A Quantum Psychopathological Account of Anorexia Nervosa

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ABSTRACT
Anorexia Nervosa (AN) is a mental disorder characterised by a refusal to maintain body weight at or above 85% of the minimally normal weight for age and height, an intense fear of gaining weight and a disturbance in the way in which one’s body is perceived such that the sufferer is often unable to see that s/he is underweight. Contemporary psychodynamic, feminist and neuropsychological accounts of AN present only partial and sometimes conflicting accounts of this disorder. A quantum psychopathological account of AN might therefore enrich our understanding of this disorder by providing links between the social and the neural explanations for AN while at the same time adding substantially to their depth. In this vein, this paper follows and builds on the recent work of Donald Mender, who has suggested that Quantum Paradigms of Psychopathology (QPP) might be preferable to the currently prevalent biopsychosocial model of mental illness, and who has more specifically suggested that quantum theories of mind might offer a way to render psychoanalytical accounts of mental illness scientifically falsifiable. The first part of this paper will provide a brief yet thorough account of the psychodynamic, feminist and neuropsychological accounts of AN; the second will provide an in-depth overview of four contemporary quantum theories of mind; and the third will consider how these theories might be useful in our understanding of AN, examining specifically their impact on neuropsychology, their impact on psychotherapy and finally the possibility of developing a Quantum Object Relations (QOR) account of AN, based on Mender’s suggestion that “sociable” bosons might account for the impact of internalised ‘objects’ on a patient’s mental health, as identified in the psychoanalytic literature.

Key Words: anorexia nervosa, eating disorders, quantum paradigms of psychopathology, object relations, psychotherapy

Introduction
Anorexia Nervosa is a mental disorder characterised by a refusal to maintain body weight at or above 85% of the minimally normal weight for age and height, an intense fear of gaining weight and a disturbance in the way in which one’s body weight or shape is experienced such that the sufferer is overly influenced by body weight or shape on self-evaluation and/or denies the seriousness of the current low body weight. It can be characterised as either restricting type or binge-eating/purging type, the difference being the former does not engage in bingeing and purging behaviour, while the latter does

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also hold insights for our understanding of the etiology and treatment of Anorexia Nervosa.

Aiming towards this goal, this article will be divided into several sections. Part 1 will provide a brief outline of some already existing theories that attempt to shed light on the causes of Anorexia Nervosa. This will mainly be for the benefit of those readers who are unfamiliar with this disorder and the existing literature on the subject, and will mainly focus on the ideas found within psychodynamic, feminist and neuropsychological schools of thought. Part 2 will serve as a preliminary to the main discussion on how QPP might impact our understanding of Anorexia Nervosa. It will provide a brief critical outline of some existing quantum theories of mind, examining the evidential and logical base of each in order to decide which to use in Part 3’s discussion of how these theories might contribute to the understanding developed in Part 1.

**Part 1. Existing Paradigms**

**A. Psychodynamics**

A psychodynamical viewpoint regards the etiology of Anorexia Nervosa as largely developmental in nature. It views the disorder as a response to deficits in development whereby a lack of parental nurturing led to a failure in the now anorexic patient to develop a coherent sense of self.

According to psychodynamics, a newborn child experiences herself as a mass of separate experiences and requires the nurturing presence of an empathic and loving caregiver to bring these experiences together into a coherent whole (Lemma, 2009; Lacan, 2007). The caregiver is required to attune herself to the baby’s subtle cues which indicate its every need. This attunement is initially expressed preverbally through touch, empathic resonance and mirroring behaviour (Krueger, 2002a) and, according to Bernstein, is necessary from the very start so that the infant child can begin to differentiate between pleasure and pain (Rice, Hardenbergh & Hornyak, 1989). This is the first stage in the development of a healthy body image: the second occurs between the ages of six months and two years, when the child begins to differentiate between self and other, between “me” and “not me” (Krueger, 2002a). Once more, the successful navigation of this stage is only achieved with continuing parental support, in the form of mirroring behaviour and reciprocal interaction (Krueger, 2002a). When, between 15 and 18 months, the child begins to say “no” and can recognise herself in the mirror, she shows that she is starting on a path towards individuation that will be completed between the ages of 6 and 8 years old, by which point she should be able to abstractly recognise the difference between her subjective self and the objective other, and to experience herself as one whole being, rather than a separate mind and separate body only loosely linked (Krueger, 2002a).

Bernstein proposes a different, yet complementary, chronology for the emergence of a healthy body image. After the infant has begun to differentiate between self and other, it is suggested, the next step is recognition of different body parts and their relationships and, subsequently, an exploration of the movement of the whole body through space. It is at this point that Bernstein sees the infant as beginning to enjoy a proper sense of self-control (Rice, Hardenbergh & Hornyak, 1989) and, given that Bruch identifies anorexia as being chiefly a search for a sense of self-control by an adolescent whose childhood denied this to her (1974), it is perhaps at this point that the developmental deficit that results in anorexia occurs.

