

Anorexia Nervosa: An Evolutionary Puzzle

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Anorexia nervosa (AN) has proven difficult to explain and is especially so from an evolutionary perspective. It is widespread, has probably existed for centuries and includes a genetic component but leads to starvation, infertility and sometimes death. An attempt to explain AN will be made using a synthesis of evolutionary ideas about responses to threat. Dietary restriction is described as a response to perceived threats of exclusion from the group, which would once have been dangerous. This can develop into AN only where the weight loss sets off an ancient adaptive response to the threat of famine. Eating again and weight gain would mean re-entering the competition for status and belonging and are therefore felt as threatening. This synthesis can explain the unusual mix of features found in AN that are otherwise resistant to explanation. Copyright © 2006 John Wiley & Sons, Ltd and Eating Disorders Association.

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INTRODUCTION

Eating disorders are generally viewed as being caused by an interaction of psychological, social and biological factors. However, Connan, Campbell, Katzman, Lightman and Treasure (2003) say that 'few of these risk factors are specific to anorexia nervosa and no single factor has been shown to be either necessary or sufficient to express the disorder'. Collier and Treasure (2004, p. 363) add that 'little is known about this aetiology, particularly its biological components, and this is severely hampering the development of new treatments'. Palmer (2000, p. 58), discussing the causes of eating disorders, suggests an approach 'in which physiology and psychology are brought together and, perhaps, even included within the framework of wider biological thinking, such as that of evolutionary theory. Such a synthesis is too rarely attempted'.

From an evolutionary perspective anorexia nervosa (AN) is a puzzling condition and there are a number of features which are difficult to explain. Why, in a culture where dissatisfaction with weight and consequent dieting is so prevalent, do so few develop AN? Why are most of those who do female? How is the difficult task of not eating for long periods achieved? Why, despite the risks of very low weight, and the usual absence of any intention to die, are people with AN so ambivalent about the prospect of recovery? And how do some people manage to function relatively well at a low body mass index (BMI)? It is plausible to argue that AN has existed for a long time (Bemporad, 1996) and that there is a genetic component (Winchester & Collier, 2003), both of which suggest that the genetic vulnerability has been conserved in the population and that at least some features of the disorder may have, or have had, an adaptive function. Yet two of the four diagnostic criteria in DSM IV (APA, 1994) appear powerfully counter to what may be seen as the evolutionary command to 'eat, survive and reproduce'. People with AN do not eat and most become unable to reproduce as menstruation ceases. Some do not survive: AN has the highest mortality

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rate of any psychiatric disorder (Sullivan, 1995; Laird Birmingham, Su, Hlynsky, Goldner, & Gao, 2005). Voland and Voland (1989, p. 224) say: 'At first glance, it appears absurd that AN could have evolved as an adaptive feature. How can temporary or permanent sterility, or under extreme conditions, self-sacrifice, pass the test of natural selection?' Yet most of those who develop AN do start eating again, do survive and some go on to reproduce.

This paper will introduce the evolutionary perspective and then attempt to answer some of the above questions with a synthesis of ideas about responses to threat. Humans will be described as social animals whose survival depends on belonging to a group, which inevitably means competition for status within the group (Gilbert, 1992, 2004; Baumeister & Leary, 1995). This can lead to the threat of exclusion, which in the past would have been a catastrophe. Attempting to control eating and lose weight is described as a response to this threat, because current culture places a high value on these behaviours (Stevens & Price, 2000). The development of dietary restriction into AN is described using the positive-incentive theory of eating (Pinel, Assanand, & Lehman, 2000) and two models of adaptation which might work together to bring about AN and explain the unusual features. The first suggests that AN only occurs when weight loss triggers the reactivation of an old adaptive response to the threat of famine (Guisinger, 2003). This can explain the ability to tolerate starvation and that some aspects of being at a low weight are experienced in a positive way. The fear of weight gain and the difficulty of recovery are explained by describing AN as part of female intra-sexual competition and a 'losing' strategy (Mealey, 2000). Weight loss removes people from the competition for status and the fear of weight gain is then a fear of re-entering the competition and risking attack by others and possible exclusion. The strengths and weaknesses of this synthesis will be discussed and some suggestions made about evaluation of the models.

