and the temporal step size respectively by

$$\Delta x = \frac{L}{N_x} \tag{123}$$

$$\Delta t = \frac{T}{N_t}. \tag{124}$$

The value of the quantum field $\psi(x, t)$ at the grid point (i, j) can then be denoted by $\psi_{i,j}$, in which $i = 0, 1, \ldots, N_x - 1$ and $j = 0, 1, \ldots, N_t - 1$. Simply for the purposes of the convenience, the following notation will be used

$$\psi_{i+1,j} = \psi(x_i + \Delta x, t_j),\ \psi_{i-1,j} \tag{125}$$

$$\psi_{i-1,j} = \psi(x_i - \Delta x, t_j) \tag{126}$$

$$\psi_{i,j+1} = \psi(x_i, t_j + \Delta t) \tag{127}$$

$$\psi_{i,j-1} = \psi(x_i, t_j - \Delta t). \tag{128}$$

Now are able to approximate the partial derivatives of the quantum field by using finite difference formulas, such as

$$\frac{\partial \psi(x,t)}{\partial x} \approx \frac{\psi_{i+1,j} - \psi_{i-1,j}}{2\Delta x} \tag{129}$$

$$\frac{\partial \psi(x,t)}{\partial t} \approx \frac{\psi_{i,j+1} - \psi_{i,j-1}}{2\Delta t} \tag{130}$$

$$\frac{\partial^2 \psi(x,t)}{\partial x^2} \approx \frac{\psi_{i+1,j} - 2\psi_{i,j} + \psi_{i-1,j}}{\Delta x^2} \tag{131}$$

$$\frac{\partial^2 \psi(x,t)}{\partial t^2} \approx \frac{\psi_{i,j+1} - 2\psi_{i,j} + \psi_{i,j-1}}{\Delta t^2}. \tag{132}$$

Substituting those formulas into the equation (116) yields

$$\frac{\psi_{i,j+1} - \psi_{i,j-1}}{2\Delta t} = \eta_{i,j} - \frac{k}{4\pi}\psi^{\dagger}_{i,j}\frac{\psi_{i,j+1} - \psi_{i,j-1}}{2\Delta t} \wedge \frac{\psi^{\dagger}_{i,j+1} - \psi^{\dagger}_{i,j-1}}{2\Delta t}\psi_{i,j} + \frac{i}{2}\frac{\psi_{i+1,j} - 2\psi_{i,j} + \psi_{i-1,j}}{\Delta x^2}. \tag{133}$$

Now we have obtained a finite difference equation for the quantum field $\psi_{i,j}$. This equation is non-linear and implicit for $\psi_{i,j}$, which holds dependence on its values at the next time steps as well as those which are prior, along with the neighbouring spatial points. To solve the equation, we find the roots of a non-linear equation by using an iterative procedure. Let (133) be differentiable with a unique solution for each grid point (i, j). The solution can be marked as $\psi^*_{i,j}$ with the initial guess being $\psi^0_{i,j}$. The notation

$$f(\psi) = \frac{\psi - \psi_{i,j-1}}{2\Delta t} - \eta_{i,j} + \frac{k}{4\pi}\psi^{\dagger}_{i,j}\frac{\psi - \psi_{i,j-1}}{2\Delta t} \wedge \frac{\psi^{\dagger} - \psi^{\dagger}_{i,j-1}}{2\Delta t}\psi - \frac{i}{2}\frac{\psi_{i+1,j} - 2\psi + \psi_{i-1,j}}{\Delta x^2} \tag{134}$$

$$f'(\psi) = \frac{1}{\Delta t} + \frac{k}{4\pi}|\psi|^2 + \frac{k}{4\pi}|\psi_{i,j-1}|^2 - i\frac{\psi^{\dagger}_{i,j-1}}{\Delta t} - i\frac{\psi^{\dagger}}{\Delta t} + i\frac{\psi_{i+1,j} - 2\psi + \psi_{i-1,j}}{\Delta x^2} \quad (135)$$

will be used. These represent the function and its derivative which we want to find the root of. The procedure goes as follows

1. Start with an initial guess $\psi^0_{i,j}$ for the solution $\psi^*_{i,j}$. This may be arbitrarily selected or it may be derived from some heuristic.
2. Compute the value of the function $f(\psi^0_{i,j})$ and its derivative $f'(\psi^0_{i,j})$ using the formulas that are presented above.
3. Update the guess by means of subtraction of the ratio of the function and its derivative, such that

$$\psi^1_{i,j} = \psi^0_{i,j} - \frac{f(\psi^0_{i,j})}{f'(\psi^0_{i,j})}. \quad (136)$$

4. Iterate the process until we arrive at the point in which we have reached a satisfactory level of accuracy or a maximum number of iterations. The final guess is to be written as $\psi^n_{i,j}$, where n is the number of iterations. This guess is used as an approximation for the solution $\psi^*_{i,j}$, such that

$$\psi^*_{i,j} \approx \psi^n_{i,j}. \quad (137)$$

By this procedure, we have the ability to solve (133) for each grid point (i, j) and thus obtain for the quantum field $\psi(x, t)$ an approximation at each time step. Afterwards, we may use this approximation to compute a variety of quantities that would be of an interest to us, such as the mean g, the entropy of g, and so on. Plotting $\psi(x, t)$ as a function of space and time is also a possible option so that we may visualise how it evolves under dysgenics. Consider the following parameters

- $L = 10, T = 10, N_x = 100, N_t = 1000, \Delta x = 0.1, \Delta t = 0.01$
- $k = 1, D = 0.001$
- $\eta(x, t) = 0.01e^{\frac{-(x-5)^2}{2}} e^{-\frac{t}{10}}(\cos(t) + i\sin(t))$
- $\psi(x, 0) = e^{\frac{-x^2}{2}}(\cos(x) + i\sin(x))$

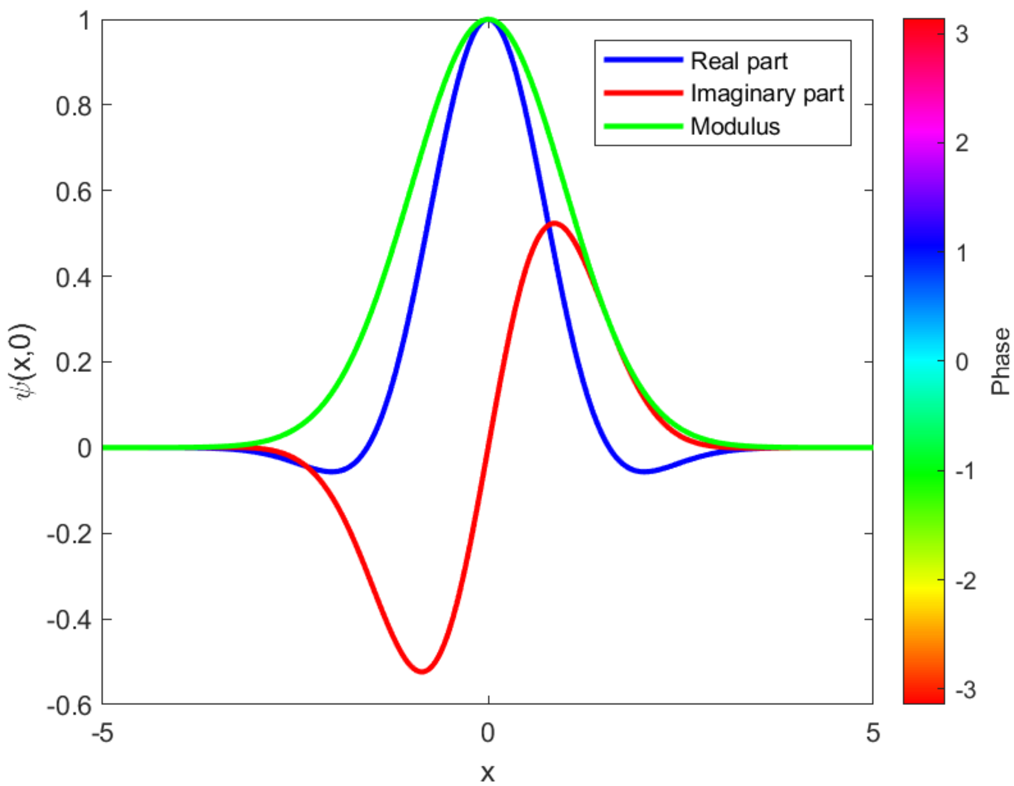


Fig. 1 Plot of the initial condition $\psi(x,0) = e^{\frac{-x^2}{2}}(\cos(x) + i\sin(x))$ as a function of x

This is the initial condition for the quantum field $\psi(x,t)$ at time $t = 0$, which represents the initial state of the society. This function is an example of a complex-valued function of a Gaussian curvature and a sinusoidal phase. Interpret the function as a superposition of two quantum states, one with positive g and the other with negative g. Then we can plot this function as a function of x to visualise its phase and shape. This code was employed

```

% param
L = 10;
T = 10;
Nx = 100;
Nt = 1000;
dx = L/Nx;
dt = T/Nt;
k = 1;
D = 0.01;
% define both the x and t range
x = linspace(0,L,Nx);
t = linspace(0,T,Nt);
% define the noise term
eta = @(x,t) 0.01 * exp(-(x-5).^2/2) .* exp(-t/10) .* (cos(t) + 1i * sin(t));
% define the initial condition
psi0 = @(x) exp(-x.^2/2) .* (cos(x) + 1i * sin(x));
```

```
% initialize the psi matrix
psi = zeros(Nx,Nt);
% set initial condition at t=0
psi(:,1) = psi0(x);
% set boundary condition at x=0 and x=L
psi(1,:) = psi(1,1);
psi(end,:) = psi(end,1);
% solve the finite difference equation
for j=2:Nt % loop over time steps
    for i=2:Nx-1 % loop over spatial points
        % define the function and its derivative
        f = @(psi) (psi - psi(i,j-1))/(2*dt) - eta(x(i),t(j)) + (k/(4*pi)) * psi(i,j-1)' * (psi - psi(i,j-1))/(2*dt) * (psi' - psi(i,j-1)')/(2*dt) * psi - (1i/2) * (psi(i+1,j) - 2*psi + psi(i-1,j))/(dx^2);
        fp = @(psi) 1/dt + (k/(4*pi)) * abs(psi)^2 + (k/(4*pi)) * abs(psi(i,j-1))^2 - 1i * psi(i,j-1)' / dt - 1i * psi' / dt + (1i/2) * (psi(i+1,j) - 2*psi + psi(i-1,j))/(dx^2);
        % initial guess
        psi0 = psi(i,j-1);
        % maximum tolerance and iterations
        tol = 1e-6;
        maxiter = 100;
        % error and iteration initialisation
        err = inf;
        iter = 0;
        % loop start
        while err > tol && iter < maxiter
            % update guess by subtracting ratio of function and derivative
            psi1 = psi0 - f(psi0)/fp(psi0);
            % compute error
            err = abs(psi1 - psi0);
            % update iteration
            iter = iter + 1;
            % update previous guess
            psi0 = psi1;
        end
        % set final guess as approximation for solution
        psi(i,j) = psi0;
    end
end
% modulus plotting and phase of quantum field
figure(2)
pcolor(x,t,abs(psi)')
shading interp
hold on
quiver(x,t,real(psi)',imag(psi)', 'k')
hold off

xlabel('x')
ylabel('t')
zlabel('|\psi(x,t)|')
c = colorbar;
c.Label.String = 'Modulus';
```

The blue curve shows the real part of the function, the red curve shows the imaginary part of the function, and the green curve shows the modulus of the function. The phase of the function is indicated by the color gradient from blue to red. This plot shows that the initial condition $\psi(x,0)$ has a maximum modulus at $x = 0$, which would mean that there is a higher concentration of individuals with positive θ at the center of the society. As x move away from 0, the modulus decreases, meaning that there is a lower concentration of individuals with negative θ at the edges of the society. The phase of the function varies from 0 to π as x increases from negative to positive values. That means that there is a phase difference between positive and negative g at various regions of the society itself.

