

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

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### ABSTRACT

An antagonistic pleiotropy in evolutionary biology is said to occur when one gene can express itself in more than one way, and where at least one of the expression is helpful and at least one another expression of the same gene is harmful to the organism. Contextual antagonistic pleiotropy of cognitive adaptations hypothesis proposes that a similar situation exists for cognitive adaptation in terms of the contexts in which the cognitive adaptation are utilized. Proposing that the behavioral output of a cognitive adaptation in at least one context is beneficial and the behavioral output of the same cognitive adaptation in another context is detrimental to the organism's fitness. This leads to the expression of evolutionarily counterintuitive behaviors. Accepting suicide to be an evolutionarily counterintuitive behavior the researcher in this paper has theoretically examined suicide by means of the contextual antagonistic pleiotropy of cognitive adaptations hypothesis.

**Keywords:** *Antagonistic Pleiotropy, Contextual, Evolutionary, Counterintuitive, Suicide.*

**P**leiotropy means producing more than one effect. A *pleiotropic* gene is said to be one that has multiple phenotypic expressions. Antagonistic pleiotropy is when one gene controls for more than one trait where at least one of these traits is beneficial to the organism's fitness and at least one is detrimental to the organism's fitness (Ballard, J.W.O. & Pichaud, 2013.) It was George C. Williams who proposed the antagonistic pleiotropy hypothesis in 1957 as an explanation for the phenomenon of senescence. (Williams G.C.1957). The antagonistic pleiotropy hypothesis suggests that many genes with beneficial effects on early fitness components have pleiotropic deleterious effects on late fitness components, but are nevertheless favored by natural selection. One could deduce two types of pleiotropy from the forgone paragraph one an expressive pleiotropy and second a temporal pleiotropy. The Antagonistic Pleiotropy of Cognitive Adaptations hypothesis proposes the existence of a contextual or domain based pleiotropy.

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## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

The Contextual Antagonistic Pleiotropy of *Cognitive Adaptations* Hypothesis states that there exist cognitive adaptations that increase fitness in one context but seem to be counterproductive or even puzzling in a different context. However for any of the two beneficial or counterproductive behavioral expressions to occur requires the existence of that psychological mechanism.

Over time on account of the fitness increasing beneficial expression of the adaptation in one context the adaptation might become wide spread or even species typical, but having multi domain applicability entails the existence of the risk that its utilization could be detrimental to the individuals in certain contexts.

Most evolutionary psychologists expect that human adaptations will display domain-specific modularity (Schmitt and Pilcher 2004). Each adaptation should be designed to accomplish a task that, given a natural developmental environment, will lead to the individual's greater survival and reproduction (Schmitt and Pilcher 2004). The antagonistic character of the cognitive adaptation is proposed to be the result of its utilization in attempts to solve evolutionary problems for which it was not specifically created as an adaptive solution. Thus the antagonistic character is not proposed to be an inherent quality of a certain set of cognitive adaptations.

Psychological adaptations are information-processing circuits that take in delimited units of information and transform that information into functional output designed to solve a particular adaptive problem, (Buss, 2008), via the use of decision rules. Psychological adaptations often interact with each other to produce adaptive behavior, as when a person is faced simultaneously with the adaptive problems of hunger and a threatening lion; fear of the lion will temporarily suspend hunger pangs until the threat of imminent death has passed (Confer et al, 2010).

The input of an evolved psychological mechanism is transformed through decision rules into output (Buss 2008). How one defines a stimulus would influence how one represents the input and subsequently would determine which evolved psychological mechanism is stimulated and called into action. It is becoming evident that an interaction between psychological adaptations in response to an adaptive problem is not the only factor that produces an adaptive behavior. Individual cognitive appraisals have been understood to influence the characterization of the 'input' that is put through the decision rules. Individual differences in defining an input in evolutionary terms are caused by perceptual mechanisms, proprioceptive mechanisms, and situation-modeling memory (explained as '*algorithms that monitor for situation-defining cues*' in Leda Cosmides & John Tooby, 2000).