EVOLUTIONARY PERSPECTIVES

Evolutionary perspectives in psychology and psychiatry remain subject to debate, but the use of such ideas in the understanding and treatment of psychological disorders has been advocated by a number of authors (Nesse & Williams, 1995; McGuire & Troisi, 1998; Abed, 2000; Stevens & Price, 2000; Gilbert, 2001b). McGuire and Troisi (1998) and Stevens and

Price (2000) argue that evolutionary thinking can provide a framework that psychiatry currently lacks. An important distinction is between evolutionary explanations as distal, or ultimate, and other explanations as proximate (Nesse & Williams, 1999). An ultimate explanation is about how a particular trait or behaviour may have, or have had, a fitness advantage (though as explained later, not necessarily for the individual who expresses the behaviour). It is about why the trait occurs at all. A proximate explanation looks at how this works in an individual during their lifetime, the physiology and psychology that are part of its function. These are different levels of explanation rather than opposing views and can be complementary. Cosmides and Tooby (1999) and Nesse (1999) propose lists of different ways in which evolution may play a part in what Wakefield (1999) calls 'harmful dysfunctions'. These include 'unwanted design products of adaptations, such as evolved defences' (Cosmides & Tooby, 1999, p. 460). For example, since human ancestors lived in a dangerous world, humans have highly sensitive systems for detecting threat. The unwanted outcome is that this detects things that are not threatening; hence arachnophobia is common in the UK where there are no dangerous spiders. Another type of harmful dysfunction is 'ancestrally reliable cues become unreliable in modern conditions' (p. 460). These are adaptations that evolved in ancestral environments that may be damaging in the different conditions that now exist. This type of explanation is also known as an 'evolutionary mismatch' or 'genome-lag' hypothesis. A widely accepted explanation of this sort is that the current rise in obesity is, at least in part, the result of evolved adaptations to cope with food shortages which still operate in a world where food is abundant and people exercise little (Pinel et al., 2000).

DIETARY RESTRICTION: THE THREAT OF EXCLUSION

Humans are social animals, and the problems with both needing to belong to a group and to compete within that group can lead to various responses, including the desire to control eating and lose weight. This desire is neither necessary nor sufficient to produce AN and in most cases does not, but is described in detail as an ultimate perspective on issues that become entangled with weight loss (Palmer, 2000) and as the setting for the section on the maintenance of restriction.

If it is accepted that humans are evolved animals, like other animals in many ways, it can be seen that through 'millions of years of having to solve challenges to reproduction and survival, humans (like other animals) have evolved a complex array of motivations, strategies and mental mechanisms that predispose them to act in species-typical ways' (Gilbert, 2001b, p. 274). Specifically humans are social animals who have evolved in a very dangerous world. Any human not under the protection of a group would have been not only unlikely to reproduce but also vulnerable to starvation, predation and probably attack by members of other groups (Gilbert, 2004). Individuals not part of a group would have been unlikely to survive for long. It is therefore possible to see belonging to a group as the most fundamental of human needs. Baumeister and Leary (1995) explore the 'need to belong' and conclude: 'The desire for interpersonal attachment may well be one of the most far-reaching and integrative constructs currently available to understand human nature' (p. 522). Consequently, the 'array of motivations, strategies and mental mechanisms' include ones for maintaining membership of, and cooperating and competing within, a group. One way evolution works is that those behaviours that have proven successful in the long run are experienced as rewarding and are sought out: those that have been unsuccessful are experienced as unpleasant and are avoided (Pani, 2000). Food tastes good and sex is pleasurable; succeeding and belonging feel good; loss, failure and exclusion are painful.

Being a social animal is a two-edged sword: it gives protection but leads to competition. As social animals people have to compete with others for resources and other people are one of those resources. Continuous competition between group members would be damaging so a hierarchy tends to form (Stevens & Price, 2000). Competition for status in many animals involves threats or displays and in order to assess its chance in an encounter, and not risk injury or exclusion, an animal has to be able to assess its worth relative to that of others. In humans competition includes not only threat but also attraction (Gilbert, 1992, 2001a). Gilbert (1992) uses the term 'social attention holding power' to describe an individual's ability to hold attention and gain investment from other members of the group. Attachment (Bowlby, 1969; Sloman & Atkinson, 2000) plays a significant part in this as 'our attachment relationships are the first place we learn about our attractiveness to others, the preparedness of others to invest resources in us, and regulate our emotional states' (Sloman, Gilbert, & Hasey 2003,

p. 116). An individual's experience of their social attention holding power can be equated with the concept of self-esteem, the 'internal tracking of one's attractiveness to others and sense of belonging' (Gilbert, 2001a, p. 730; see also Leary, Tambor, Terdal, & Downs, 1995). Furthermore, the degree to which a person feels in control is closely related to their social attention holding power (Sloman et al., 2003; Marmot, 2004). Individuals perceive themselves to occupy a position, or status, within the group(s) to which they belong. Those who perceive themselves to be towards the top of a group, in a more dominant position, feel more in control. Those lower down, in a more submissive position, feel less in control and show submissive behaviours towards those of higher status (Marmot, 2004). If someone of lower status attempts to improve his or her position, this can be perceived as a threat by the more dominant, who may then attack the threat. The person providing the threat can then continue the fight and risk injury or exclusion, or back-down and show clear signals of submission.