2.3.3 The θ Factor

We can get the average θ by obtaining the mean genetic quality of a population. The average value phenotypic traits that are influenced by θ determine that. We can compute the average θ from the quantum field $\psi(x,t)$ by taking the expectation value of its modulus over space and time

$$\langle\theta\rangle = \frac{1}{LT}\int_0^L\int_0^T |\psi(x,t)|dxdt. \tag{138}$$

Our formula shows that the average θ is proportional to the average modulus of the quantum field $\psi(x,t)$ in which the average probability of finding an individual with a given θ in a given region of space and time is represented. The average θ is the measure of the overall well-being or performance of a society. Higher θ simply means that there are higher levels of intelligence, health, and so on.

We get the heterogeneity of genetic quality in a population by taking the variance of g. This is determined by the dispersion of the phenotypic traits that g influences. We can compute variance of g using the formula

$$\mathrm{Var}(\theta) = \frac{1}{LT}\int_0^L\int_0^T |\psi(x,t)|^2dxdt - \langle\theta\rangle^2. \tag{139}$$

The variance of θ is the measure of the diversity and complexity of a given society, with higher $\mathrm{Var}(\theta)$ meaning higher levels of differentiation and variation among groups and individuals in a society.

The uncertainty or disorder of genetic quality can be acquired by finding the entropy of θ. Unpredictability or randomness of phenotypic traits influenced by θ is the determinant here. By taking the expectation value of the Wehrl entropy of the quantum field, we arrive at

$$S(\theta) = -\frac{1}{LT}\int_0^L\int_0^T |\psi(x,t)|^2\log|\psi(x,t)|^2dxdt. \tag{140}$$

The Wehrl entropy is defined as

$$W(\psi) = -|\psi|^2\log|\psi|^2. \tag{141}$$

This is the measure of quantum uncertainty, satisfying the following inequality

$$W(\psi) \geq 1, \tag{142}$$

where equality holds for pure states and inequality holds for mixed states. The entropy of θ is the measure of the stochasticity and disorder that a society has. Higher $S(\theta)$ means more randomness and unpredictability among the patrons of a society.

2.3.4 The Intelligence Quotient

The average IQ will measure the mean cognitive ability or intelligence of a population. It is important to note that the average value of IQ is influenced by θ. We compute the average IQ from the average θ by means of a linear transformation

$$\langle IQ \rangle = a\langle \theta \rangle + b, \tag{143}$$

where a and b are constants that depend on the scale and units of an IQ test. Let us say that we are using the Stanford-Binet Intelligence Scale. That has a mean of 100, a standard deviation of 15. So we can then substitute these values into a and b . Thus

$$a = 15 \tag{144}$$

$$b = 100. \tag{145}$$

The average IQ is proportional to the average θ which is proportional to the average modulus of the quantum field $\psi(x, t)$. We can then proceed to derive the variance of IQ as

$$\mathrm{Var}(IQ) = a^2 \mathrm{Var}(g), \tag{146}$$

and the entropy of IQ, which would be

$$S(IQ) = S(\theta) + \log(a). \tag{147}$$

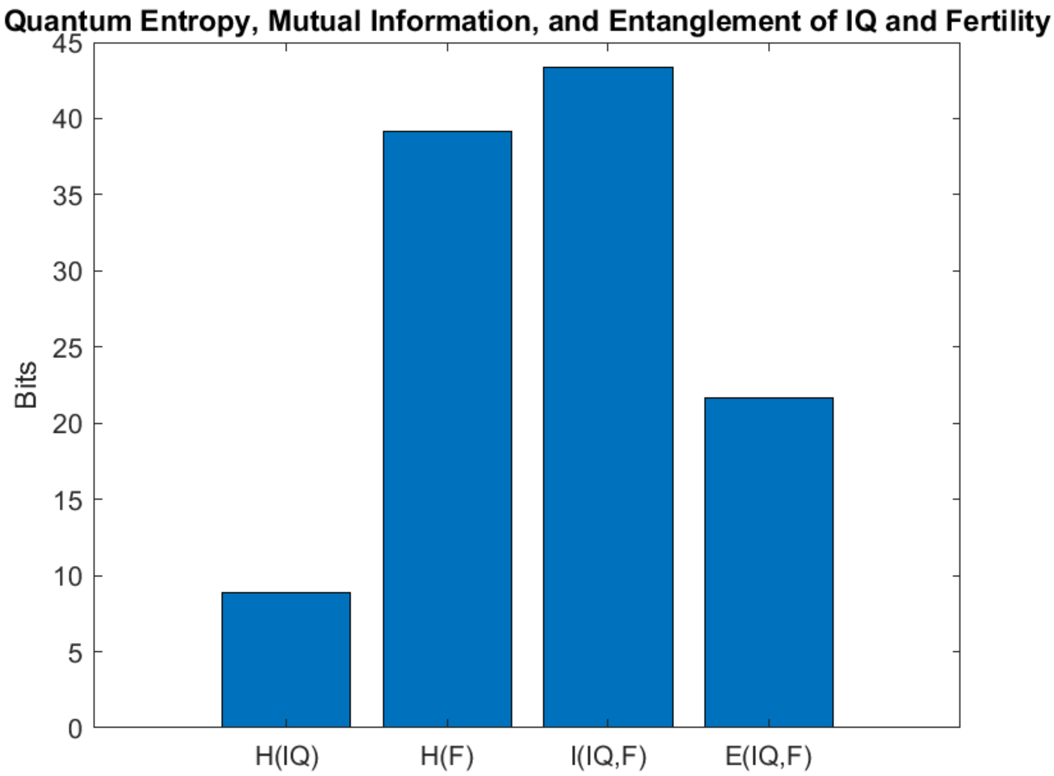

Quantum Entropy, Mutual Information, and Entanglement of IQ and Fertility
Bits
0
5
10
15
20
25
30
35
40
45
H(IQ)
H(F)
I(IQ,F)
E(IQ,F)

Fig. 2

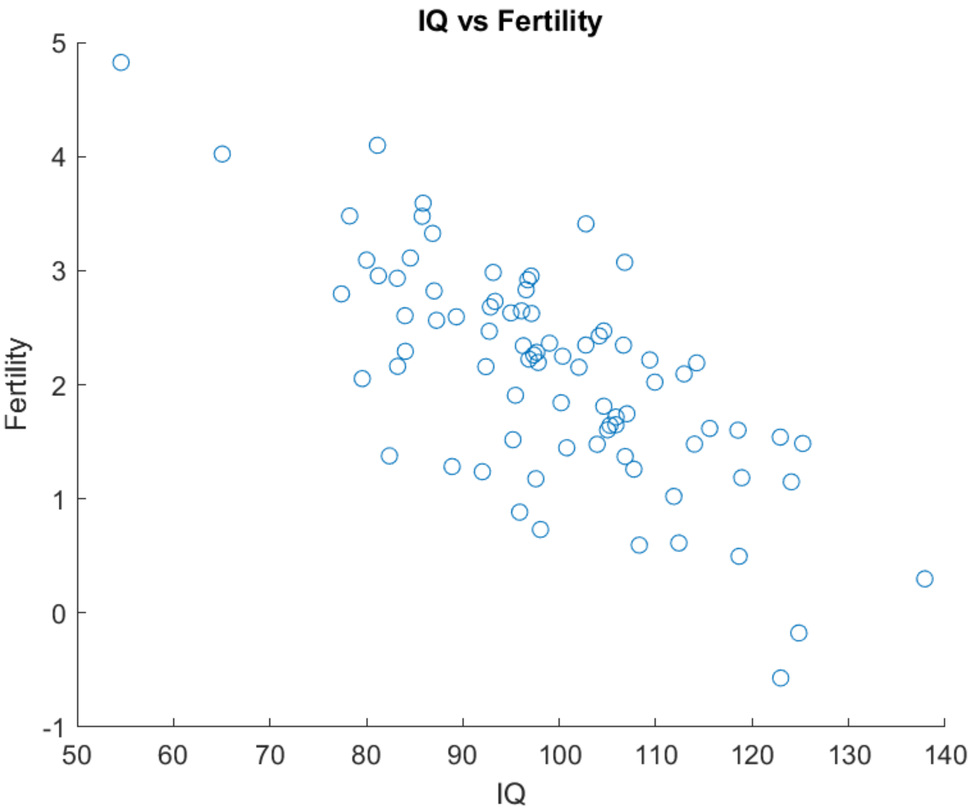


Fig. 3

2.4 Dysgenic Field Theory IV

Let there be some society of which N agents constitute. Each agent is to be characterised by a set of variables that represent their intelligence, earnings, dysgenic traits, etc. Such variables are continuous and bounded. The intelligence of an agent is measured by a single factor, denoted by g. The value of g is usually distributed normally in a population, with a mean and standard deviation respectively: μ_g, σ_g. Consider an agent's occupation. This is determined by a function $f(g)$ that maps the value of g to one of M discrete levels of occupational status. Denote this by

$$s_1 \leq s_2 \leq \cdots \leq s_M. \tag{148}$$

The function $f(g)$ is monotonic and increasing, with higher values of g corresponding to higher levels of occupational status. Determine the earnings of an agent by the function $h(s)$. This maps the occupational status level s to a positive number in $\mathbb{R}$, denoted by e. The same function properties of $f(g)$ apply here. Higher values of $h(s)$ are correspondent to higher levels of occupational status. The dysgenic traits of an agent are represented by a vector

$$\mathbf{d} = (d_1, d_2, \ldots, d_x), \tag{149}$$

in which each component d_k measures the degree of a specific dysgenic trait that is present within an agent. The value adhering to d_k is normally distributed. The dysgenic traits are negatively correlated with the value of g such that higher values of d_k imply lower values of g. We will write the correlation coefficient between d_k and g as

$$\rho_{d_k g}. \tag{150}$$

Agents interact with each other. They do this through social processes like migration, reproduction, employment, and so on. These processes affect the values of the variables that characterise the agents and also the quantum state of the system. Model the society as a quantum state composed of N agents

$$\psi(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_N), \tag{151}$$

where

$$\mathbf{x}_i = (g_i, s_i, e_i, d_i) \tag{152}$$

is the vector of variables of which an agent i is characterised by. The wave function satisfies

$$i\hbar \frac{\partial \psi}{\partial t} = H\psi. \tag{153}$$

The Hamiltonian is constituted by two terms: a kinetic term and a potential term. The kinetic term represents the intrinsic energy of each agent due to their intelligence and dysgenic traits. The potential term represents the interaction energy between agents due to their occupation and earnings. The Hamiltonian operator for this is given by

$$H = -\sum_{i=1}^{N} \frac{\hbar 2}{2m} \nabla_i 2 + V(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_N). \tag{154}$$