Whenever it occurs, the psychodynamic viewpoint is that, somewhere along the line, something goes wrong in this developmental process to cause anorexia later in life. The general view is that, for whatever reason, the pre-anorexic child failed to develop a sense of self whereby her bodily sensations were not identified, labelled and integrated into her psychic experience as they should have been. Lacking this identity, she introjected a “false self” from significant others around her whereby she identified herself with their needs and their desires (Hudgins, 1989; Krueger, 2002b). This is why a pre-anorexic child is often described as a “good” little girl who never was any trouble and was always (overly) compliant to her parents (Woodall & Anderson, 1989): she could be nothing else, since her identity was their identity. And when, upon adolescence, she is expected to become independent, having never learnt to recognise or respond to her own needs, (which is often called the “selflessness” of anorexia; Curiel-Levy, 2012), she reacts to this crisis of self by resorting to self-starvation.
This recourse to self-starvation might have several meanings. Bruch saw it, quite logically, as an extreme attempt at self-control (1973), while Lawrence expands on this idea to argue that the anorexic is not simply trying to control herself, but also her internal ‘objects’ (i.e., the internalised images of her family) (2001). The self-starvation might also present itself as a guilt-free rebellion against the mother who prevented her independence (Lemma, 2009; Woodall & Anderson, 1989). Having never developed the strong sense of self, or “ego”, that would be required for open hostilities against her parents (which would consume her with guilt), she instead chooses to reject the symbol of parental love: the food they give her every evening as a meal.

Various authors have suggested various reasons why the pre-anorexic child might have failed to develop a healthy sense of identity. Lemma suggests that the anorexic’s mother might have over-invested herself in her daughter’s appearance at the expense of her personality (2009) and consequently prevented the daughter having the freedom to explore her individuality. Curiel-Levy suggests an infant daughter might copy the self-sacrifice of a mother suffering from depression (2012); and according to Lawrence, anorexia and other eating disorders might be seen as “mechanisms that patients use to buttress manic defences against depressive pain associated with the reality of the oedipal situation”, based on the observation that some of his patients seemed unable to deal with an outside influence in the mother-daughter relationship, whether that be from their father in relation to their mother, or from their husband in relation to their daughter (2001).

A psychodynamic account such as the one given above has strengths and weaknesses. In its favour, it opens our eyes to the influence that early parent-child relationships can have on adolescent and adult mental health; yet, despite all its detail, the theoretical approach of psychodynamics fails to address the fact that Anorexia is mainly a problem experienced by women and adolescent girls. While psychodynamics largely ignores this question, it forms the centre-point of the feminist approach to anorexia.

**B. Feminism**
A significant body of thought within feminism has drawn on insights from the previously articulated psychodynamic account of anorexia, which can lend itself well to a feminist analytic: in Krueger’s account of body image development, for example, he talks of how an anorexic is alienated from her body (2002a); how, even after the parent’s job is done, body image must still evolve in line with the maturing body and its physical surroundings (2002a); and how one of the causes of later body image problems might be a mother who passes on her own rift between mind and body to her child (2002b). Equally, if feminism can draw from psychodynamic thought, it can also add to it. It is easy to see where we might profit by including a feminist account of how that body is alienated, how those physical surroundings affect the still-evolving body image, and why precisely this mother has such a rift between her own mind and body. And yet, despite there being ample room for a feminist contribution to psychodynamic thought, the two theories still manage to rub up against each other.

The key contribution of feminist thought is to situate it within the realm of the social and political. Orbach is particularly adept at this, and bases her approach on the view that “we always need to set the unconscious within its social context... [t]he unconscious becomes the mechanism by which the individual accepts unacceptable aspects of the world as she sees it” (2005, p.84). Following on from this viewpoint, eating disorders such as Anorexia Nervosa can then be seen as “the psychological symptoms of women who are the products of late twentieth-century capitalism” (2005, p.27). If women in the late 19th century were more likely to manifest symptoms of hysteria due to their contemporary culture idealising a female social role of romance and frailty, then women in the latter half of the 20th century, and beyond, are more likely to respond to a culture where they are simultaneously expected to be the all-providing mother in the kitchen and the stick-thin model on the catwalk, and where they are encouraged to view their bodies externally as commodities rather than internally as integrated parts of themselves, by developing a disturbed relationship with food. Orbach paints a dystopian and disturbing vision where this cultural imperative, or “psychology of feminity” (2005, p.86), is passed down through the generations from mother to daughter both consciously and unconsciously: consciously, because the
parents might choose deliberately to raise their daughter in line with social expectations of how females should behave; unconsciously, because the mother might project her own body insecurities onto her infant daughter and allow them (unwittingly) to affect the mother-child relationship and the daughter's mental development; and, even if this child has the best of starts in life with the best of parents, her inevitable exposure to the outside world will quickly educate her as to the role she is supposed to be playing as a female in Western society. Her body becomes her commodity - a commodity that simply can't compete with the fictions presented in fashion magazines and billboards - and, even if she avoids contracting a full-blown eating disorder, she is destined to spend the rest of her life feeling ashamed of something that should be enjoyed. It is in this social context that Orbach can confidently make the claim that “while anorexia does not affect all women, there is a continuity in all women’s experience that makes them vulnerable to such problems” (2005, p.28).

Another contribution from feminist thought is the notion of “Objectified Body Consciousness”, which is a composite idea based on the social constructionist view that women experience their bodies as objects to be watched and which includes measures of body surveillance, internalisation of cultural beauty standards and appearance control beliefs (i.e.,the belief that it is actually possible to achieve the cultural ideal) (McKinley, 2002). This measure has been the basis of experimental studies that have confirmed, unsurprisingly, that higher levels of body shame and body surveillance can be linked to lower levels of body satisfaction and higher rates of eating problems (McKinley, 2002). Moreover, unsurprisingly, other studies have confirmed that cultural and social imperatives communicated through the media (Tiggemann, 2002; Hardit & Hannum, 2012) and peer victimisation in early or pre-adolescence (Lunde & Frisén, 2011) can also lead to greater body dissatisfaction and, in some cases, eating disorders. One important point to register here, however, is that the study by Hardit and Hannum only found the media to have a significant influence on levels of body satisfaction when the person being exposed to the media already had relationships based on “anxious attachments” (2012).