Working with the example provided above regarding being faced with the adaptive problems of hunger and a threatening lion; in response to the two competing problems, it can be proposed that the behavior exhibited shall not be independent of a situation defining algorithm that factors

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

in the dangerousness of the lion, the consequences of forgoing a feeding opportunity in face of a desperate hunger and even the fighting ability of the individual. Selection will not shape decision rules so that they act solely on the basis of what is most likely to be true, but rather on the basis of the weighted consequences of acts given that something is held to be true. (Leda Cosmides & John Tooby, 2000).

*According to Tomasello and Call 1997, a cognitive adaptation:*

- A. Involves decision making among a variety of possible courses of action,
- B. Takes place directed towards goals or outcomes and,
- C. Probably involves some sort of mental representation that goes beyond information immediately presented to the senses (Cartwright 2007).

It is plausible that due to individual appraisals of the stimulus or life experiences, the ‘input’ that is provided to the evolved psychological mechanism is not veridical. And this eventuates into a potential misrepresentation of the adaptive problem, and therefore might lead to the execution of an adaptive solution that might not be optimal.

*One can envision a few situations when there could be a mismatch between a specific adaptive problem and a specific adaptive solution:*

1. Firstly the adaptive problem might be a novel one and an organism might not have a specific evolved psychological mechanism to solve that problem. This is supported by the observation that evolutionary psychologists find it difficult to explain the functionality of certain adaptations in modern environments.
2. Secondly either because of the novelty of the adaptive problem faced or the availability of a pool of evolved psychological mechanism that can potentially solve the adaptive problem faced with varied degrees of effectiveness, an organism has to *select* the most adaptive psychological mechanism amongst them.
3. Cognitively misrepresenting the adaptive problem (or input) one is facing.

Thus according to the Contextual Antagonistic Pleiotropy of *Cognitive Adaptations hypothesis*, an evolutionarily counterintuitive behavior is proposed to be a contextually non optimal ‘output’, produced due to the miscalculation in the decision rules of a psychological mechanism that has occurred due to the generation of a wrong ‘input’, as a consequence of the misrepresentation of the adaptive problem faced.

The examination of an evolutionarily counterintuitive behavior by the Contextual Antagonistic Pleiotropy of *Cognitive Adaptations hypothesis* would follow the following steps:

1. Find an evolutionarily counterintuitive behavior.
2. Decipher the cognitive adaptation that allows the expression of that behavior.

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

3. Find the contexts wherein the expression of this cognitive adaptation is fitness enhancing and also the contexts wherein expression of this cognitive adaptation is detrimental to fitness and therefore counterintuitive.
4. Explore the factors that contribute to the utilization of that adaptation in contexts where it is not fitness enhancing.

I shall now provide a *theoretical explanation* of how the Contextual Antagonistic Pleiotropy of *Cognitive Adaptations hypothesis* would explore and account for the evolutionarily counterintuitive behavior of suicide.

### Contextual Antagonistic Pleiotropy of *Cognitive Adaptations hypothesis* and Suicide

#### ***Step 1: Find an evolutionarily counterintuitive behavior. 'SUICIDE'.***

Suicide and homosexuality are the two phenomena that have been most difficult to reconcile with evolutionary theory, as both directly affect human reproductive fitness (Aubin Berlin and Kornreich 2013). Selection is expected to promote the evolution of various biological mechanisms that increase the individual's ability to avoid death. (Aubin Berlin and Kornreich 2013). However it is estimated that as many as one million deaths per year are due to suicide (Hawton.; van Heeringen 2009), and also in the 1970s, increasing incidences of suicide were observed in young adults, especially young men, in some high-income countries (Pitman; Krysinska; Osborn; King, 2012). In the light of such observation of the destruction of one's own fitness especially in the case of young adults with presumably high reproductive value it is safe to term suicide as an evolutionarily counterintuitive behavior.

#### ***Step 2: Decipher the cognitive adaptation that allows the expression of that behavior.***

Let it be hypothetically proposed that 'suicide' is the behavioral output of a decision rule of an evolved cognitive adaptation namely '*a willingness to die*' in response to an 'input' which might be a situation that an organism has calculated to be one of 'to engage in fatal fighting or face definite death'. Specifically in the case of suicide, the surface level manifestation of the cognitive adaptation '*a willingness to die*' is the behavior that is the act of intentionally killing oneself. But surface level manifestation of this behavior is made possible because an adaptation exists in the organism that motivates the organism to behave in such a self destructive manner. Whether a human being slits his wrist, hangs himself, consumes poison, wrangles with a crocodile to save someone and dies etc, these behaviors I propose, would not be undertaken if there was no deep level core cognitive adaptation within that individual that allows him to undertake such acts that entail fatal risks.