The potential function is taken to have the following form

$$V(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}N) = \sum i = 1^N V_0(\mathbf{x}i) + \sum i < j V_1(\mathbf{x}_i, \mathbf{x}_j), \tag{155}$$

The single agent potential $V_0(x_i)$ are external factors and forces that act on each agent. The two-agent potential $V_1(x_i, x_j)$ represents the internal forces which emerge from interaction between agent to agent, like cooperation or competition. The single-agent potential takes the form

$$V_0(\mathbf{x}i) = V_g(g_i) + V_d(\mathbf{d}i), \tag{156}$$

The potential due to the intelligence of agent i is represented by $V_g(g_i)$ while the potential due to the dysgenic traits is $V_d(d_i)$. Suppose that the potential due to intelligence is a harmonic oscillator potential. We give this by

$$V_g(g_i) = \frac{1}{2} m\omega^2 (g_i - \mu_g)^2. \tag{157}$$

So what we now have is that agents have some tendency to oscillate around their mean intelligence levels. Higher deviations from the mean would have to require higher energy. The potential due to dysgenic traits is a linear combination of harmonic oscillator potentials. This is given by

$$V_d(\mathbf{d}i) = \sum k = 1^K a_k \frac{1}{2} m\omega_k^2 (dik - \mu d_k)^2, \tag{158}$$

where a_k are positive coefficients that measure the relative importance of each dysgenic trait. Agents tend to oscillate around their mean dysgenic trait levels. The coefficients a_k and the frequencies ω_k are negatively correlated with the correlation coefficients $\rho_{d_k g}$. That means that more dysgenic traits have higher importance and lower frequencies.

We give the two-agent potential by the form

$$V_1(\mathbf{x}i, \mathbf{x}j) = V_s(s_i, s_j) + V_e(e_i, e_j), \tag{159}$$

where $V_s(s_i, s_j)$ is the potential due to the occupational status (PDOS) of agents i and j while $V_e(e_i, e_j)$ is the potential due to earnings (PDE). The PDOS is given by

$$V_s(s_i, s_j) = \frac{q}{4\pi\epsilon_0} \frac{s_i s_j}{rij}, \tag{160}$$

where we have the entailment that agents with a similar OS have a tendency to repel each other, while agents with a different OS have a tendency to attract each other. The PDE is given by

$$V_e(e_i, e_j) = 4\epsilon \left[\left(\frac{\sigma}{e_{ij}} \right)^{12} - \left(\frac{\sigma}{e_{ij}} \right)^{6} \right]. \tag{161}$$

Agents ith low earnings have a tendency to form stable bonds with each other, but agents with high earnings have a tendency of avoiding each other. The parameters ϵ and σ are positively correlated with the mean intelligence μ_g yet negatively correlated with the mean dysgenic trait levels μ_{d_k}. More intelligent and less dysgenic societies have stronger and longer-rage interactions.

2.4.1 Dynamics

Recall the equation (153). Its Hamiltonian may be written as

$$H = -i\hbar c \sum_{\mu=0}^{3} \sigma^\mu \partial_\mu + e \sum_{\mu=0}^{3} \sigma^\mu A_\mu. \tag{162}$$

To calibrate the Hamiltonian for our purposes, we will set $A_\mu = 0$ and we will also set $c = 1$. We can then write the wave function as a product of single-agent wave functions

$$\psi(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}N) = \prod i = 1^N \psi_i(\mathbf{x}_i), \tag{163}$$

. We can proceed to decompose the spinor $\psi_i(\mathbf{x}_i)$ as

$$\psi_i(\mathbf{x}_i) = \begin{pmatrix} u_i(\mathbf{x}_i) \\ v_i(\mathbf{x}_i) \end{pmatrix}. \tag{164}$$

Now we write for each agent

$$i\hbar \frac{\partial \psi_i}{\partial t} = -i\hbar \sum_{\mu=0}^{3} \sigma^\mu \partial_\mu \psi_i. \tag{165}$$

In component form, this is expressed as

$$i\hbar \frac{\partial u_i}{\partial t} = -i\hbar \left(\frac{\partial u_i}{\partial g_i} + \frac{\partial v_i}{\partial s_i} + \frac{\partial v_i}{\partial e_i} + \sum_{k=1}^{K} \frac{\partial v_i}{\partial d_{ik}} \right) \tag{166}$$

$$i\hbar \frac{\partial v_i}{\partial t} = -i\hbar \left(\frac{\partial v_i}{\partial g_i} - \frac{\partial u_i}{\partial s_i} - \frac{\partial u_i}{\partial e_i} - \sum_{k=1}^{K} \frac{\partial u_i}{\partial d_{ik}} \right) \tag{167}$$

The equations are homogeneous and linear, so normalisation and superposition of the wave function is thus preserved.

2.4.2 Operators and Observables

Such a theory must be in need of measuring properties that a society has. The number of agents, mean intelligence, and mean dysgenic trait level for a trait k can be respectively represented as

$$N = \sum_{i=1}^{N} 1, \tag{168}$$

$$\bar{g} = \frac{1}{N} \sum_{i=1}^{N} g_i, \tag{169}$$

and

$$\bar{d}k = \frac{1}{N} \sum_{i=1}^{N} d_{ik}. \tag{170}$$

We are going to have to now introduce some operators that represent the creation and annihilation of agents and their variable transformation. At a given state ψ, the creation operator $\hat{a}_i^\dagger(x_i)$ will create an agent i with variables $\mathbf{x_i}$. We can define the action for that easily. To do that, we will write

$$\hat{a}_i^\dagger(\mathbf{x}_i)\psi = \psi_i(\mathbf{x}_i)\psi, \tag{171}$$

For the action of the annihilation operator, it will be defined as

$$\hat{a}_i(\mathbf{x}_i)\psi = \int d\mathbf{x}'_i \delta(\mathbf{x}_i - \mathbf{x}'_i) \frac{\psi_i(\mathbf{x}'_i)}{\psi_i(\mathbf{x}_i)} \psi, \tag{172}$$

of which the Dirac delta function ensuring only that agents with variables $\mathbf{x_i}$ are annihilated. The anti-commutation relations

$$\hat{a}_i(\mathbf{x}_i), \hat{a}_j^\dagger(\mathbf{x}j) = \delta ij \delta(\mathbf{x}_i - \mathbf{x}_j) \tag{173}$$

$$\hat{a}_i(\mathbf{x}_i), \hat{a}_j(\mathbf{x}_j) = 0 \tag{174}$$

$$\hat{a}_i^\dagger(\mathbf{x}_i) \tag{175}$$

$$\hat{a}_j^\dagger(\mathbf{x}_j) = 0 \tag{176}$$

are satisfied by both operators. By the Pauli exclusion principle, no two *agents* can have the same ***exact*** set of variables. The change of variable operator $\hat{b}_i(\mathbf{x}, \mathbf{x}')$ will change the variables of an agent i from $\mathbf{x}$ to $\mathbf{x}'$. This operator has the action

$$\hat{b}_i(\mathbf{x}_i, \mathbf{x}'_i)\psi = \frac{\psi_i(\mathbf{x}'_i)}{\psi_i(\mathbf{x}_i)} \psi. \tag{177}$$

Now we can introduce the observables, which will be written as

$$\hat{N} = \sum_{i=1}^{N} \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i) \tag{178}$$

$$\hat{\bar{g}} = \frac{1}{\hat{N}} \sum i = 1^N g_i \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i) \tag{179}$$

$$\hat{\bar{d}}k = \frac{1}{\hat{N}} \sum i = 1^N d_{ik} \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i). \tag{180}$$

These operators are *not* Hermitian, but as long as we can take care of the complex conjugation and normalisation, then we can calculate the system's statistics.

2.4.3 Observable Expectation Values

Using Wick's theorem again, we can contract two operators by

$$\hat{A}\hat{B}\hat{A}\hat{B} = \langle \hat{A}\hat{B} \rangle - \langle \hat{A} \rangle \langle \hat{B} \rangle, \tag{181}$$

with the theorem being such that

$$\hat{A}_1\hat{A}_2 \ldots \hat{A}_n =: \hat{A}_1\hat{A}_2 \ldots \hat{A}n : + \sum i < j : \hat{A}_1\hat{A}\hat{A}_1\hat{A}_2 \ldots \hat{A}_i\hat{A}\hat{A}_i \ldots \hat{A}_j\hat{A}\hat{A}_j \ldots \hat{A}_n : + \ldots, \tag{182}$$

so now we can re-express the expectation values as

$$
\begin{aligned}
&\langle N\rangle \\
&= \sum_{i=1}^{N} \langle \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i)\rangle \\
&= \sum i = 1^N : \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i) : + \sum i = 1^N \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}\hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i) \\
&= \sum i = 1^N : \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i) : + \sum i = 1^N \langle \hat{a}_i^\dagger(\mathbf{x}_i)\hat{a}_i(\mathbf{x}_i)\rangle - \langle \hat{a}_i^\dagger(\mathbf{x}_i)\rangle\langle \hat{a}_i(\mathbf{x}_i)\rangle \\
&= N + \sum i = 1^N (\langle \hat{n}_i\rangle - |\langle \hat{a}_i(\mathbf{x}_i)\rangle|^2)
\end{aligned}
\tag{183}
$$

2.5 Dysgenic Field Theory V

Let N be the number of agents in a population. The state of an agent i at time t can be written as

$$x_i(t) = (x_{i1}(t), x_{i2}(t), \ldots, x_{in}(t)) \tag{184}$$

where n is the number of variables, such as dysgenic traits, cognitive ability, etc. Each variable $x_{ij}(t)$ takes values in a finite set X_{ij}. Those values depend on the measurement scale and nature of the variable though. Some Binary variable would may take values $X_{ij} = \{0, 1\}$ while a continuous variable may take values in $X_{ij} = [0, 1]$. There is a network of interactions among these agents. This is how they get influenced by each other's states. The network can be written by a weighted adjacency matrix

$$A = (a_{ij}). \tag{185}$$

Do note that $a_{ij} \geq 0$ is the interaction strength from some agent j to another agent i. A is symmetric for all i, j and A has zero diagonal entries for all i. It is sparse. Most agents have only a few direct connections with other agents. Now let us consider some external factors that can affect the network and the state of agents. We can write this as

$$u(t) = (u_1(t), u_2(t), \ldots, u_m(t)). \tag{186}$$

Finite values are also taken for each factor. A set of parameters should be added now. The vector parameter

$$\theta = (\theta_1, \theta_2, \ldots, \theta_p) \tag{187}$$

will denote this. We have p as the number of parameters. The final state of this system yields to be

$$s(t) = (x_1(t), x_2(t), \ldots, x_N(t), A, u(t), \theta)\,. \tag{188}$$

A stochastic process $\{s(t)\}_{t\geq 0}$ will be what evolves this system.