There is a considerable amount of tension between the feminist account related here and the psychodynamic account related above. Feminism argues that a theory like Freudian psychodynamics, based as it is on questionable ideas like ‘penis envy’, ‘natural’ female masochism and the unformed quality of the female superego, has no business in dealing with what is predominantly a female mental health issue. Psychoanalysis, for its part, asserts that the treatment of Anorexia Nervosa by feminist theorists such as Orbach fundamentally misunderstands certain principles and concepts of psychodynamic theory, while at the same time failing to explain precisely how cultural prohibitions embed themselves in a patient’s unconscious. There is also the accusation that feminist theory brings with it a certain cultural bias. For example, Young-Bruehl makes the suggestion that feminist thought is so embroiled in the 1960s ideology of sexual liberation from which it sprang that it cannot see the forest for the trees: perhaps, so the argument goes, the issue is not so much that women today grow up in a society where they, as women, are sexually objectified, but rather that the very legacy of sexual liberation itself is that today’s generation, in general, are growing up in a “tyranny of youthful sexual experimentation”, a culture of “compulsory promiscuousness”, where the teenage girl who develops anorexia, with its concomitant loss of sexual function and a return to child-like appearance and behaviour, is in fact rebelling against sexualisation in general rather than female sexual objectification in particular (1993).

However, while this particular argument is undoubtedly true for some anorexics, it does not carry the explanatory power of the feminist theories described above for making clear why so many more women than men suffer from anorexia in the first place. Moreover, perhaps these anorexic behaviours can best be explained by the feminist idea that the “psychology of feminity” passed down through the generations is not just about a prohibition on food, but is mainly about giving up one’s own desires and needs in general for the sake of others (the archetypal image being the mother and wife who puts her husband and children first) (Orbach, 2005). Considered in this light, the unconscious suppression of one’s sexual needs would be no different from the
unconscious suppression of one’s need for food.²

If, then, it can be argued that the feminist approach to Anorexia Nervosa tells us why so many more women suffer from it than men, we still have one more question to ask: if feminism tells us that cultural standards of feminine behaviour are to blame, and psychoanalysis tells us that early family relationships are responsible, then why do only some people respond to these influences by developing an eating disorder while others do not?

The answer to this question might be provided by the curious role of serotonin in the anorexic brain.

C. Neuropsychology

Altered brain serotonin (5-HT) function could contribute to a susceptibility to developing eating disorders. While modern neuropsychology is not yet clear whether the alterations in brain serotonin (5-HT) functionality found within anorexic and bulimic brains is the cause or the effect of the eating disorder (Pichika et al., 2011), a mounting body of evidence from molecular genetic research would seem to indicate that abnormalities in serotonin function should at least partially be considered to be a priori causes rather than a posteriori effects of Anorexia Nervosa (Klump & Gobrogge, 2005; Stoltenberg et al., 2012).

Serotonin is a neurotransmitter that has been associated both with appetite dysregulation and with anxiety or obsessive behaviours and extremes of impulse control. Multiple studies exist confirming that the anorexic brain, as well as the bulimic brain exhibits abnormal 5-HT functional activity when compared with controls: specifically, when one looks at 5-HT₁A receptor binding in certain regions of the brain, one sees a 50-70% increase in activity in anorexies and a 20-40% increase in activity in bulimics; and when one looks at postsynaptic 5-HT₂A receptor binding, one sees a reduction in the left frontal, bilateral parietal and occipital cortex in the anorexic brain, and in the parietal cortex in the bulimic brain (Duvvuri et al., 2010; Goethals et al., 2007).

While the presence of altered serotonin function in Anorexia Nervosa is clear, its cause is not. Debate still rages about whether it is the cause of the disorder or the effect of malnutrition (Pichika et al., 2011). However, evidence from molecular genetic research would imply that it is the former. In a 2005 review of 30 molecular genetic studies conducted on the impact of genetics in the etiology of Anorexia Nervosa, Klump & Gobrogge describe “significant associations”³ between the 5-HT₂A receptor gene and Anorexia Nervosa, as well as, more generally, between chromosome 10 and Anorexia Nervosa (Grice et al., 2002), bulimia nervosa (Bulik et al., 2003) and, in general, obsessionality and a drive for thinness (Devlin et al., 2002).

What is interesting about this research is how these genes might work to affect the behaviour and experience of the person who carries them. Klump & Gobrogge (2005) suggest that the functionality of the 5-HT₂A polymorphism might be to predispose the onset of Anorexia Nervosa through personality traits such as harm avoidance and basic affects such as anxiety and depression. While this viewpoint is little more than speculation on their part, one recent study provides evidence of the potential effect of one particular gene: the serotonin transporter gene SLC6A4. It shows that women who are born with a lower expressing allele of this gene and exposed to higher levels of childhood trauma are more likely to contract an eating disorder later in life (Stoltenberg et al., 2012). What this might mean, in relation to the two theories discussed above, is that genetic factors predispose one to be susceptible (or not) to responding to deficits in early parental care and/or a culture that objectifies female bodies by developing Anorexia Nervosa, either or both of which might be experienced as mental trauma by the growing child.

The increasing prevalence of anorexia among women and adolescent girls might also have a simpler biological explanation. Klump & Gobrogge, while admitting that genetic factors must be considered alongside other

² A recent study by Curiel-Levy (2012) casts doubt on the idea that AN is predominantly about a denial of need/desire. It failed to find any difference in subjugation of one’s needs or desires to others in anorexics as compared to a control group of depressives- yet since depressives are also known to subjugate their needs to others, this may be unreliable.