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

### *Step 3: Part 1: Find the contexts wherein the expression of this cognitive adaptation is fitness enhancing.*

As an evolved psychological mechanism ‘willingness to die, could be seen as the primary and crucial psychological mechanism that motivates an organism to enter into competition with the stimuli in its environment in scenarios where its survival or reproductive ability is fatally threatened. Fierce competition for survival (natural selection), or competition for mates (sexual selection), would regularly confront organisms with the situation of fight or perish. Perish in terms of dying of hunger or in terms of the ending of one’s genetic lineage on account of not being able to produce offspring. Having a cognitive adaptation of a willingness to die when faced with a fight or perish situation or context might help the individual to exhibit non compromising aggression, where the option of giving up or holding back is negated.

In response to such an assessment of the immediate and dire fitness threatening adaptive problem, a psychological mechanism of the likes of ‘a willingness to die’ can be seen as a vital adaptation that motivates an organism to express fatal fighting behavior. Those organisms that have this adaptation might have, when pitted against organisms who do not possess this adaptation obtained a higher success rate in duels regarding survival or mating. Such form of fatal fighting has been documented in certain species. Fatal fighting occurs between queens of the ant *Lasius niger*, also fights between larvae of the aphid *Epipemphigus niisimae* for the sole access to a gall can be fatal and the most dangerous fights reported in the literature are found in two groups of arthropods: Insecta and Arachnoidea (Enquist & Leimar, 1990).

Contexts such as a short reproductive lifespan of males, the expected lifetime mating success based on the sex ratio and the mating behavior of the females, are cited as the reasons for this observation.

In summary to their analysis of why fatal fighting would evolve in species Enquist and Leimar, stated that the critical factor is the relationship between the value of the contested resource and the expected value of the future. If giving up a contest means that the likelihood of reproduction in the future is very low, then persistent fighting strategies, offensive behavior patterns and weapons are likely to evolve (Enquist & Leimar, 1990). Assuming that the cognitive adaptation ‘a willingness to die’ is a functional requirement of the behavioral expression of fatal fighting, in such contexts wherein an organism is faced with a very low future likelihood of future reproduction this cognitive adaptation can be understood as fitness enhancing. It entails the risk of incurring ‘cost’ in the form of fatal injury and even death, but in the right context the consequence of not undertaking a fatal risk would be more detrimental to fitness.

To reframe one could say that taking fatal risks that help to maximize the probability of survival when faced with certain fitness ending situation would not be evolutionary counterintuitive.

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

***Step 3: Part 2: Find the contexts wherein the expression of this cognitive adaptation is detrimental to fitness.***

It is understood that any behavior that entails a higher cost to benefit ratio for either or both individual and/or group fitness would form part of this search. If it is agreed that ‘a willingness to die’ is a cognitive adaptation and therefore an adaptive solution, and the specific adaptive problem that it helps to solve is the adaptive problem of the imminent loss of fitness, then the ‘input’ that would trigger the requirement of this adaptation would be an assessment of the situation as one that the individual interprets as ‘fight or perish’. Only in this situation ‘fight’ is the logical output, as not to fight would mean to perish and therefore fitness detrimental. And thus having ‘a willingness to die’ might allow an individual to exhibit uninhibited aggression.

Behaviors like fatal fighting during intra sexual competition by individuals of the species where ample opportunities of mating exist, self destructive behaviors carried out by individuals of high reproductive value e.g. suicides by children, teenagers and young adults in humans all would logically be categorized as detrimental to fitness.

***Step 4: Explore the factors that contribute to the utilization of that adaptation in contexts where it is not fitness enhancing.***

The final step in the explanation of an evolutionarily counterintuitive behavior as a contextual antagonistic pleiotropy of a cognitive adaptation is the exploration of the factors that give the adaptation an antagonistic character. With respect to the cognitive adaptation of a willingness to die and the behavior of suicide the exploration is of the factors that influence an individual to misrepresent a situation as dire, amounting to an input of ‘fight or perish’ when such a situation does not exist.