2.5.1 Dynamical Rules

Taking a density operator $\hat{\rho}_i(t)$ acts on some Hilbert space $\mathcal{H}_i$, we can have an evolution equation for density operators

$$\frac{d\hat{\rho}_i(t)}{dt} = -i[\hat{H}i(t), \hat{\rho}i(t)] + \sum j = 1^N \mathcal{L}_{ij}(t)(\hat{\rho}_j(t)) + \mathcal{D}_i(t)(\hat{\rho}_i(t)). \tag{189}$$

This is only associated for one agent i. For a population, we shall write

$$\frac{d\hat{\rho}(t)}{dt} = -i[\hat{H}(t), \hat{\rho}(t)] + \sum_{i=1}^{N} \mathrm{Tr}{-i} \left(\sum j = 1^N \mathcal{L}_{ij}(t)(\hat{\rho}_j(t)) + \mathcal{D}_i(t)(\hat{\rho}_i(t)) \right). \quad (190)$$

Social influence can affect the dynamics of dysgenic traits by decreasing or even increasing the adoption or rejection of these traits among populations. This can be modelled as

$$\mathcal{L}_{ij}(t)(\hat{\rho} j(t)) = \sum k = 1^n a_{ij}\theta_{ijk}(\hat{x}_{jk}(t)\hat{\rho} j(t)\hat{x}^{\dagger}_{jk}(t) - \frac{1}{2}\hat{x}^{\dagger}_{jk}(t)\hat{x}_{jk}(t), \hat{\rho}_j(t)). \quad (191)$$

The Genetic correlation which we will describe as a degree measure to which two traits are influenced by the same genes can affect whether there is a co-occurrence or trade-off of traits. Write this as

$$\hat{H}_i(t) = \sum j, k = 1^n u_1(t)\theta_{ijk}\hat{x}_{ij}(t)\hat{x}_{ik}(t). \quad (192)$$

A measurement error will exists by which prediction of a dysgenic trait will be limited either negatively or positively

$$\mathcal{D}_i(t)(\hat{\rho} i(t)) = \sum j = 1^n w_{ij}(t)(\hat{x}_{ij}(t)\hat{\rho} i(t)\hat{x}^{\dagger}_{ij}(t) - \frac{1}{2}\hat{x}^{\dagger}_{ij}(t)\hat{x}_{ij}(t), \hat{\rho}_i(t)). \quad (193)$$

Mutation of genes will take the form

$$\hat{H}_i(t) = \sum j = 1^n u_2(t)\theta_{ij}(\hat{x} ij(t) - \hat{x}^{\dagger}_{ij}(t)). \quad (194)$$

3 Molecular and Genetic Aspects of Dysgenics

Assume that we are working with a set of individuals of which each individual has a set of genes that determine their genetic quality. These could be things such as IQ, fertility, and so forth. Denote the strategy of an agent (or individual) i by s_i and the corresponding quantum state by $|\psi_i\rangle$. The observable that measure the strategy is denoted by S. The observable S itself has non-degenerate and discrete eigenvalues and eigenvectors. Each gene corresponds to a quantum state that can be described by a density matrix ρ. Diagonalising the density matrix leads to

$$\rho = \sum_i p_i |\psi_i\rangle\langle\psi_i| \quad (195)$$

By the Liouville-von Neumann equation given in the form

$$\frac{\mathrm{d}}{\mathrm{d}t}\rho = -i[H, \rho] + L(\rho)], \quad (196)$$

we can have the density matrix ρ evolve in time.

3.1 Modelling Dysgenic Trait Evolution

Let the initial state of i be a pure state that is given by

$$|\psi_i(0)\rangle = |s_i\rangle \tag{197}$$

The initial density matrix of i is given by

$$\rho_i(0) = |\psi_i(0)\rangle\langle\psi_i(0)| = |s_i\rangle\langle s_i.| \tag{198}$$

The initial average density matrix of all individuals/agents is given by

$$\bar{\rho}(0) = \frac{1}{N}\sum_{i=1}^{N}\rho_i(0) = \frac{1}{N}\sum_{i=1}^{N}|s+i\rangle\langle s_i| \tag{199}$$

where N is the total number of individuals/agents in a population. By the McKean-Vlasov equation

$$\frac{\mathrm{d}}{\mathrm{d}t}\rho_i = -i[H_i + V(\bar{\rho}), \rho_i] + L(\rho_i) \tag{200}$$

we get the evolution of the density matrix of some individual i. The Hamiltonian operator H_i is the descriptor for the energy and dynamics of some individual i in isolation. Assume that it takes the form

$$H_i = E(s_i)S \tag{201}$$

where $E(s_i$ is a representative function of i's energy with strategy s_i. The eigenvalues and eigenvectors of H_i are then given by

$$H_i|s_j\rangle = E(s_j)s_j|s_j\rangle \tag{202}$$

where j is any index from 1 to n. The Hamiltonian H_i assigns a numerical value to each strategy based on its reproductive success. The potential energy term $V(\bar{\rho})$ describes the interaction between i and other individuals because of their mean behaviour. Let the potential energy term be given by the form

$$V(\bar{\rho}) = -J\bar{S}S, \tag{203}$$

where J is a coupling constant that measures the strength of the interaction, and $\bar{S}$ is the mean value of the observable S over all agents. This is given by

$$\bar{S} = \mathrm{Tr}(\bar{\rho}S) = \frac{1}{N}\sum_{i=1}^{N}\mathrm{Tr}(\rho_i S) = \frac{1}{N}\sum_{i=1}^{N}s_i. \tag{204}$$

The potential energy term $V(\bar{\rho})$ is the quantum version of social influence. We define social influence to be when the behaviour of some agent or individual happens to be affected by the mean behaviour of other individuals/agents. Eigenvalues and eigenvectors are attached to the potential energy term and this is given by

$$V(\bar{\rho})|s_j\rangle = -J\bar{S}s_j|s_j\rangle \tag{205}$$

The Linbald operator $L(\rho)$ of the McKean-Vlasov equation takes the following form

$$L(\rho) = \sum_k \left(A_k \rho A_k^\dagger - \frac{1}{2} A_k^\dagger A_k \rho - \frac{1}{2} \rho A_k^\dagger A_k \right), \tag{206}$$

and it describes the non-unitary evolution of the system in light of the case that dissipation would occur. Using the McKean-Vlasov equation, we can model the evolution of dysgenic traits in a population. The Linbald operator $L(\rho_i)$ of the equation is what acts as the external factors on an individual i. We take the McKean-Vlasov equation to be the quantum version of evolutionary game theory (an important branch of game theory that studies how strategies evolve in population due to natural section and mutation). Now we will use it to calculate the expectation value of the observable S for an individual i in a given state $\rho_i(t)$ as so

$$\langle S\rangle_i(t) = \mathrm{Tr}(\rho_i(t)S) = \sum_j s_j \langle_j|\rho_i(t)|s_j\rangle. \tag{207}$$

The inner product of the equation are the diagonal elements of the density matrix $\rho_i(t)$. Using this expectation value, we may derive a mean value of an agent's strategy at time t. Variance of the observable, quantum entropy, and observable-wide correlation may also be calculated should we wish to do so.

3.2 Heritability and Adaptability

Let ρ represent the quantum state for an individual in a population. This will be a density matrix describing the probability distribution of the genetic states that they have. The transferring of the quantum states that hold the genetic information of a parent can be created by a quantum channel $\mathcal{E}$

$$\rho_{\text{offspring}} = \mathcal{E}(\rho_{\text{parents}}) \tag{208}$$

where we see that $\mathcal{E}$ as a quantum adaptive process. This essentially creates an optimisation of the quantum state of an offspring according to environmental conditions. Decomposing $\mathcal{E}$ is possible. We get thence a unitary operator U of which genetic mutation and recombination is encoded, a measurement operator M where the adaptation and selection of genes can be represented, and a noise operator N that represents fluctuations of genes. Now we write

$$\mathcal{E}(\rho) = N(M(U(\rho))). \tag{209}$$

The heritability of a dysgenic trait x_i can be estimated by comparing the correlation function between the trait and the quantum state ρ for the offspring and parents. We give this by

$$\langle x_i \rho \rangle = \mathrm{Tr}(x_i \rho) \tag{210}$$

and the heritability of x_i by

$$h_i^2 = \frac{\langle x_i \rho_{\text{offspring}} \rangle}{\langle x_i \rho_{\text{parents}} \rangle} \tag{211}$$

where h_i^2 is some number between 0 and 1 that will be measuring the variation in x_i by due of genetic factors. Higher values indicate more heritability, but lower values would indicate x_i has more influence by factors from an environment.