³ This statement describes the findings of a meta-analysis of 9 other studies (Gorwood et al., 2003). Klump & Gobrogge are more cautious, noting that 5 subsequently published studies were not included in this meta-analysis.
environmental and biological factors, focus their discussion on the biological factors alone and, in particular, the potential role of oestrogen (2005). They cite scientific evidence that oestrogen is important in the regulation of serotonin receptors in the brain as well as in serotonin gene transcription, and speculate that the onset of eating disorders around puberty might be explained by the upsurge in hormones, including oestrogen. Although this argument is never explicitly made by Klump & Gobrogge, it might be inferred that, given that oestrogen is more associated with women, this might provide a complementary or alternative explanation for why so many more women than men contract eating disorders.

Part 2. The Quantum Mind Evaluated
Part 3 will discuss how Quantum Paradigms of Psychopathology (QPP) might add to the ideas presented above. For now, though, it is necessary to discern which quantum theories of mind have sufficient evidential and logical foundations to merit their inclusion in an account of the psychopathology of Anorexia Nervosa. This will be the purpose of Part 2; and, specifically, we shall be evaluating the validity of: Henry Stapp’s interactive dualism; Pylkkänen’s Bohmian approach to psychopathology (2010); the Penrose-Hameroff Orchestrated Objective Reduction (Orch OR) hypothesis; and Thermofield Brain Dynamics (TBD).

The Orch OR hypothesis of Hameroff and Penrose proposes that human consciousness can be explained by the operation of a process called ‘objective reduction’ at the level of microtubules in the brain. This idea is collaboratively based on the work of 1) Hameroff, who postulated based on his work in anaesthesiology that microtubules in each of the brain’s neurons function as automata with vast powers of computation that regulate neuron-level synaptic operations, and 2) Penrose, who came to view ‘objective reduction’ (the idea that superposition is understood as space-time curvatures going in opposite directions at the Planck scale, and that what is commonly called ‘measurement’ or ‘wave function collapse’ occurs when an objective threshold is reached, at which point the unstable separation of these superposed states is reduced) as crucial to the understanding of human consciousness (Hameroff, 2007). Bringing their two approaches together, they posit a quantum theory of mind centred around the microtubules in the brain, or their subunit tubulins. These tubulins are posited as being related to each other by quantum superposition and as performing the functions of a quantum computer. Consciousness is achieved when a maximum of “coherent excitation” is reached within the microtubules, posited to occur according to a cycle that repeats every 25-500 ms in which the maximal threshold value of coherence is reached and then collapses due to gravitational effects, allowing for the appearance of classical physical events (Zizzi & Pregolato, 2012).

Thermofield Brain Dynamics is another theory that rests heavily on the influence of microtubules, but does so in a different way. Originally developed by Jibu and Yasue under the label ‘Quantum Brain Dynamics’ (QBD) (Jibu et al., 1995) and then further developed and modified by Vitiello under a new designation, ‘Thermofield Brain Dynamics’ (Vitiello, 1995; 2003), this approach views consciousness as being attributable to an understanding of the brain as a coherent water dipole field created by solitons interacting with the neuronal cytoskeleton (Woolf, Craddock, Frieson & Tuszynski, 2010). Both QBD and TBD try to explain memory and consciousness by means of symmetry-breaking vacuum ground states of the brain’s water dipole field. In each of these ground states, where the dipoles are all correlated and pointing in the same direction, rotating each dipole to the same degree results in a different ground state. Disruption of any one ground state causes symmetry to be lost from the dipoles but compensatorily preserved by a release of Nambu-Goldstein bosons called “symmetrons”. External sensory input disrupts the ground state, but the traces are stored in symmetron condensates; and, as these are near-zero in energy and easily excited out of their vacuum state when the same sensory signals are replicated, this excitement out of the ground state mediates memory via consciousness.

This is the claim of QBD; what TBD adds is the idea that the ground state can have dual modes, developing QBD in such a way that it now not only explains memory and consciousness, but can also attempt to explain mental disorders as a splitting or mistuning of the self-tuning mechanism in the brain.
Globus states that these dual modes of the vacuum state, labelled non-tilde and tilde, relate to each other in an “intrinsic” way, meaning that the duality only exists between the two of them and that “the unity of phenomenal consciousness is between-two” (Globus, 2010). The form of consciousness according to Globus is influenced by three different wave functions acting on the ground state: external stimuli, memory, and self-tuning. When self-tuning goes wrong, it is argued, it is possible for the unity of consciousness in the between-two to be maintained, while the self-tuning mechanism is split, creating two autonomous personalities in one conscious space and, thus, accounting for the schizophrenic experience of hearing another person’s thoughts in their own head. As will be seen, this will have relevance for our treatment of Anorexia Nervosa later on.

Reliance of each of these theories on microtubules is potentially problematic, since the role of microtubules in the creation of consciousness in far from clear. For Lane (2000), in fact, this reliance signals the death knell to the Hameroff-Penrose hypothesis, since many anaesthetics induce states of unconsciousness without affecting the microtubules, and many chemicals—such as colchicine— are known to affect microtubules without concurrently having any effect on human consciousness. This objection is disputed by Woolf et al. (2010), who state on the contrary that when colchicines bind to tubulins and disrupt microtubule functioning, this interferes with subject performance on several tasks, and who also assert that several genes associated with psychiatric illness, such as disrupted-in-schizophrenia-1 (DISC1), neuregulin-1, dysbindin, and neurexin-1, have a complementary role to play in the regulation of neuroplasticity via interactions with the cytoskeleton, implicating a role for cytoskeleton dysregulation in the generation of mental illness. While this point is valid as far as it goes, it hardly constitutes proof of either the Hameroff-Penrose position or that taken by microtubule-instantiated versions of TBD.