In the past, exclusion had extreme consequences so any threat to the sense of belonging is felt as potentially serious. In practice, falling out with a group of friends or work colleagues does not now mean that the person is likely to starve or be eaten by a sabre-toothed tiger, but since the evolved psychology was honed in an environment where that was possible, the threat is still experienced as powerful (Bearman & Moody, 2004; Baumeister, De Wall, Ciarocco, & Twenge, 2005). Those with a less secure attachment history may be especially sensitive (Sloman, 2000). Threat requires a response: the concept of 'fight-or-flight' is a well used evolutionary explanation and several different psychological problems may be forms of fight or flight in response to the threat of exclusion (Baumeister & Leary, 1995; Gilbert, 2001b, 2004). One possible response is to give clear signals of defeat and of not being a threat to dominants. This is the basis of the social competition model of depression (Price, 1967; Gilbert, 1992; Sloman & Gilbert, 2000). Depressive states are described as being triggered automatically in people in subordinate positions as a way of changing their behaviour and signalling to competitors that they do not present a threat, thus protecting the defeated person from further attack and possible exclusion. Depression is an unwanted, but originally adaptive, defence (Cosmides & Tooby, 1999). Depression can include aspects of both fight and flight (Gilbert, 2000). Other forms of flight may include ways of blocking feelings about the threat such as self-harm, alcohol abuse or binge eating.

Fight may take the form of attempting to become more valuable and attractive. Competitive striving may be a way of doing this but it is also possible to see dietary restriction as an attempt of this sort (Goss & Gilbert, 2002).

In order to assess their value to the group an individual has to compare themselves with others. This includes comparison of physical appearance, a major indicator of resources in general, and of health and reproductive potential in particular. Through most of human history people lived in small groups and had relatively few others with whom to compare. The range was not great and although there was a hierarchy, it was relatively flattened (Gilbert, 2001a, 2004). The current existence of the influential, and largely visual, mass media, mean that comparison is now possible across a huge range of people so contrasts are much greater but the same psychology functions (Barkow, 1992; Gilbert, 1992, 2001a; Etcoff, 1999; Pani, 2000). There are always available for comparison those who appear extremely successful (Tiggerman & Slater, 2003; Morrison, Kalin, & Morrison, 2004). Furthermore, it can be argued that until recently it was common to attribute success or failure more to external powers than the individual. This view is now less common and since people are reluctant to attribute things to chance, blame for both success and failure is attributed to the individual (Gilbert, 2005). Stevens and Price (2000) suggest that until recently obesity was a sign of good resources, as only the wealthy could afford to be obese. Now that in many cultures food is abundantly available and relatively cheap, resisting it has become a sign of status and self-control, and thus rewarding. Dietary restriction, made evident by weight loss, is thus an attempt to demonstrate status and control.

RESTRICTION MAINTAINED: THE TWIN THREATS OF STARVATION AND OF EATING

Many people attempt to restrict their diet, very few develop AN. Those who do, find themselves in a profoundly ambivalent state, probably as difficult for them to understand as for anyone else. An attempt to explain this will be made by describing two different adaptive responses which coincide to produce AN. The ambivalence, and the mix of symptoms which occur, are explained because one is the reactivation of an old adaptive response to famine, triggered by weight loss that is not now due to famine, and the other is a strategy induced

by others—and not to the advantage of the person who expresses the response.

To eat or not to eat? In order for AN to develop, there needs to be a change in the balance of incentives. Pinel et al. (2000, p. 1105) describe the positive-incentive theory of eating. They say that 'thinking about hunger and eating has long been dominated by the set-point assumption: that declines in energy below their set points produce compensatory increases in hunger—and in eating'. Pinel et al. (2000) argue that a settling-point view better explains the rising problem of obesity and fits better with research findings. Settling-point models have weight stabilising when energy intake and expenditure are in balance, but able to shift to a new settling point when one or both change. Pinel et al. (2000) see eating being driven by the positive-incentive value of food. People eat because food tastes good and eating is rewarding. Hunger usually increases the incentive, food becoming even more appealing. Most people, when at a normal weight, a BMI of 20–25 kg/m², and having not eaten for several hours, would find a tasty meal difficult to resist. Imagine being presented with the same meal having eaten virtually nothing for several weeks and being at a BMI of 15 kg/m². Then how hard would it be to resist? This is just what people with AN do. Pinel et al. (2000, p. 1114) say: 'The positive-incentive value of food increases to such high levels under conditions of starvation that it is difficult to imagine how anybody—no matter how controlled, rigid, obsessive and motivated—could refrain from eating in the presence of palatable food. Why this protective mechanism is not activated in severe anorexics, is a key question about the aetiology of AN that needs to be addressed'. Pinel et al. (2000) suggest that there is a decline in the positive-incentive value of eating to the anorexic. What could deactivate the protective mechanism enough to decrease the incentive to eat below that of not eating? Epling and Pierce (1992) and Guisinger (2003) suggest that it may be the reactivation of an old adaptive response to famine.