3.3 Dysgenic Phenotypes

Dysgenic phenotypes being the manifestations of dysgenic traits or a genotype that is observable could be described by an open quantum system. We will write ϕ to describe the phenotypic density matrix for the representation of some individual's phenotypic information. The total quantum state of the individual and the environment is given by

$$\phi_{\text{total}} = \phi \otimes \sigma \tag{212}$$

and it will evolve under the Schrödinger equation as

$$\frac{d}{dt}\phi_{\text{total}} = -i[H, \phi_{\text{total}}]. \tag{213}$$

By tracing out the environment, however, we obtain a reduced quantum state

$$\phi(t) = \mathrm{Tr}E(\phi_{\text{total}}(t)) \tag{214}$$

by which the master equation

$$\frac{d}{dt}\phi(t) = -i[H_S, \phi(t)] + \mathcal{L}(\phi(t)) \tag{215}$$

is satisfied. We give the effect of environmental factors on x_i by

$$e_i = \langle x_i \rho(t) \rangle - \langle x_i \rho(0) \rangle. \tag{216}$$

3.4 Quantum Dysgenic Epistasis

Given various quantum fields $\hat{X}_i(x,t)$ that correspond to different dysgenic traits X_i, a cubic term on a potential function $V(\hat{X}_1, \ldots, \hat{X}_n, \hat{E})$ can be added, which yields

$$V(\hat{X}1, \ldots, \hat{X}n, \hat{E}) = \sum i = 1^n \lambda_i \hat{X} i \hat{E} + \sum i, j, k = 1^n h_{ijk} \hat{X}_i \hat{X}_j \hat{X}_k. \tag{217}$$

where h_{ijk} are coupling constants that measure the strength of the interaction between some two genetic traits X_i and X_j. What the cubic term that we just added will do is that it will create an epistatic effect of multiple quantum fields $\hat{X}_j(x,t)$ and $\hat{X}_k(x,t)$ on one quantum field $\hat{X}_i(x,t)$. The sign and magnitude of the coupling constants will determine whether the epistatic effect is either positive or negative, and either synergistic or antagonistic as how classical epistasis does. If the coupling constant is positive, then $\hat{X}_j(x,t)$ and $\hat{X}_k(x,t)$ have a positive effect that they give onto $\hat{X}_i(x,t)$. This would mean that individuals who have high values of two traits will also have a high value of some other dysgenic trait. A positive feedback loop could be created by this where we would see that individuals with multiple dysgenic traits will have lower fitness and reproductive success. They will be more likely to pass on their dysgenic traits to their offspring. This can result in an increase in the frequency and severity of dysgenic traits in the population over generations. But what about if the coupling constant is negative? Well, if that is the case then those two quantum fields will obviously have a negative effect on $\hat{X}_i(x,t)$. What does this mean, though? Those same two individuals will have a *low* value of another dysgenic trait. A negative feedback loop could be lead because of this, whereby individuals with multiple dysgenic traits will be more successful in fitness and reproductive while being less likely to pass on their dysgenic traits. The frequency and severity of dysgenic traits can indeed be lessened. Suppose we are in a stable and homogeneous environment. The epistatic effect may be more pronounce and consistent because those two quantum fields will take more of their influence from their intrinsic properties and interactions. If we were in a dynamic and heterogeneous society, however, the circumstances and events of the environment will be the influencers of those two quantum fields. Populations with large genetic diversity usually hold to an epistatic effect that is of high complexity and being able to vary because those quantum fields will have more variation. Smaller genetic diversity in a population leads to a more uniform epistatic effect. High epistasis will usually result in a single quantum field being affected by many genes or quantum fields while lower epistasis will result in that particular quantum field being affected by less genes.

3.5 Quantum Dysgenic Pleiotropic Dynamics

Consider two basis states $|0\rangle$ and $|1\rangle$ which will represent respectively the dominant and recessive alleles of some gene. The interactions between different genes or genetic variants can induce transitions between different states, and such transitions can be represented by the operators: σ_x, σ_y, and σ_z. The first operator is induction by mutation, the second by recombination, and the last one by selection.

The state of a single gene or genetic variant at any given time can be represented by a state vector of either $|\psi\rangle$ or a density matrix ρ. Represent the state of a population of individuals with different genes as

$$|\Psi\rangle = \bigotimes_i |\psi_i\rangle \tag{218}$$

or

$$\rho = \bigotimes_i |\rho_i\rangle. \tag{219}$$

A Schrödinger equation of the form

$$\frac{d}{dt}|\psi\rangle = -iH|\psi\rangle \tag{220}$$

can describe the evolution of a single gene over time. For the population of individuals with those genes, however, we can describe them by

$$\frac{d}{dt}\rho = -i[H,\rho] + \sum_i L_i \rho L_i^\dagger - \frac{1}{2} L_i^\dagger L_i, \rho \tag{221}$$

To calculate the probability of observing a recessive allele at any given time, use

$$\mathbb{P}(0) = |\langle 0|\psi\rangle|^2 = \rho_{00}. \tag{222}$$

For recessive traits, we can similarly write

$$\mathbb{P}(1) = |\langle 1|\psi\rangle|^2 = \rho_{11} \tag{223}$$

Peculiar combinations of phenotypes or alleles in a population may be described by

$$\mathbb{P}(\Psi) = |\langle \Psi|\Psi\rangle|^2 = \rho_{\Psi\Psi} \tag{224}$$

3.5.1 Pleiotropic Information

We can write a Wigner function of a single gene can be calculated as:

$$W(\alpha) = \frac{1}{\pi} \sum_{n,m} \rho_{nm} e^{-|\alpha|2} L_n(2|\alpha|^2) L_m(2|\alpha|^2) e^{i(m-n)\theta}. \tag{225}$$

For populations, the function takes a similar form

$$W(\vec{\alpha}) = \frac{1}{\pi^N} \sum_{\vec{n},\vec{m}} \rho_{\vec{n}\vec{m}} e^{-|\vec{\alpha}|2} L_{\vec{n}}(2|\vec{\alpha}|^2) L_{\vec{m}}(2|\vec{\alpha}|^2) e^{i(\vec{m}-\vec{n})\cdot\vec{\theta}}. \tag{226}$$

3.5.2 Pleiotropic Noise

By the Langevin Equation

$$m\frac{d^2x}{dt^2} = F(x) + \xi(t) \tag{227}$$

The position of a single gene can be given by

$$x = \sqrt{\frac{\hbar}{2m\omega}}(\psi^* a + \psi a^\dagger) \tag{228}$$

wherefore the Langevin equation is the position of a population

$$\vec{x} = (\sqrt{\frac{\hbar}{2m_1\omega_1}}(\psi_1^* a_1 + \psi_1 a_1^\dagger), \ldots, \sqrt{\frac{\hbar}{2m_N\omega_N}}(\psi_N^* a_N + \psi_N a_N^\dagger)). \tag{229}$$

For a single gene we can write

$$m\frac{d^2x}{dt^2} = -m\omega^2 x + \eta(t) \tag{230}$$

and

$$m_i\frac{d^2x_i}{dt^2} = -m_i\omega_i^2 x_i + \eta_i(t) \tag{231}$$

for a population. Note that $\eta(t)$ is what represents noise by which a transition is induced between $|0\rangle$ and $|1\rangle$ for this oscillator model of pleiotropic noise.

4 Statistical Approaches

Diving off but not too far off from quantum interpretations of dysgenics, we will attempt to go more classical in the following subsections for our analysis. Denote the trait of an individual i by X_i and the corresponding random variable by X_i

4.1 Stochastic Interpretation

We derive an SDE that will interpret dysgenic traits as stochastic processes. Let the trait of an individual i at time t be $X_i(t)$. We write

$$dX_i(t) = f_i\left(X_i(t), t\right) dt + g_i\left(X_i(t), t\right) dW_i(t) \tag{232}$$

where the first term is a function (call it "F1") that represents a deterministic change of X_i and the second term is a function (call it "F2") that represents the stochastic part of X_i. The differential $dW_i(t)$ is of a Wiener process. It is a shock of the trait X_i. Using the Ornstein-Ulhenbeck process, we can model dysgenic trait evolution in a manner that is different than what we have done previously. Write

$$dX_i(t) = \alpha\left(\mu - X_i(t)\right) dt + \sigma dW_i(t). \tag{233}$$

So natural selection can be modelled by this. We take μ to be a desired value of the trait, α being the representative of the strength or the speed of the natural selection process, while σ represents the variation that the particular trait exhibits. By this process, X_i tends to revert to the mean value μ because of natural selection but something else happens. It does so *while* exhibiting fluctuations around the mean value μ.

The expectation value of X_i at t may be calculated as

$$\mathbb{E}\left[X_i(t)\right] = \mu + \left(X_i(0) - \mu\right) e^{-\alpha t}. \tag{234}$$

This represents the mean value of a trait at time t.

4.1.1 g Factor Dynamics and Transformation

For the g factor, we can write

$$dg_t = \mu(g_t, t)dt + \sigma(g_t, t)dW_t. \tag{235}$$

The diffusion term $\sigma(g_t, t)$ may be decomposed into a double term equation

$$\sigma(g_t, t) = \sigma_G(G_t, t) + \sigma_E(E_t, t). \tag{236}$$

The first term is the genetic component and the second term is the environmental component. Then we can write the g factor SDE.

$$dg_t = (\mu_G(G_t, t) + \mu_E(E_t, t))dt + (\sigma_G(G_t, t) + \sigma_E(E_t, t))dW_t \tag{237}$$

We should probably transform the SDE from the original coordinate system that it has to a new one that is more suitable to analyse g. We will have to make use of Ito's lemma to do that, which states that

$$dY_t = \left(\frac{\partial h}{\partial t} + f\frac{\partial h}{\partial x} + \frac{1}{2}g^2\frac{\partial^2 h}{\partial x^2}\right)dt + g\frac{\partial h}{\partial x}dW_t \tag{238}$$

only under the condition that if X_t is a stochastic process that satisfies

$$dX_t = f(X_t, t)dt + g(X_t, t)dW_t \tag{239}$$

and $Y_t = h(X_t, t)$ is another stochastic process that is a function of X_t and t. Let us now introduce some new coordinate system. This will be defined by two new variables: Z_t and R_t. The first variable represents a normalised g and the second one represents the ratio of the genetic component to the total g. We can express the new variables as functions of the original variables as

$$Z_t = \frac{g_t - \mu_g(t)}{\sigma_g(t)} \tag{240}$$

$$R_t = \frac{G_t}{g_t} \tag{241}$$

and then invert them to express the original variables as functions of the new variables

$$g_t = \mu_g(t) + \sigma_g(t)Z_t \tag{242}$$

$$G_t = R_t g_t. \tag{243}$$

By Ito's lemma, the SDE for the standardised g factor Z_t can be written as

$$dZ_t = \left(\frac{\mu_G(R_t g_t, t) + \mu_E((1-R_t)g_t, t)}{\sigma_g(t)} - Z_t \frac{\sigma_G(R_t g_t, t) + \sigma_E((1-R_t)g_t, t)}{\sigma_g(t)} - Z_t \frac{d\mu_g}{dt} - \frac{d\sigma_g}{dt} \right) dt + (\sigma_G(R_t g_t, t) + \sigma_E((1-R_t)g_t, t)) dW_t \tag{244}$$

and the SDE for the ratio of genetic component to total g factor R_t as

$$dR_t = \left(\frac{\mu_G(R_t g_t, t)}{g_t} - R_t \frac{\mu_G(R_t g_t, t) + \mu_E((1-R_t)g_t, t)}{g_t} + R_t(1-R_t) \frac{\sigma_G(R_t g_t, t) - \sigma_E((1-R_t)g_t, t)}{g_t} \right) dt + R_t(1-R_t) \frac{\sigma_G(R_t g_t, t) - \sigma_E((1-R_t)g_t, t)}{g_t} dW_t. \tag{245}$$

Now with these new SDEs for the new variables that we have imposed, *relativised* and *standardised* g can be studied over the course of time within populations with different genetic makeup under external influence.