Another stark problem with the Hameroff-Penrose hypothesis is the famous Tegmark decoherence objection, according to which the kind of quantum coherence postulated by Penrose and Hameroff to occur in the brain’s microtubules could not possibly take place in an environment as warm as that of the human brain (Tegmark, 2000). The problem here lies in the fact that the entangled states envisioned by the Penrose-Hameroff approach would decohere too quickly in the warm human brain to account for the millisecond time scales observed in neuroscience (Woolf, Craddock, Frieson & Tuszynski, 2010). Attempts have been made to resolve this issue, for example by arguing that coherence time might be extended through counter-ion shielding, actin shielding or intrinsic error correction (Woolf, Craddock, Frieson & Tuszynski, 2010); nevertheless, these attempts remain largely theoretical, and the Tegmark objection remains to this day one of the biggest obstacles to a wide-spread acceptance of the Hameroff-Penrose hypothesis.

Stapp’s approach claims to be able to resolve or circumvent this objection, however, by positing the interaction of an abstract mind with the brain by means of Quantum Zeno Effect (QZE) in a theory sometimes called ‘interactive dualism’ (Georgiev, 2012). His theory is based on von Neumann’s interpretation of the Copenhagen formulation of Quantum Theory, according to which measurement or observation causes the collapse of a quantum’s wavefunction and its entry into particular form. Even according to standard accounts of the Copenhagen formulation, the presence of an observer is crucial for the collapse of the wave function; yet in experimental practice, this is usually interpreted as the presence of the physicist conducting the experiment, where the physicists are viewed as the “observing” part of the situation whose “free choice” causes the collapse of the wave function in the “observed” part of the situation. For Stapp, this conventional approach is not sufficient to qualify as a “rationally coherent theory of reality” (Stapp, 2012); to achieve this, we need to adopt von Neumann’s interpretation of the Copenhagen formulation, which merely pushes it to its logical limits: for what, precisely, is doing the observing in the above described scenario? We could respond that it is the physicists, but then we could also say that they are observing themselves with their eyes; we could go further, and state that the signals from their eyes are being measured by their brains, and we could go further still, until we are forced to posit the existence of an “abstract ego” whose subjectivity, interacting with the brain, is observing the whole
apparatus just described. For von Neumann, a description of the world that just includes the Schrödinger equation (which he labels in his scheme of thought as 'process 2') is incomplete. To achieve a "rationally coherent theory of a fully quantum mechanical psychosocial reality" (Stapp, 2012), we must factor in two other pre-existing processes as well: the observation of an "abstract ego" (process 1) and a "choice on the part of nature" (process 3), where the observation of the subjective abstract ego forces reality, previously described by the indeterminacy of the Schrödinger equation, to choose between one of several possibilities that were previously superposed on top of one another. This abstract ego is where we find the origins of consciousness and subjectivity.

Stapp’s theory is elegant, yet suffers several problems. The first is that it rests whole-heartedly on a very particular interpretation of the Copenhagen formulation, so that if we take this view of Quantum Theory to be correct, then his conclusions follow on logically, but if we opt for a "many worlds" approach (Werneke, 2011) or the ‘Objective Reduction’ approach offered by Hameroff (Woolf, Craddock, Frieson & Tuszynski, 2010), then Stapp’s approach fails to hold water. Given that both of these alternatives remain controversial within the physics community, this criticism is not so damaging, but the next one is: for while Stapp’s theory predicts the presence of quantum effects in Ca²⁺ ion channels in order to explain the interaction of his “abstract ego” with the physical world, it has been argued that, given the fact that ions flow in single file across these channels and that large numbers of proteins are involved in the regulation of such flows, we would not expect to see quantum effects in such channels (Woolf, Craddock, Frieson & Tuszynski, 2010). Finally, and most devastatingly, the very claim at the heart of Stapp’s approach— that an abstract mind interacting with the brain by means of QZE could circumvent the Tegmark objection— is questionable: specifically, Georgiev (2012) claims to have constructed a quantum mechanical theorem based on a calculation of the von Neumann entropy of the brain density matrix to show that QZE exerted by the mind locally on the brain could not slow down or reverse the effects of environmental decoherence, thus leaving the Tegmark objection in place— although, naturally, Stapp disputes this, arguing for his part that the model used by Georgiev, which assumes a quantum system comprised of just two basis states, cannot provide any meaningful conclusions about the functioning of the brain which, in Stapp’s estimation, has “a very high-dimensional continuum of states along the diagonal”, and that, at any rate, his theory does not even claim that the QZE exerted by the mind can slow down environmental decoherence but, rather, that it merely works to prevent the brain reverting to the previous state that it embodied before a prior process-1 choice, a process that occurs in a context where environmental decoherence is a constant occurrence (Stapp, 2012). The evidential and logical basis for Stapp’s approach remains ambiguous then: on the one hand, its elegance would solve the problems of observer effect in the Copenhagen formulation and of the emergence of mind in neuroscience in one fell swoop and in a seemingly logical manner; on the other hand, the absence of evidence for any quantum effects in Ca²⁺ ion channels and the controversial nature of Stapp’s central claim should give us cause for caution.