The Threat of Starvation

That some features of starvation may be adaptive responses has long been seen as a possibility. The increased activity would be useful as in conditions of famine it would make sense to increase movement in order to search for sources of food (Fessler, 2002). Epling and Pierce (1992) describe a condition they call 'activity anorexia', which they distinguish from AN. Based on animal models, Epling and Pierce

(1992) suggest that activity anorexia is not caused by psychological problems but by a coincidence of dieting and increased activity. This produces a feedback cycle where both continue and weight loss and psychological disturbance are the outcome. Epling and Pierce (1992) suggest that this may be an old adaptive strategy to cope with famine. It is very likely that humans have had to cope with periods of famine for thousands of years. Famine would have exerted a powerful selective pressure and in such circumstances animals have three options. Some species hibernate, but humans do not. The other options are to stay, conserve energy and wait for the shortage to end, or to ignore what food is available locally and move away in the hope of finding new resources. Both of these strategies may be successful at different times so the tendency to do both would be conserved in the population.

Guisinger (2003) develops these ideas. Referring to the probability that conditions of famine were common during the recent human past, Guisinger (2003, p. 748) suggests that in order to migrate to find new resources, it would have been adaptive to 'stop foraging locally, to feel restless and energetic, and optimistically to deny that one is dangerously thin'. This is the 'Adapted to Flee Famine' hypothesis. When people lose over 15% of their body weight, whether by dieting or otherwise, they are as if in a state of famine. Guisinger (2003, p. 746) suggests that some individuals 'have inherited a genetic ability to respond to such low body weight with specific adaptations that originally evolved to facilitate leaving food depleted areas'. The over activity, denial of starvation and refusal to eat what limited food is available are seen as part of an adaptation which helped some people migrate in order to find more food. Now, when those with this genetic susceptibility lose weight, this ancient adaptation is triggered: an 'ancestrally reliable cue becomes unreliable in modern conditions' (Cosmides & Tooby, 1999, p. 460). It is also possible that being able to tolerate starvation relatively well and perhaps lead other group members to migrate, may have raised the self-esteem of these early anorexics, and that this may now be an aspect of the increased self-esteem which occurs in AN (Gatward, 2001). Though the weight loss usually starts as an attempt to feel better, (to increase status and decrease the risk of exclusion) it is possible that some people who lose weight for other reasons, such as depression, physical illness or religiously motivated starvation, may develop AN. Whatever the cause, the weight loss sets off the famine response (Guisinger, 2003).

The Threat of Eating

Why is it so difficult to escape from this famine response and recover? Wasser and Barash (1983) suggest that reproduction may be suppressed when conditions are unfavourable in order to save resources for more favourable conditions later. Evidence from other species suggests that this can be a successful strategy. Wasser and Barash (1983) do not refer specifically to AN though several authors have seen this playing a part (Surbey, 1987; Voland and Voland, 1989; Anderson and Crawford, 1992; McGuire and Troisi, 1998; Crawford and Salmon, 2002). Wasser and Barash (1983) also suggest that competitors may induce suppression of reproductive ability since suppressing the reproduction of other females in the group can improve the suppressor's success. This involves the concept of the extended phenotype: an adaptive strategy can be one that manipulates the behaviour of one organism to the advantage of the organism that provokes the behaviour (Dawkins, 1982). An example in humans is the use of the 'put down', which reduces another's confidence and self-esteem thus reducing their ability to compete. Mealey (2000) suggests that the desire to lose weight is open to exploitation by 'dominant' women, and describes AN as a 'losing' strategy. Mealey (2000, p. 108) suggests that 'as long as it is temporary and not life-threatening, anorexia may indeed be adaptive for individuals who exhibit relatively mild symptoms', but views AN in some as being an adaptive strategy for those who provoke it rather than for those who develop the condition. More socially dominant women 'manipulate' those who feel subordinate into self-imposed starvation thus removing them from the competition. The manipulation is achieved through the media as 'socially successful and dominant women who, as consumers (purchasers), drive media trends' (p. 110). The 'slim is good' philosophy is promoted and absorbed, and subordinate women consequently suffer. The women are stressed and their reproductive ability is suppressed. AN is therefore an example of female intra-sexual competition.