4.1.2 Quantum Stochastic Interpretation

A quantum SDE will take the form

$$d|\psi(t)\rangle = -\frac{i}{\hbar} \hat{H} |\psi(t)\rangle dt + \sum_{j=1}^{M} \hat{L} j |\psi(t)\rangle dW j, t. \tag{246}$$

The Linbald operators $\hat{L}_j$ satisfy

$$\sum_{j=1}^{M} \hat{L}_j^\dagger \hat{L}_j = \hat{I} \tag{247}$$

and

$$[\hat{L}_j, \hat{H}] = 0. \tag{248}$$

Take some quantum field. It will be subjected to intrinsic noise and extrinsic noise. Intrinsic noise occurs because of quantum fluctuations within a quantum field itself while extrinsic noise is due to external sources of which the quantum field is affected by. This is already implied by the names. Define the Lindbald operators for each quantum field as

$$\hat{L}_j = \sqrt{\gamma_j} (\hat{\varphi}_j - V_j(x, t)), \tag{249}$$

Understand that

- γ_j is some positive constant that measures the strength of noise for some genetic trait x_j
- $V_j(x, t)$ is an environmental function that affects a genetic trait x_j

With the Linbald operators being defined, we can derive a Hamiltonian for the quantum SDE

$$\hat{H} = \sum_{j=1}^{M} \int d^3x \left(\frac{1}{2} \left(\frac{\partial \hat{\varphi}_j}{\partial t} \right)^2 + \frac{1}{2} (\nabla \hat{\varphi}_j)^2 + \frac{1}{2} m_j^2 \hat{\varphi}_j^2 + V_j(x,t) \hat{\varphi}_j \right)$$
$$+ \sum j, k = 1^M \int d^3x \left(g_{jk} \hat{\varphi}_j \hat{\varphi} k + h_{jk} (\nabla \hat{\varphi}_j) \cdot (\nabla \hat{\varphi} k) + f_{jk} (\nabla^2 \hat{\varphi}_j)(\nabla^2 \hat{\varphi}_k) \right). \tag{250}$$

4.2 Quantised Fokker-Plank

For some quantum field ϕ_i, choose a basis of eigenstates $\{|n\rangle\}$, then

$$\mathcal{P}(\phi_i) = \sum_n |n\rangle\langle n|\phi_i|n\rangle\langle n| \tag{251}$$

The projection operator satisfies both

$$\mathcal{P}^2 = \mathcal{P} \tag{252}$$

and

$$[\mathcal{P}, H] = 0 \tag{253}$$

We lead ourselves to a set of ordinary differential equations which have been coupled for the diagonal elements of a probability density matrix

$$\frac{d}{dt}\rho_{nn} = -i \sum_m (\omega_{nm} - \omega_{mn}) \rho_{nm} + \sum_m \Gamma_{nm} (\rho_{mm} - \rho_{nn}) + \sum_m \Lambda_{nm} (\rho_{mn} + \rho_{nm}). \tag{254}$$

Choose a basis of coherent states $|\alpha\rangle$, for each field ϕ_i. Then

$$\mathcal{D}\phi = \prod_i \mathcal{D}\alpha_i \prod_n |\alpha_n\rangle\langle\alpha_n|. \tag{255}$$

The path integral measure satisfies

$$\int \mathcal{D}\phi = 1 \tag{256}$$

and

$$\int \mathcal{D}\phi |\phi\rangle\langle\phi| = 1. \tag{257}$$

Expressing a probability density matrix as a path integral over quantum fields with some approximations such as expanding in powers of coupling constants and applying the stationary phase approximation yields

$$\frac{\partial}{\partial t}\rho(\phi, \phi', t) = -i(H(\phi) - H(\phi'))\rho(\phi, \phi', t) + D(\phi, \phi') \frac{\delta^2}{\delta\phi\delta\phi'} \rho(\phi, \phi', t) + F(\phi, \phi') \frac{\delta}{\delta\phi'} \rho(\phi, \phi', t). \tag{258}$$

4.3 Uncertainty in Dysgenic Systems

The probability distribution of X_i is $\mathbb{P}(X)$, but the probability of a unique value of X_i will be written as

$$\mathbb{P}(X_i = x). \tag{259}$$

Using a normal distribution, we write

$$\mathbb{P}(X_i = x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \tag{260}$$

where μ is the mean and σ represents the standard deviation of X_i. This will be related to the central limit theorem, but quantised for our case. Let each trait be influenced by a large number of independent and identically distributed factors. Each trait then tends to follow a normal distribution alongside some mean and standard deviation.

By normal distribution, the probability of a specific value or even a range of values for each trait is

$$\mathbb{P}(a < X_i < b) = \int_a^b = \mathbb{P}(X_i = x) = \frac{1}{\sqrt{2\pi}\sigma} \int_a^b e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx. \tag{261}$$

The probability of a specific value or range of values for each trait represents the likelihood or frequency of observing that particular value or range in a population that we are studying. The probability distribution of each dysgenic trait can be described by a Bernoulli distribution

$$\mathbb{P}(X_i = x_i) = p_i^{x_i}(1 - p_i)^{1-x_i}. \tag{262}$$

and the g factor can be described by normal distribution

$$\mathbb{P}(G = g) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(g-\mu)^2}{2\sigma^2}} \tag{263}$$

5 Analysis

5.1 Hypotheses

- Dysgenes are quantum entangled states that exhibit non-local correlations and violate classical inequalities.
- Dysgenes are influenced by external factors such as environment, stress, and noise, which cause dissipation, decoherence, and mutation.
- Dysgenes are subject to natural selection and social influence, which cause reversion, diffusion, and recombination.
- Dysgenes affect the genetic quality and fitness of individuals and populations, which can be measured by observables such as but not limited to IQ.
- There is a relationship between dysgenic fertility and lack of selection pressures due to technological factors.

- A total wave function Ψ has a non-zero expectation value for any linear combination of dysgenic traits; there is no pure state that corresponds to a completely dysgenic-free or completely dysgenic-full population:

$$H_0 : \langle \Psi | A | \Psi \rangle \neq 0 \tag{264}$$

- Dysgenic traits have a negative impact on the energy and fitness of the society, as they increase the energy and decrease the fitness over time.
- Social interactions have a positive feedback effect on dysgenic traits, as they increase their value and their effect on energy and fitness over time.
- The entropy of IQ increases over time, which indicates an increase in the uncertainty or disorder of cognitive ability or intelligence in the population.

5.2 Predictions

- Dysgenes will exhibit non-local correlations and violate classical inequalities when measured by observables. We predict that there will be a violation of the Bell inequality between IQ and health measured on two distant individuals with dysgenes. This means that there will be a stronger correlation between IQ and health than what is expected by classical theory.
- Exposure to harsh environment, high stress, or low noise will cause dysgenes to lose energy, coherence, or change state. This means that there will be a decrease in genetic quality or fitness due to external factors.
- Natural selection will favour individuals with higher genetic quality or fitness, and social influence will favor individuals with similar traits. This means that there will be a tendency for dysgenes to revert to the mean value, fluctuate around the mean value, or exchange with other traits.
- Individuals with dysgenic traits will have lower IQ, health, or fertility than individuals without dysgenes and thus cause a negative impact of dysgenes on the individual and population level.

6 Appendix

A Incomplete Dysgenic Field Theories

These are a set of field theories in relation to dysgenics that I have tried working on but laid off for various reasons. You are free to expand onto them.

A.1 Dysgenic Field Theory A

Let there be a set of dysgenic traits, $X_1, X_2, \ldots X_n$ in which n is the number of dysgenic traits considered. We can write the quantum field corresponding to the trait X_i by $\hat{X}_i(x,t)$. These quantum fields will be scalar by nature. They will also be coupled to an environment, and such an environment. We can summarise everything by the action functional

$$S[\hat{X}1, \ldots, \hat{X}n, \hat{E}] = \int d^4x \left(\sum i = 1^n \frac{1}{2} \partial\mu \hat{X}_i \partial^\mu \hat{X}_i - \frac{1}{2} m_i^2 \hat{X}_i^2 - V(\hat{X}_1, \ldots, \hat{X}n, \hat{E}) + \mathcal{L}\text{env}(\hat{E}) \right). \tag{265}$$

A.1.1 Potential Environment and Linear Potential

The potential function inside the action functional will be expressed as

$$V(\hat{X}_1, \ldots, \hat{X}n, \hat{E}) = \sum i = 1^n \lambda_i \hat{X}_i \hat{E}, \tag{266}$$

thus making the action functional become

$$S[\hat{X}1, \ldots, \hat{X}n, \hat{E}] = \int d^4x \left(\sum i = 1^n \frac{1}{2} \partial\mu \hat{X}_i \partial^\mu \hat{X}_i - \frac{1}{2} m_i^2 \hat{X}_i^2 + \lambda_i \hat{X} i \hat{E} + \frac{1}{2} \partial\mu \hat{E} \partial^\mu \hat{E} - \frac{1}{2} M^2 \hat{E}^2 \right). \tag{267}$$

Varying the action functional for the dysgenic and environmental quantum fields and setting the variations to zero yields

$$\partial_\mu \partial^\mu + m_i^2) \hat{X} i(x,t) - \lambda_i \hat{E}(x,t) = 0, \tag{268}$$

$$(\partial\mu \partial^\mu + M^2) \hat{E}(x,t) - \sum_{i=1}^{n} \lambda_i \hat{X}_i(x,t) = 0. \tag{269}$$

These are the equations of motion.