Bohm’s theory is crucial in this list insofar as it lacks any particular claims about neurobiological correlation: where Hameroff and Vitiello look to microtubules, and where Stapp rests on Ca²⁺ ion channels, Bohm’s view remains largely theoretical. Against the tendency of most contemporary physicists to reject an account of Quantum Theory that includes reference to hidden variables, Bohm’s approach admits that, while the Schrödinger equation accounts for the mean behaviour of the ψ-field, where the wavefunction (ψ) is assumed to represent an objectively real field, the individual fluctuations of the ψ-field “can be regarded as coming from a deeper sub-quantum-mechanical level” (2002, p. 98). He additionally posits that, besides the ψ-field, there is always also a particle, which is acted upon by a “quantum potential” (2002, p.98). He goes on to show how such an approach could resolve one of the difficulties with contemporary relativistic quantum field theory: namely, the fact that as we consider situations with increasingly high energies and increasingly short distances within the framework of relativistic quantum field theory, the fluctuation per degree of freedom increases without limit, towards infinity. Of course, if we were to accept that this example shows the
validity of a Bohmian approach, we would also have to accept the idea of a “sub-quantum-mechanical level”- and it is here that Bohm introduces the concept of an “implicate order” (2002, p.186-190). Noting that relativity theory and quantum theory are both incompatible and incomplete (since there is no role for the relativistic notion of ‘signal’ in a quantum reality, and there is no room for the concept of a ‘quantum state’ in relativity theory), he takes what both have in common—namely, the implication of undivided wholeness- to suggest that this is the feature that characterises an underlying “implicate” or ‘enfolded’ order, of which both quantum theory and relativity theory are simply unfolded sub-totalities relevant in their applicable domains. This “implicate order” is taken to be synonymous with the notion of ‘holomovement’, an “unbroken and undivided totality” of movement containing enfolded information about order and measure, operating in a way roughly analogous to that of a hologram, where in each region of space, of whatever size, is enfolded the entire structure of a certain object. In this context, the movement of an electron would not be taken to be the movement of a point-particle through empty space but, rather, the swift repetition of unfolding and enfolding projections from an implicate order extending, in principle, to an infinite number of dimensions and covering the entire universe. Just as matter is said to unfold from the implicate order, so is consciousness, even to the extent of suggesting that conscious experience itself is a link to the implicate order, in that both are able to account for the sensation of flow in movement in a way that effectively resolves Zeno’s paradox: for if we consider motion as the movement of a point along a line, then an equation written to express this point’s velocity would express it in terms of the relationship between what is (the point and time at which it is now found) and what is no longer (the point and time at which it began). This, of course, succeeds only in describing motion in an abstract way, leaving out the present sensation of movement; but if we consider also the implicature order, and if we posit a link between it and our consciousness, then we see that the previous point and time have not truly ceased to exist, but have merely become once more enfolded; and, if consciousness is connected to the implicate order, then we are now considering a relationship between what is (unfolded) and what is (enfolded), which better accounts for the conscious experience of flow. Of course, consciousness is not seen by Bohm as being analogous to the implicate order but rather, like matter, as being linked to it by a repeating chain of unfolding and enfolding moments, so that the deepest actuality is posited as being a higher-dimensional actuality that is neither mind nor matter, and yet is the source of both. Consciousness is seen as not just including the explicate content of neurophysiological processes, but also an implicate background analogous to the ‘sea’ of ‘zero-point’ energy that fills seemingly ‘empty’ space (Bohm, 2002).

It is clear that the general ground covered by Bohm’s quantum ontology is a fertile soil, rich with possibilities for development. The last point made in the previous paragraph may constitute theoretical support for such notions as Jung’s ‘collective unconscious’ (1991), and may also provide the basis for new ideas useful in a therapeutic framework. Specifically, Pyllkännen has used the idea of a quantum field containing “active information” about the electron’s environment that gives rise to a “quantum potential” as an analogy for the brain. On this view, the human mind could be considered to be a variant of, or analogous to, the quantum field, where “the information that is experienced in consciousness is carried by some much more subtle medium, analogous to the quantum field, but capable of much more complex properties, including qualia, subjectivity and conscious experience” (Pylkkänen, 2010). Continuing the analogy, this “subtle medium” would not be seen as separate from the brain, but rather the brain and mind would be considered as a union of the particle and the field, and mental disorders could be seen as deficits in the way this brain-mind union manages its “active information”. This view may be favoured by some, as it does away with the awkward idea that particles are no longer there when no longer observed, and it lends itself to some interesting therapeutic applications, which will be discussed in more detail later. Nonetheless, the fact that it does not come with a falsifiable hypothesis may prove frustrating to some, and certainly reduces its standing as an experimentally verifiable theory of mind in its own right.
In conclusion, then, none of the theories thus far considered can be seen as conclusively proven. At best, they constitute the embryonic steps of a new paradigm in science, for which evidence will be collected as time goes on; at worst, some of them should be declared unworkable even at this early stage. The considerations developed in this part of the article should be kept in mind as we continue on to examine the claim that these quantum paradigms of mind have something to add to our existing understanding of Anorexia Nervosa.