In the social competition model of depression people give clear signals of submission in order to avoid the risk of further attack and possible exclusion (Gilbert, 2000). Treasure and Owen (1997) describe a condition similar to AN in other species subjected to stress as a submissive response. Connan et al. (2003) suggest that AN in humans is also a submissive response in people vulnerable through genetic factors and early attachment experience. Troop, Allen, Treasure and Katzman (2003) have

found some evidence to support this view. They examined social comparison and submissive behaviour in eating disorders and found that the degree of submissive behaviour and unfavourable social comparison were related to the severity of the symptoms. Although only a preliminary investigation they also found some suggestion that people with eating disorders do not differentiate well between degree of attractiveness and social rank and group fit. The reproduction suppression model describes this as an adaptation to delay reproduction during unfavourable conditions, but Mealey (2000) views it as a response to what can be described as 'hostile-dominant' signals by others, whom it benefits. Very low weight also gives a clear signal of submission. Strober (2004) describes AN as involving an 'overexpression' of fear based learning which is pathological and directed at eating and weight gain, and says that 'morbid fear of weight is a cardinal feature of the illness, ostensibly the proximal motive for pathologic dieting' (Strober, 2005, p. S93). Most easily learned fears tend to be of things that were dangerous in the past, such as spiders and open or closed spaces (Hofmann, Moscovich, & Heinrichs, 2004). Eating and being at a normal weight would be difficult to describe as dangerous (Strober, 2004) and Waller and Kennerley (2003, p. 243), in a review of cognitive-behavioural treatments, conclude that 'eating psychopathology is strongly associated with threat cognitions that are unrelated to the overt pathology of the disorders', so perhaps the ultimate motive is the fear of exclusion, a possible outcome of weight gain. Threat can bring a desire to hide, and as a former client said, 'anorexia is a safe place to hide'. But if weight gain means leaving this hiding place and re-entering the struggle for control, status and belonging, then the incentive to eat will remain low, and the incentive to hide at a low weight will remain high. When others try to get the person to eat this will be felt as an attack and a ceding of control to others, and thus be defended against vigorously. This then may explain why it is so difficult to recover from AN.

Humans need to live in groups in order to survive and reproduce. Group living entails competition for status, and threats to position within the group and the risk of exclusion require a response. One response, partly determined by current social and cultural values, may be an attempt to improve attractiveness and show self-control by restricting eating and losing weight. In some people, weight loss below a certain level triggers the reactivation of an old adaptive response to famine which *enables* the individual to lose weight but allows them to be

disabled by competitors. Then the fear of re-entering the competition and provoking further attack prevents recovery.

DISCUSSION: STRENGTHS AND WEAKNESSES

The strengths and weaknesses of the models in this synthesis will be discussed, and then some predictions made.

Social comparison in eating disorders is a complex issue (Morrison et al., 2003) but there is some evidence that people restrict their eating as a result of comparing themselves with the successful (Morrison et al., 2004), and in response to fears of loss of status. Gilbert and Meyer (2003, 2005a, 2005b) have found that fear of negative evaluation may lead people to restrict their eating in order to raise their status among peers. Gerner and Wilson (2005) found that adolescent girls viewed being thin as an 'important contributor to peer status' (p. 319). Dietary restriction as a response to a perceived threat of exclusion has not been explored and is described here as one of a number of possible responses to this threat. There is no suggestion of a specific link between a sense of belonging and AN but it is an area which may be worth further exploration. This perspective offers an alternative view of the importance of the socio-cultural environment to the development of AN and has similarities to the cognitive-behavioural approach of Vitousek (see Shafran & De Silva, 2003).

There are alternative evolutionary models of AN based on competition. Suppression of reproduction in unfavourable conditions in order to save resources for better conditions later has been mentioned. Voland and Voland (1989) suggest that avoidance of unwanted sexual attention may be part of reproductive suppression and that in some cases AN may be a way for an otherwise powerless person to achieve this. Crisp (2000) presents this idea in the form of a story about a stone age girl who restricts her eating to prevent her body changing into that of a woman, and therefore escapes the sexual attention of an unsuitable mate. Abed (1998), in the 'sexual competition hypothesis for eating disorders', suggests that female shape is an indicator of youth and reproductive potential and therefore acts as a sign of attraction to males and competition to other females. Having a low waist-to-hip ratio is a sign of higher reproductive potential (and indicates that the female is not already pregnant) and is described as 'nubile'. Abed (1998, p. 532) says that