A.1.2 Perturbative Analysis

We can start from a free system where the dysgenic and environmental fields do not hold interactions with each other and then adding an interaction term as a small perturbation. By doing so, we derive this action functional

$$S_0[\hat{X}1, \ldots, \hat{X}n, \hat{E}] = \int d^4x \left(\sum i = 1^n \frac{1}{2} \partial\mu \hat{X}_i \partial^\mu \hat{X}_i - \frac{1}{2} m_i^2 \hat{X} i^2 + \frac{1}{2} \partial\mu \hat{E} \partial^\mu \hat{E} - \frac{1}{2} M^2 \hat{E}^2 \right). \tag{270}$$

The equations of motion for this are

$$(\partial_\mu \partial^\mu + m_i^2) \hat{X} i(x,t) = 0, \tag{271}$$

$$(\partial\mu \partial^\mu + M^2) \hat{E}(x,t) = 0. \tag{272}$$

We can create a general solution for a dysgenic quantum field as

$$\hat{X}_i(x,t) = \int \frac{d3k}{(2\pi)3} \frac{1}{\sqrt{2\omega_k}} \left(ai, k e^{-ikx} + a_{i,k}^\dagger e^{ikx} \right), \tag{273}$$

with the satisfaction of the following commutation relations

$$[a_{i,k}, a_{j,k'}] = 0, \tag{274}$$

$$[a_{i,k}, a^{\dagger}_{j,k'}] = (2\pi)^3 \delta_{ij} \delta(\vec{k} - \vec{k'}). \tag{275}$$

For the environmental quantum field, it has a solution

$$\hat{E}(x,t) = \int \frac{d3k}{(2\pi)3} \frac{1}{\sqrt{2\Omega_k}} \left(b_k e^{-ikx} + b_k^{\dagger} e^{ikx} \right). \tag{276}$$

A.1.3 Renormalisation

We will impose a cutoff Λ on both the dysgenic and environmental quantum fields, with modes with only $|\vec{k}| \leq \Lambda$ being considered. Thus

$$\int \frac{d^3k}{(2\pi)3} \rightarrow \frac{1}{V_\Lambda} \sum_{\vec{k} \in V_\Lambda} . \tag{277}$$

This procedure has now introduced a dependence on Λ in the solutions for both of the quantum fields. This is unwanted, however. We have no use for this, so we have to remove it. To do that, we would need to renormalise m_i and M along with the coupling constants λ_i by adding counterterms which will cancel out divergences. Thus

$$m_i^2 = m_i^2(\Lambda) + \delta m_i^2(\Lambda), \tag{278}$$

$$M^2 = M^2(\Lambda) + \delta M^2(\Lambda), \tag{279}$$

$$\lambda_i = \lambda_i(\Lambda) + \delta \lambda_i(\Lambda). \tag{280}$$

Now let us determine the counterterms by imposing some renormalisation conditions.

$$m_i^2 = -p^2 - \Sigma_i(p^2), \tag{281}$$

$$M^2 = -p^2 - \Pi(p^2). \tag{282}$$

The self-energy corrections for both of the quantum fields may be computed by various methods. Using one-loop order, they are given by

$$\Sigma_i(p^2) = -i\lambda_i^2 \int \frac{d4k}{(2\pi)4} \frac{1}{k^2 - M^2 + i\epsilon}, \tag{283}$$

$$\Pi(p^2) = -i \sum_{i=1}^{n} \lambda_i^2 \int \frac{d4k}{(2\pi)4} \frac{1}{k^2 - m_i^2 + i\epsilon}. \tag{284}$$

We can not stop here, however. The integrals that are in both equations diverge once we arrive at large values for k, so we are going to have to regularise them by imposing Λ. Afterwards, we can find the counterterms by solving for them in terms of Λ and the bare parameters. Thus

$$\delta m_i^2(\Lambda) = i\lambda_i^2 \int_{|\vec{k}|<\Lambda} \frac{d4k}{(2\pi)4} \frac{1}{k^2 - M^2 + i\epsilon}, \tag{285}$$

$$\delta M^2(\Lambda) = i \sum_{i=1}^{n} \lambda_i^2 \int_{|\vec{k}|<\Lambda} \frac{d4k}{(2\pi)4} \frac{1}{k^2 - m_i^2 + i\epsilon}, \tag{286}$$

$$\delta\lambda_i(\Lambda) = 0. \tag{287}$$

The purpose of the last equation that we have written here is for it to serve as a reminder λ_i are not renormalisable at one-loop order. They are finite and independent of Λ. Now we have to adjust the fields themselves. This can be done by introducing some wavefunction renormalisation factors Z_i and Z_E such that

$$\hat{X}_i(x,t) = \sqrt{Z_i}\hat{X}_i^R(x,t), \tag{288}$$

$$\hat{E}(x,t) = \sqrt{Z_E}\hat{E}^R(x,t). \tag{289}$$

Now we have renormalised both the dysgenic and the environmental fields. We can determine the wavefunction renormalisation factors by requiring that the residues of the propagators are equal to one,

$$Z_i = \left(1 - \frac{\partial \Sigma_i}{\partial p^2}\right)^{-1}, \tag{290}$$

$$Z_E = \left(1 - \frac{\partial \Pi}{\partial p^2}\right)^{-1}. \tag{291}$$

Now we can obtain finite and meaningful results for whatever quantities that we choose to hunt for. It is important, though, to check that the consistency and robustness of whatever results we have by taking a limit

$$\Lambda \to \infty \tag{292}$$

and undergo comparisons with different schemes.

A.1.4 Properties of the Dysgenic and Environmental Fields

The energy and momentum distributions for both of the fields are defined by

$$\rho_i(\omega, \vec{k}) = \frac{1}{2\pi} \int d^4x e^{ikx} \langle [\hat{X}_i(x,t), \hat{X}_i(0,0)] \rangle, \tag{293}$$

$$\rho_E(\omega, \vec{k}) = \frac{1}{2\pi} \int d^4x e^{ikx} \langle [\hat{E}(x,t), \hat{E}(0,0)] \rangle. \tag{294}$$

The propagators for both fields are

$$G_i(x-y) = \langle \hat{X}_i(x,t)\hat{X}_i(y,t) \rangle, \tag{295}$$

$$G_E(x-y) = \langle \hat{E}(x,t)\hat{E}(y,t) \rangle. \tag{296}$$

Now we can express the propagators in terms of the original spectral functions that we derived at the beginning of this sub-subsection as

$$G_i(x-y) = \int \frac{d^4k}{(2\pi)4} e^{-ik(x-y)} G_i(k), \tag{297}$$

$$G_E(x-y) = \int \frac{d^4k}{(2\pi)4} e^{-ik(x-y)} G_E(k). \tag{298}$$

The Fourier transforms of both propagators are given by

$$G_i(k) = \frac{i}{k^2 - m_i^2 + i\epsilon + \Sigma_i(k^2)}, \tag{299}$$

$$G_E(k) = \frac{i}{k^2 - M^2 + i\epsilon + \Pi(k^2)}. \tag{300}$$

Those spectral functions can be obtained from the propagators by the following relations

$$\rho_i(\omega, \vec{k}) = -\frac{1}{\pi} \mathrm{Im} G_i(\omega, \vec{k}), \tag{301}$$

$$\rho_E(\omega, \vec{k}) = -\frac{1}{\pi} \mathrm{Im} G_E(\omega, \vec{k}). \tag{302}$$

The spectral functions satisfy

$$\rho_i(\omega, \vec{k}) = -\rho_i(-\omega, -\vec{k}), \tag{303}$$

$$\rho_E(\omega, \vec{k}) = -\rho_E(-\omega, -\vec{k}), \tag{304}$$

$$\rho_i(\omega, \vec{k}) \geq 0, \tag{305}$$

and

$$\rho_E(\omega, \vec{k}) \geq 0. \tag{306}$$

Selecting a vacuum state reduces the spectral functions to

$$\rho_i(\omega, \vec{k}) = 2\pi\delta(\omega^2 - \vec{k}^2 - m_i^2), \tag{307}$$

$$\rho_E(\omega, \vec{k}) = 2\pi\delta(\omega^2 - \vec{k}^2 - M^2). \tag{308}$$

Free quantum fields hold these spectral functions. We give them solutions by dispersion relations

$$\omega^2 = \vec{k}^2 + m_i^2, \tag{309}$$

$$\omega^2 = \vec{k}^2 + M^2. \tag{310}$$

Selection of different quantum states like a thermal state will cause the spectral functions to be given by

$$\rho_i(\omega, \vec{k}) = \frac{1}{e^{\beta\omega} - 1} 2\pi\delta(\omega^2 - \vec{k}^2 - m_i^2), \tag{311}$$

$$\rho_E(\omega, \vec{k}) = \frac{1}{e^{\beta\omega} - 1} 2\pi\delta(\omega^2 - \vec{k}^2 - M^2). \tag{312}$$

The average energy of the dysgenic quantum field in a given quantum state may be calculated as

$$E_i = \int d^3k \frac{\omega_k}{V_\Lambda} \langle a^\dagger_{i,k} a_{i,k} \rangle = \int d^3k \frac{\omega_k}{V_\Lambda} \frac{\rho_i(\omega_k, \vec{k})}{e^{\beta\omega_k} - 1}, \tag{313}$$

whereas for the environmental field, we similarly calculate it as

$$E_E = \int d^3k \frac{\Omega_k}{V_\Lambda} \langle b^\dagger_k b_k \rangle = \int d^3k \frac{\Omega_k}{V_\Lambda} \frac{\rho_E(\Omega_k, \vec{k})}{e^{\beta\Omega_k} - 1}. \tag{314}$$

A.1.5 Intercorrelations of the Dysgenic and Environmental Quantum Fields

The two-point correlation function of the dysgenic quantum field is defined as

$$C_i(x, y) = \langle \hat{X}_i(x, t) \hat{X}_i(y, t) \rangle, \tag{315}$$

and for the environmental field as

$$C_E(x, y) = \langle \hat{E}(x, t) \hat{E}(y, t) \rangle, \tag{316}$$

with the cross-correlation ultimately being

$$C_{iE}(x, y) = \langle \hat{X}_i(x, t) \hat{E}(y, t) \rangle, \tag{317}$$

which will measure the correlation or response of trait X_i for an individual located at $\vec{x}$ at some time t with the environment at $\vec{y}$ at t. The definitions can be generalised, if we choose to do so. Using the propagators that we derived earlier, we can calculate these correlation functions as

$$C_i(x, y) = G_i(x - y), \tag{318}$$

where the propagator for the dysgenic quantum field is given by

$$G_i(x - y) = \int \frac{d^4k}{(2\pi)4} e^{-ik(x-y)} G_i(k), \tag{319}$$

and the Fourier transform of the propagator being

$$G_i(k) = \frac{i}{k^2 - m_i^2 + i\epsilon + \Sigma_i(k^2)}. \tag{320}$$

The correlation functions satisfy

$$C_i(x, y) = C_i(y, x), \tag{321}$$

$$C_E(x,y) = C_E(y,x), \tag{322}$$
$$C_{iE}(x,y) = C_{iE}(y,x), \tag{323}$$
$$C_i(x,y) = 0 \text{ if } x^0 < y^0, \tag{324}$$
$$C_E(x,y) = 0 \text{ if } x^0 < y^0, \tag{325}$$
$$C_{iE}(x,y) = 0 \text{ if } x^0 < y^0. \tag{326}$$