Part 3. Applying the Theories: The Quantum Psychopathology of Anorexia Nervosa

Given the unproven nature of the theories discussed above, it is pertinent to ask why it is relevant to consider the quantum mind at all in relation to Anorexia Nervosa. The answer, quite simply, is that the biopsychosocial model of mental illness, of which the above analysis in Part 1 is a part, is currently insufficient to allow us to fully understand the causes of and appropriate treatments for Anorexia Nervosa. Mender (2010) offers several specific reasons in an attempt to justify the pursuit of quantum accounts of psychopathology, such as the fact that patients may not respond as expected to prescribed medication, that observed brain changes may just as easily be the result of mental illness rather than the cause, and that the current biopsychosocial model, based as it is on the notion of emergent phases, cannot adequately account for the therapeutic effect of macro-level psychological and social interventions on micro-level dysfunctions in neurochemistry. While many of these points are made with specific reference to schizophrenia, they apply equally well to Anorexia Nervosa: despite observations that anorexics have significantly altered functioning in the serotonin systems of their brains, medication designed to deal with this dysfunction is often ineffective (Lock, le Grange, Agras & Dare, 2001; Wilson, Grilo & Vitousek, 2007); while evidence points to a genetic disposition for developing Anorexia Nervosa, the exact determination of which alterations in brain functioning have been caused by the illness and which were pre-existent remains troublesome (Duvvuri, Bailer & Kaye, 2010); and, if the biopsychosocial model cannot account for the effectiveness of social and psychological interventions in schizophrenia, then it follows that it would also struggle to account for the relative efficacy, at least as compared with psychopharmacological interventions, of psychotherapeutic interventions such as CBT and Family Therapy in relation to Anorexia Nervosa (Wilson, Grilo & Vitousek, 2007). Mender asserts that these challenges can potentially be overcome by a quantum paradigm of psychopathology, since “the relationship between causation and scale within quantum physics is more expansive in several fundamental ways, including not only allowance of "downward" causation among scales, but more pointedly the potential relief of [quantum] phase transitions from encumbrance by any rigid notion of scale whatsoever” (2010). This would allow for an explanation of how social and psychological interventions can affect the minutaie of neurochemical changes, and would thus improve our understanding of the etiology and treatment of Anorexia Nervosa.

While it is acknowledged following the considerations of Part 2 that the quantum theories of mind considered thus far are merely in their embryonic stages of development, it is worth here outlining some potential and specific ways that they may help us understand both the neuropsychology and psychotherapy of Anorexia Nervosa as they develop. This consideration will be divided into three parts, where A examines the potential impact on our biological and neuropsychological understanding, B examines how a quantum understanding of Anorexia Nervosa may presently impact current paradigms of psychotherapy, and C offers a theoretical framework through which quantum theories of mind might accommodate the insights of psychoanalytic Object Relations in relation to Anorexia Nervosa.

A. The Impact on Neuropsychology

It was earlier remarked that the Penrose-Hameroff model has drawn tentative support from the fact that genes associated with psychiatric illness, such as disrupted-in-schizophrenia-1 (DISC1), neuregulin-1, dysbindin, and neurexin-1, have a complementary role to play in the regulation of neuroplasticity via interactions with the cytoskeleton, implicating a role for cytoskeleton dysregulation in the generation of
mental illness (Woolf, Craddock, Frieson & Tuszynski, 2010).

This claim was made in relation to schizophrenia and genes specifically implicated in the etiology of schizophrenia, but it could equally well be made in relation to Anorexia Nervosa if research evidence were forthcoming. It was also earlier noted that a specific lower expressing allele of the serotonin transport gene SLC6A4 has been linked to a higher probability of developing Anorexia Nervosa later in life after experiencing childhood trauma in a population of women (Stoltenberg et al., 2012). If this particular allele were also found to have demonstrable effects on the regulation of neuroplasticity via interactions with the cytoskeleton, then this would add credence to the hypothesis of Woolf et al. that variations in the brain’s cytoskeleton structure are correlated to psychopathology, which would also provide support for the perennially troubled Penrose-Hameroff model of the quantum mind. Thus far, it seems that research into this particular attribute of SLC6A4 has either not been forthcoming, or else has been fruitless: a quick search of the archives of the American Journal of Human Genetics finds only one article in which both ‘SLC6A4’ and ‘cytoskeleton’ are found, and this only to state that “[t]he activity of cadherins... depends on their anchorage to the cytoskeleton via proteins termed catenins”, which is an entirely useless finding for the present article when one considers that SLC6A4 is not found within the group of canhedin repair considered by the authors (Vink JM et al., 2009); and similar searches within the archives of the International Journal of Eating Disorders and of Human Molecular Genetics prove themselves to be equally as fruitless, with the only relevant article in the latter journal discussing ‘cytoskeleton’ solely in relation to the genes SH3GL1, SH3GL2 and SH3GL3 (Dorschner et al., 2000). This may indicate that the potential impact of SLC6A4 of the cytoskeleton and microtubules is a potentially fruitful yet currently unstudied area of research that could, in future, provide support for the hypothesis that microtubule dysfunction plays an important role in psychopathology; or, alternatively, it might indicate that it is now common knowledge in human genetics that SLC6A4 has no significant impact on the cytoskeleton, and, thus, that the Penrose-Hameroff model of mental illness that rests upon microtubule dysfunction to explain schizophrenia (Woolf, Craddock, Frieson & Tuszynski, 2010) could not be translated well into the domain of eating disorders.

Nevertheless, if this speculative hypothesis were found to be true, then there is already a model based on the Penrose-Hameroff model that could help to explain the psychopathology experienced in Anorexia Nervosa. Assuming the validity of the Penrose-Hameroff model, Woolf et al. document how Craddock and colleagues have determined four potential types of behaviour that could be exhibited by microtubule automata: a homogenous state (type I), a simple stable or periodic structure (type II), an unpredictable pattern (type III), or complex, sometimes long-lived localised structures (type IV), and it is suggested that symptoms of anxiety of mania may be linked to an excess of type IV behaviour (2010). Recalling Lawrence’s conception of Anorexia Nervosa as a mechanism potentially “use[d] to buttress manic defences against depressive pain” (2001), this is potentially a factor in understanding the etiology of Anorexia Nervosa- provided, of course, that the Penrose-Hameroff model is shown to be valid.