'an adaptation involving a behavioural strategy that aims at the preservation or the restoration of the nubile shape (the drive to thinness) would have given females who possessed it (who were attempting to attract long-term mates) a reproductive edge in the ancestral environment'. Modern conditions have then led to an over activation of this strategy. However, the reproductive suppression and sexual competition models both have difficulty explaining the degree of weight loss. In order to do so, the adaptive responses described would need to be taken to unadaptive extremes. AN, by definition at present, leads to suppression of reproduction, but weight loss to a BMI of 17.5 kg/m^2 achieves this in most cases. As a strategy to avoid unwanted sexual attention (Crisp, 2000; Volland and Volland, 1989) reproductive suppression may be a plausible explanation for some cases of AN but it would be difficult to argue that it can be applied to all. Abed (1998, p. 536) describes AN as competition taken to an extreme and that the 'destructive potential of adaptive strategies taken to extremes is a well known phenomenon'.

The major strength of the 'adapted to flee famine' hypothesis is that it explains features of AN that other models do not explain well. Few models attempt to account for how people with AN manage to refrain from eating for long periods in the presence of palatable food. Pinel et al. (2000) do address this issue and conclude that AN involves a decline in the positive-incentive value of eating to the anorexic. Palmer (2003, p. 6) describes this view as suggesting 'the drive to eat must be less than normal if the subjects are to "successfully" stop themselves from eating in the face of gross deprivation'. However, it may be that it is the relative balance of incentives that determines whether someone eats rather than hunger or appetite, feelings that have been difficult to evaluate and remain unclear (Palmer, 2003). Guisinger (2003) views weight loss as a trigger to a position where the incentive to eat what food is available falls because there is a greater incentive to move in search of better resources. In the ancestral environment the weight loss would not have occurred except in famine and would have been a reliable trigger—but weight loss now occurs in the midst of plenty because it is initially motivated.

Casper (1998, p. 386–387) calls attention to three 'paradoxical' symptoms of AN: 'denial and lack of concern', 'contentment' and 'liveliness and overactivity', which are 'core symptoms'. These symptoms are experienced in a positive way by individuals with AN (Serpell, Treasure, Teasdale, & Sullivan,

1999), but Casper (1998) says that they have been little researched and describes the commonly observed contentment and optimism as 'astonishing'. Lack of concern can be seen as part of the psychopathology. Anderson and Paulosky (2004) refer to 'denial and minimization of symptoms' and say 'in extreme cases, the patient completely denies that he or she has an eating disorder, even when there is objective evidence of the problem' (p. 116). However, clinical experience working within day and in-patient treatment programmes for AN makes it clear how relatively well individuals at very low weight can function. Engaging in ordinary pursuits, such as playing board games or going to the cinema, with such people is both a strange and surprisingly 'normal' experience. Strange because of the relatively normal way in which people with AN manage. It is difficult to believe that most people would be able to tolerate starvation so well (Keys, Brozek, Henscel, Mickelsen, & Taylor, 1950). If an unusual ability to tolerate the effects of starvation is part of AN then perhaps the individual's experience is not denial but lack of subjective evidence. Individuals at very low weight may report that they do not feel as if they have a problem. People usually describe themselves as 'ill' when they feel ill. Feeling physically okay and able to do most activities of daily life, even when at a BMI of under 15 kg/m^2 , may make it difficult for the person to believe they are 'ill' even though everyone else says they are. The ability to tolerate starvation and not feel ill would be a very useful part of an adaptation to escape from famine. The contentment may be pathological, but it may also be a reflection of the fact that the person does not feel as ill as they appear. It is unlikely that anyone would feel content during a famine and it may be that the reinforcing sense of control restriction of eating gives (Fairburn, Shafran, & Cooper, 1999), the relief at having taken themselves out of the competition, and the absence of feeling ill, leave the person feeling relatively content. The liveliness and urge to be active can be explained as another way of controlling weight. But feeling lively at a BMI of under 15 kg/m^2 is still difficult to comprehend, except perhaps as part of an adaptation to move away in search of new resources. Casper (1998, p. 387) proposes that 'caloric deprivation severe enough to result in significant weight loss for the individual provokes in individuals, with an innate vulnerability to develop anorexia nervosa, sensations of behavioural arousal and activation'. Guisinger (2003) explains this by proposing that this innate vulnerability is the presence of an adaptation to escape famine.