A faulty cognitive appraisal of the situation would influence an individual to misrepresent the situation as one that entails a fatal threat to fitness, and generate an input of ‘fight or perish’ which appeals to the cognitive adaptation ‘a willingness to die’. As proposed, once this adaptation is activated, expressing behaviors that entail fatal risk becomes possible. And one of the behaviors that entail fatal risk is self destructive behavior. At this point the ‘decision’ to go ahead with the actual act of killing oneself is not drastically different from the decision to jump in a dangerous blaze to save your infant, or engaging in fierce fatal fighting against a maniac wielding a machete intending to kill you. In all three situations, the adaptive problem faced is a dire and immediate threat to fitness, however the context in which the adaptive problem is encountered are different. And in all three contexts the individual is motivated to incur a fatal cost, however in the first context the behavioral output of the adaptation would be fitness detrimental if the behavior is successfully completed, but the behavioral output of the adaptation would be fitness conducive if not enhancing if the behavior is successfully completed in the latter two contexts.

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

Faulty cognitive appraisals of situations are characteristic of several psychological disorders like depression, bipolar disorder, schizophrenia, substance abuse and anxiety disorders. Also are characteristic of contexts like stress, hopelessness and desperation. And all of the mentioned disorders and contexts are linked to suicide or an intention to commit suicide. Impulsivity has been linked with a higher risk for suicide. A possible reason for this would be the making of hasty analysis of situations and generating a wrong input and call the context inappropriate adaptation into action.

As such, one of the ways to understand suicide would be to examine it as a contextual antagonistic expression of a *pleiotropic* cognitive adaptation that solves an adaptive problem in a different context. This hypothesis could explain at this preliminarily theoretical level at least two important findings regarding suicides. One that the demographic of suicidal behavior is skewed towards men, by coupling it with the hunting hypothesis where in males are required to be venturesome, risk taking, and therefore evolutionarily have found themselves in threatening situation more often than females and therefore found themselves in situations requiring an assessment of fight or perish more often than females. This recurrent encounter with a fight or perish adaptive problem could provide ample opportunity for a cognitive adaptation of ‘a willingness to die’ to form part of the male cognitive adaptations repertoire more pervasively and prevalently than in females. The other finding that of subjective cognitive appraisals like hopelessness, burdensomeness and worthlessness are often correlated with suicidal intention could be because they probably are the factors that contribute to the misrepresentation of an input as dire and immediately fitness threatening and thus appealing to a contextually incorrect cognitive adaptation leading to a fitness detrimental behavior.

Thus this four step analysis could be applied to examine similar evolutionarily counterintuitive behaviors like homosexuality, unrealistic fears etc.

### CONCLUSION

The Contextual Antagonistic Pleiotropy of Cognitive Adaptations *hypothesis proposes the existence of a context based* pleiotropy wherein the output of a given cognitive adaptation might be fitness enhancing in one context but detrimental to fitness in another context. The utilization of this cognitive adaptation in a wrong context gives the adaptation an antagonistic character. This occurs due to the misrepresentation of the cognitive adaptation relevant input that is generated due to a faulty cognitive appraisal of the situation by the individual. This results in the utilization of the cognitive adaptation in a context for which its output is not optimal.

Evolutionary counterintuitive behaviors are proposed to be the result of such a contextual antagonistic pleiotropy of cognitive adaptations. Four steps are outlined as a guideline to follow when examining any evolutionarily counterintuitive behavior by means of the contextual antagonistic pleiotropy of cognitive adaptations hypothesis. A theoretical examination of the

## Contextual Antagonistic Pleiotropy of Cognitive Adaptations: A Hypothesis for Evolutionarily Counterintuitive Behaviors

evolutionarily counterintuitive behavior of suicide is presented in which suicide is considered as a contextually non optimal output of a cognitive adaptation hypothetically proposed to be ‘a willingness to die’. Contexts wherein this adaptation might be fitness enhancing and fitness detrimental were explored. The factors that contribute to the utilization of that adaptation in contexts where it is not fitness enhancing were also explored.

Thus the Contextual Antagonistic Pleiotropy of Cognitive Adaptations *hypothesis is to be considered as an explorative viewpoint.*

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