Selecting once again a vacuum state, we reduce the correlation functions to

$$C_i(x,y) = \int \frac{d4k}{(2\pi)4} e^{-ik(x-y)} \frac{i}{k^2 - m_i^2 + i\epsilon}, \tag{327}$$

$$C_E(x,y) = \int \frac{d4k}{(2\pi)4} e^{-ik(x-y)} \frac{i}{k^2 - M^2 + i\epsilon}, \tag{328}$$

$$C_{iE}(x,y) = 0. \tag{329}$$

A.2 Dysgenic Field Theory B

Take some quantum field ϕ_i to be that which represents each dysgenic trait that exists. There are quartic interactions between different fields, which we can represent by

$$\mathcal{L}_{ij} = -\frac{g_{ij}}{4!}(\phi_i^\dagger \phi_i)(\phi_j^\dagger \phi_j). \tag{330}$$

This was selected to reflect how dysgenic traits can affect each other in a non-local and non-linear form. Each field has an equation of motion that can be obtained by

$$(\gamma^\mu \partial_\mu + m_i)\phi_i - \sum_j \frac{g_{ij}}{3!}(\phi_j^\dagger \phi_j)\phi_i = 0. \tag{331}$$

A.3 Dysgenic Field Theory Γ

$$\mathcal{F} = \mathcal{F}\phi \otimes \mathcal{F}\psi. \tag{332}$$
$$\mathcal{L}_I = \mathcal{L}_B + \mathcal{L}_R + \mathcal{L}_E. \tag{333}$$

$$\mathcal{L}_R = \sum_{i=1}^{M} \alpha_i \phi_i(x,t) + \sum_{i,j=1}^{M} \delta_{ij} \phi_i(x,t)\phi_j(x,t), \tag{334}$$

$$\mathcal{L}_B = \sum_{i=1}^{M}\sum_{j=1}^{J} \beta_{ij}\phi_i(x,t)\psi_j(x,t) + \sum_{i=1}^{M}\sum_{k=1}^{K} \gamma_{ik}\phi_i(x,t) f_k, \tag{335}$$

$$\mathcal{L}_E = \sum_{j=1}^{J} V_j(x,t)\psi_j(x,t) + \sum_{j,k=1}^{J} \epsilon_{jk}\psi_j(x,t)\psi_k(x,t), \tag{336}$$

$$\mathcal{L} = \sum_{i=1}^{M} L_{\phi_i} + \sum_{j=1}^{J} L_{\psi_j} + L_I. \tag{337}$$

$$\phi_i(x,t) = \sum_{k=1}^{N} \left(a_{ik} e^{-i\omega_k t + ikx} + a_{ik}^\dagger e^{i\omega_k t - ikx} \right). \tag{338}$$

$$\psi_j(x,t) = \sum_{k=1}^{N} \left(b_{jk} e^{-i\omega_k t + ikx} + b_{jk}^\dagger e^{i\omega_k t - ikx} \right), \tag{339}$$

$$|\Psi\rangle = \sum_{n_1, n_2, \ldots, n_N} c_{n_1, n_2, \ldots, n_N} |n_1, n_2, \ldots, n_N\rangle, \tag{340}$$

$$|n_1, n_2, \ldots, n_N\rangle = \prod_{j=1}^{J} \prod_{k=1}^{N} \frac{(b_{jk}\dagger) n_{jk}}{\sqrt{n_{jk}!}} |0\rangle, \tag{341}$$

$$i\hbar \frac{\partial}{\partial t} |\Psi\rangle = \hat{H} |\Psi\rangle, \tag{342}$$

$$\hat{H} = \sum_{i=1}^{M} \sum_{k=1}^{N} \omega_k \left(a_{ik}^\dagger a_{ik} + \frac{1}{2} \right) + \sum_{j=1}^{J} \sum_{k=1}^{N} \omega_k \left(b_{jk}^\dagger b_{jk} + \frac{1}{2} \right) + \hat{H}_I, \tag{343}$$

$$\begin{aligned} \hat{H}_I = \\ -\sum i = 1^M \sum_{j=1}^{J} \sum_{k=1}^{N} \beta_{ij} V_j(k) (a_{ik} + a_{ik}^\dagger)(b_{jk} + b_{jk}^\dagger) - \\ \sum_{i=1}^{M} \sum_{k=1}^{K} \gamma_{ik} f_k (a_{ik} + a_{ik}^\dagger) - \\ \sum_{i=1}^{M} \alpha_i (a_{ik} + a_{ik}^\dagger) - \\ \sum_{i,j=1}^{M} \delta_{ij} (a_{ik} + a_{ik}^\dagger)(a_{jk} + a_{jk}^\dagger) - \\ \sum_{j=1}^{J} V_j(k) (b_{jk} + b_{jk}^\dagger) - \sum_{j,k=1}^{J} \epsilon_{jk} V_j(k) V_k(k) (b_{jk} + b_{jk}^\dagger)(b_{kk} + b_{kk}^\dagger) \end{aligned}. \tag{344}$$

$$\langle \hat{H} \rangle = \langle \Psi | \hat{H} | \Psi \rangle = \sum_{n_1, n_2, \ldots, n_N} |c_{n_1, n_2, \ldots, n_N}|^2 E_{n_1, n_2, \ldots, n_N}. \tag{345}$$

$$\hat{H} |\Phi_E\rangle = E |\Phi_E\rangle, \tag{346}$$

$$|\Phi_E(t)\rangle = e^{-iEt/\hbar} |\Phi_E(0)\rangle, \tag{347}$$

$$|\Phi_E\rangle = \sum_{n_1, n_2, \ldots, n_N} c_{n_1, n_2, \ldots, n_N} |n_1, n_2, \ldots, n_N\rangle, \tag{348}$$

$$\hat{H} = \hat{H}_0 + \hat{V}(t), \tag{349}$$

$$|\Psi\rangle = \sum_n c_n(t) e^{-iE_n t/\hbar}|n\rangle, \tag{350}$$

$$i\hbar\frac{\partial}{\partial t}\psi_j(x,t) = -\frac{\hbar^2}{2m}\nabla^2\psi_j(x,t) + V_j(x,t)\psi_j(x,t), \tag{351}$$

$$\dot{c}n(t) = -\frac{i}{\hbar}\sum_m Vnm(t)e^{i(E_m-E_n)t/\hbar}c_m(t), \tag{352}$$

$$c_n^{(1)}(t) = -\frac{i}{\hbar}\int_0^t V_{nn_0}(t')e^{i(E_{n_0}-E_n)t'/\hbar}dt', \tag{353}$$

$$\hat{V}(t) = \hat{V}_0 e^{i\omega t} + \hat{V}_0^\dagger e^{-i\omega t}, \tag{354}$$

$$P_{n\to m}(t) = \frac{2\pi}{\hbar}|V_{mn}|^2\delta(E_m - E_n - \hbar\omega)t, \tag{355}$$

$$R_{n\to m} = \frac{2\pi}{\hbar}|V_{mn}|^2\delta(E_m - E_n - \hbar\omega), \tag{356}$$

$$|\alpha,\xi\rangle = \hat{S}(\xi)|\alpha\rangle, \tag{357}$$

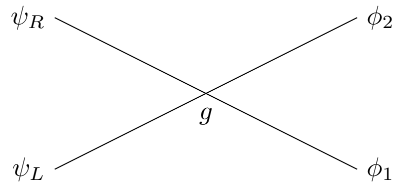
$$\hat{S}(\xi) = e^{\frac{1}{2}(\xi * \hat{a}^2 - \xi\hat{a}^{\dagger 2})}. \tag{358}$$

A.4 Dysgenic Field Theory Δ

Define a Lagrangian density

$$\mathcal{L} = \bar{\psi}\sigma^\mu\partial_\mu\psi - \frac{1}{2}\left(\partial_\mu\phi\partial^\mu\phi + m^2\phi^2\right) - g\phi\bar{\psi}\psi \tag{359}$$

where ψ is some spinor field that represents dysgenic traits and ϕ is a scalar field that represents an environmental factor.



The probability amplitude for the process of which two dysgenic traits with opposite chirality annihilate into two environmental factors with opposite frequency is given by the equation

$$A = g^2\int d^4x e^{i(p_1+p_2-q_1-q_2)-x}. \tag{360}$$

The cross section for this process can be calculated from this probability amplitude as

$$\sigma = \frac{1}{\sqrt[4]{(p_1\cdot p_2)^2 - m^4}}\int d^3q_1 d^3q_2(2\pi)^4\delta^4\left(p_1+p_2-q_1-q_2\right)|A|^2. \tag{361}$$

B Unused Equations

These are equations that I have created but not used yet. This, however, does not mean that any of these equations hold no value. Do not hesitate to employ or expand onto them in any dysgenic field theory in whatever way that seems appropriate.

B.1 Set A

$$E = \sum_{n=1}^{N} \langle \Psi_n | H_n | \Psi_n \rangle + \sum_{n<m}^{N} \langle \Psi_n \otimes \Psi_m | W_{nm} | \Psi_n \otimes \Psi_m \rangle, \tag{362}$$

$$F = \frac{1}{N} \sum_{n=1}^{N} \langle \Psi_n | S_n | \Psi_n \rangle, \tag{363}$$

$$Q_j = \frac{1}{N} \sum_{n=1}^{N} \langle \Psi_n | \phi_j(n) | \Psi_n \rangle. \tag{364}$$

B.2 Set B

$$T_{nm} = \sum_{j=1}^{J} t_j \phi_j(n) \phi_j(m). \tag{365}$$

B.3 Set Γ

$$\Psi_k(n\Delta t + \frac{\Delta t}{2}) = e^{-i\frac{k2}{2m}\frac{\Delta t}{2}} \mathcal{F}[\Psi(x, n\Delta t)], \tag{366}$$

$$\Psi(x, n\Delta t + \Delta t) = e^{-i[H_0 + H_I]\Delta t} \mathcal{F}^{-1}[\Psi_k(n\Delta t + \frac{\Delta t}{2})]. \tag{367}$$

B.4 Set Δ

$$\langle \Omega | \hat{\psi}_i(x) \hat{\psi}_j^\dagger(y) | \Omega \rangle = -\langle \Omega | \hat{\psi}_j^\dagger(y) \hat{\psi}_i(x) | \Omega \rangle = S_{ij}(x-y), \tag{368}$$

$$S_{ij}(x-y) = -\frac{i}{4\pi^2} (\sigma^\mu) ij (x-y) \mu (x-y)^{-2}. \tag{369}$$

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