AN in males is much less common than in females but does occur and requires explanation. It would be difficult to argue that suppressing reproduction in times of stress would have much benefit for males as male investment in reproduction can be extremely limited. The evidence is that males at low weight retain the possibility of reproduction to a lower BMI than females but libido decreases (Keys et al., 1950; Vitousek, Manke, Gray, & Vitousek, 2004). Abed (1998) acknowledges the difficulty of males to his hypothesis but refers to the low proportion of males with AN. There is no reason why an adaptation to cope with famine would be less common in males. A different male response to social competition and different social pressures, may lead less males to dietary restriction, hence less trigger the adaptation. It may be that intra-sexual competition in males uses the evolutionarily older style of threats, displays and competitive acquisition of physical resources (Gilbert, 1992; Wilkinson, 2000). This might explain why males are more likely to attempt to appear resourceful or muscular than slim (Connan, 1998; Etcoff, 1999; McCabe & Ricciardelli, 2001). Female competition is of a more interpersonal, social nature and more subject to social comparison, particularly of appearance and the ability to retain allies (Etcoff, 1999). Taylor et al. (2000) propose a model that might explain why females are more susceptible to feelings of exclusion than males. They suggest that rather than a 'fight-or-flight' response to stress females use 'tend-and-befriend'. Taylor et al. (2000) argue that because of the needs of their offspring, fight-or-flight would not always be the best response and that females are more likely to affiliate with others in response to stress. Hence, feelings of exclusion may have a more detrimental effect on females than males and be more likely to lead to attempts to prevent exclusion. Indeed, whereas in the past the danger from exclusion would have been due to starvation, predation or attack by others, it is now more likely to be self-attack. Bearman and Moody (2004) found that adolescent girls who felt socially isolated were more likely to have suicidal thoughts than those who did not feel isolated.

Mealey (2000) describes the adaptation as being an example of the extended phenotype, with the advantage being to those who promote the culture that leads competitors to suppress their reproductive ability. A strength of this hypothesis is that it avoids the necessity of an adaptation being taken to an unadaptive extreme. Another is that it offers an alternative view of why AN occurs predominantly in females, describing it as part of female intra-sexual competition. The 'losing' strategy hypothesis is

speculative and Mealey (2000) does not offer any suggestions as to research that might substantiate the idea. Mealey (2000, p.110) does discuss treatment and suggests that for such an 'ethical pathology' solutions should be sought by looking at the responses of the victim, especially the use of their 'extended phenotype' such as support networks and other social forms of 'fighting back'.

Viewing AN as a form of submissive behaviour has some support (Troop et al., 2003). The neurodevelopmental model of Connan et al. (2003) is a possible alternative to the synthesis presented here, with which it has similarities. Connan et al. (2003) describe AN as occurring when various stress factors, including genetic vulnerability and early attachment problems, breach a threshold and lead to a prolonged submissive stress response. This affects eating behaviour through the dysregulation of the hypothalamic-pituitary-adrenal axis. Though Connan et al. (2003) do attempt to account for the degree of weight loss, the positive symptoms remain difficult to explain.

PREDICTIONS

The Threat of Exclusion

Dietary restriction is described as one of a number of possible responses to a perceived threat of exclusion and the only prediction is that though personality almost certainly plays a part (Wonderlich, Lilienfeld, Riso, Engel, & Mitchell, 2005), no psychological disturbance that is specific to AN will be found.

The Threat of Starvation

Despite the difficulty of proving or disproving the adapted to flee famine hypothesis several predictions can be made. A central part of fleeing famine is the feeling of being energised and wanting to move so a prediction is that all those with AN will report these feelings at some point. The ability to tolerate starvation would only be useful for relatively short periods, as lengthy periods of famine would lead to the whole group starving to death. Even people with AN do not tolerate starvation indefinitely. If part of the 'denial' is not actually feeling ill, then another prediction is that those who have had AN for longer will report less 'denial' and contentment than those who are new to AN, as the physical effects become subjectively evident and make 'denial' more difficult.

Individuals with AN often describe themselves as feeling guilty when eating, or even thinking about

food. It is possible to see these feelings being a mix of guilt and shame, since the two are often not clearly distinguished but from an evolutionary perspective have different functions (Gilbert, 1992). Guilt is about feelings of letting others down and of doing something wrong. It signals to the individual that they may need to repair a relationship. Shame is about feelings of letting oneself down and of being something wrong. It signals to the individual that they are failing and need to do better. Both can occur when unwarranted. Shame has been explored in AN and is very likely to play a part (Goss & Gilbert, 2002). However, if the famine hypothesis is correct it is possible to see that eating what (little) food is available, and not keeping active, as when engaging in treatment for AN, would produce guilt about letting others down by not moving away to search for more food. Eating may also bring guilt as the individual is able to tolerate starvation relatively well and is consuming what others—relatives and friends—may need more. A prediction is that those with AN who are not eating and who are not willing to would experience less guilt (but not necessarily less shame) than those who are eating and gaining weight. If worry about the effects an individual's AN was having on family and friends was the cause of the guilt the opposite would be likely.

Guisinger (2003, p. 755) raises the issue of what would have 'helped anorectic tribal members to eat when food was once again plentiful'. A difficulty now is that the starvation is not during famine and comes to mean a great deal to the individual. Treatment usually involves being presented with high calorie foods and is perceived as a threat rather than a sign that the famine is over. Perhaps signals such as those that would have indicated finding new resources in the ancestral environment might be more likely to provide the trigger the individual needs to start eating again. Clearly someone with AN would find a plate of fruit less of a threat than a plate of potato mashed with butter, cauliflower covered with cheese sauce and baked beans. Orians and Heerwagen (1992) suggest that the physical environments people generally find most pleasant are those that would once have signalled the presence of resources, such as an area that is 'lush and green with berries, vegetables and fresh water' (p. 556). Perhaps providing such signals to those with AN might help and give support to the hypothesis. As part of treatment two groups could receive the same relatively neutral intervention, such as a daily craft group, in different environments. One would not be specially prepared. The other might contain green plants and pictures of fruit, berries, vegeta-

bles, nuts and herds of antelope, or some other way of indicating new resources. Rates of recovery could be compared and the prediction is that those in the prepared environment would show better recovery.

For each of these examples there may be alternative explanations but each would tend to support the hypothesis. Guisinger (2003) suggests a number of implications for treatment. For example, where the patient is receptive to such ideas, an explanation of AN as an old adaptation to cope with famine can help. For some patients 'these biological explanations make sense and help them to resist their urges to exercise and avoid food' (p. 756). Guisinger (personal communication, 2004) plans to produce a manual to test the idea.

If some people have an inherited ability to tolerate starvation better than others could this be found? One difficulty is to know what sort of genetic variants to look for. Another is finding groups of people who do not have AN, are not physically ill but maintain a low weight. One possible group to study, who maintain a low weight for professional reasons but are probably less susceptible to social comparison of appearance, might be flat race jockeys. Due to the archaic weight rules set during the 19th century when average height was much lower, flat race jockeys have to maintain low weights, some down to a BMI of about 17.5 kg/m^2 to practice their profession. There may be some who tolerate the low weight better than others. Finding relevant genetic variants in common with those with AN would support the idea.

The Threat of Eating

The 'losing' strategy hypothesis is difficult to evaluate but viewing starting to eat and gaining weight as a form of fighting back and thus returning to the competition allows some predictions to be made. One is that competitive or hostile attacks by other competitors will increase as the individual nears a more 'normal' weight. This fits with the view that individuals with AN are scared of being 'normal' rather than fat, and that however difficult early weight gain is, further gain once a BMI of about $16\text{--}18 \text{ kg/m}^2$ is reached can be even more difficult. At a BMI in this range the recovering person is probably beginning to re-emerge as a competitor and therefore more likely to be subject to attack. Another prediction is that individuals in a more competitive environment would be more likely to develop AN. AN would then be more common in largely female environments, such as all girls schools, and less

common where females were in largely male environments. However, it would be difficult to rule out other explanations. Since sisters would be part of the competition then AN should also be more common in families with sisters than with those with only brothers or singletons. Eagles, Johnston, and Millar (2005) have found that anorexic females had fewer brothers than controls. There is evidence that AN is more common among higher social classes (McClelland & Crisp, 2001) and it is possible to view this as a more competitive arena.

SUMMARY

Evolutionary ideas have been used to shed light on other psychological problems and the peculiarities of AN make it of particular interest. AN is here explained with a synthesis of ideas about response to threat. Dietary restriction is explained using the concept of social attention holding power (self-esteem) and the need to belong. Restriction may be part of an attempt to maintain status and belonging within a group when both feel under threat. Differences between females and males in response to intra-sexual competition may explain why dietary restriction, and hence AN, is more common in females. Some evolutionary models of AN have been proposed and it is suggested that two of these may work together to produce the odd mix of symptoms that is AN. When weight dips below a certain level an old adaptive response to the threat of famine is triggered thus enabling the weight loss to continue. This explains why AN is relatively rare, how restriction is achieved, why people can function at low weight, and why aspects of this are experienced in a positive way. Others may then exploit the weight loss, so that the fear of eating and returning to a normal weight is because doing so would reopen the possibility of attacks by others and bring back the risk of exclusion. Thus the restriction continues. These hypotheses are not easy to prove or disprove but may provide new ways of looking at AN and of finding more successful ways of helping people recover from this dangerous condition.

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