Another potential use of quantum paradigms of psychopathology in relation to Anorexia Nervosa relates to the suggestions by Globus of the way in which TBD might help explain the phenomenon of thought insertion in schizophrenia (2010). He explains how the intrinsic duality in the vacuum state allows for a continued unity of consciousness; while a fragmentation of the self-tuning mechanism means that there is simultaneously a unified consciousness but, seemingly, two separate self-concepts, so that the schizophrenic experiences some thoughts as his own and other thoughts as alien. While not one of the major symptoms of Anorexia Nervosa- indeed, there may be many patients in which this symptom is absent- it is not uncommon for an anorexic to speak as if there were a phenomenon similar to schizophrenic thought insertion taking place, such that whenever s/he eats what she perceives to be too much, a voice described as almost belonging to a separate personality, over whom the patient has no control, begins to hurl abuse at her, calling her ‘fat’ or ‘greedy’. It is possible that, if TBD is validated as a theory by experimental
evidence, this ego-alien eating-disordered phenomenon may be accounted for by a similar explanation to that given by Globus in relation to schizophrenia (2010); indeed, such an explanation would be in line with the earlier view of Janet, who conceived of Anorexia Nervosa as fundamentally defined by dissociation between, on the one hand, the patient’s ordinary personality that has given up eating and, on the other hand, the patient’s eating function, which seems to have taken on a life of its own on the rare occasions when it is let loose. Bromberg (2008) discusses this from a Jungian perspective in relation to the way in which a bulimic (and, one would also expect, a binge-eating/purging type anorexic) seems to suffer a “temporary cognitive narrowing” and a “general reduction in self-awareness” when bingeing, a phenomenon he views as being similar to the cognitive processes underlying dissociation.

B. The Impact on Psychotherapy
Psychotherapy in general and CBT in particular, could benefit from the insights of quantum theories of mind. There is potentially a lot that could be added by a quantum account of Anorexia Nervosa, at least in terms of theoretical understanding. The first point to make is that the theoretical background behind CBT relies heavily on the way in which the individual seeking treatment processes information about the world around them, whether that be in the past (historical factors) or in the present (proximal factors). In this context, it would be pertinent to point out the crucial role given by Pylkkänen (2010) to the way in which the mind deals with “active information” in his Bohmian account of mental disorder. In this framework, the mind would be viewed as a “subtle medium” analogous to the quantum field of an electron that influences the physical action of the brain in just the same way as the electron’s quantum field influences its trajectory in the Bohmian interpretation of the double slit experiment, and a cognitive approach to understanding and dealing with eating disorders could be viewed at least partially as being concerned with the way in which the sufferer’s mind is misusing “active information”.

Amore fundamental point, however, goes deeper into the philosophical roots of CBT, back to the Stoic philosophy that it is often said to reflect. Writing in the Guardian newspaper, Mark Vernon (2012) discusses the way in which modern-day CBT closely resembles ancient Stoic thought in all ways but one: while the Stoics revered what they called the λόγος, viewed by them as being something analogous to the idea that everything that happens in life is directed by an underlying rationality, so that all suffering is gladly endured by the convinced Stoic who trusts in its unseen wisdom, this aspect is missing from CBT, meaning that the successful client who comes out of CBT in an improved mental condition may not keep such a condition the next time hardship strikes due to his lack of faith in the λόγος. A similar point is made more explicitly by Shelton (2010), who tries to use the insights gleaned from Quantum Theory to suggest seven ‘quantum skills’ that therapists should develop in their work with clients, one of which is the skill of ‘quantum trusting’. In developing this, she draws on her reading of Bohm to suggest that we should have faith in the “invisible ordering principle” implied by the Bohmian notion of a quantum field that influences the movement of particles by means of active information. If clients were encouraged to have faith in such a notion, so that suffering would be easier to endure because one believes it to be rational according to the action of the Stoic λόγος or the Bohmian quantum field, then the results of CBT might be improved not just for Anorexia Nervosa, but also for many other different mental disorders for which CBT is currently prescribed.

C. Towards a Quantum Psychodynamics: Quantum Logic and ‘Sociable’ Bosons
Thus far, this paper has largely concerned itself with the implications of already-existing theories and discoveries within the field of quantum theories of mind and quantum paradigms of psychopathology. In this last section, it will attempt to push the envelope a little further by developing an account of the unconscious quantum logic of Anorexia Nervosa extrapolated from recent work that has shown how such an account might provide new understandings of both schizophrenia (Zizzi & Pregnolato, 2012) and Major Depression Disorder (MDD) (Cocchi et al., 2012). In the specific context of Anorexia Nervosa, it will also draw on the recent work of Mender (2001, 2013) in relation to the way in
which analogies to ‘sociable’ bosons may provide an empirically falsifiable account of psychoanalytic Object Relations theory, in order to develop a wider theoretical model of Quantum Object Relations (QOR).

Mender (2001; 2013) has proposed a link between Freudian psychodynamics and quantum mechanics by postulating that Maxwell-Gibbs-Boltzmann statistics may govern the actions of the ego, while Fermi-Dirac statistics may describe the logic of instinctual drives and Bose-Einstein statistics may describe the logic of Object Relations. This is because in Fermi-Dirac statistics, the Pauli exclusion principle applies, according to which two identical fermions may not occupy the same quantum state simultaneously, analogously accounting for the Freudian notion that one instinctual drive dominates at any one time to the exclusion of all others with which it is incompatible in terms of classical logic. In Bose-Einstein statistics, however, an unlimited number of bosons may condense into the same quantum state, analogously accounting for the Object Relations notion that one’s conscious psyche is always influenced by an undecurrent of simultaneously acting interpersonal ‘objects’, which represent the unconscious internalisations of external-world relationships.

This framework could be integrated into a non-Abelian gauge theory, which could provide falsifiable empirical predictions that would render psychoanalysis more scientific and could unify currently divergent strands of psychoanalytic thought. Experimental evidence demonstrating nonlinear deviations within correlated EEG and MEG data from a living human brain, if found, would show that existing gauge fields are not simply the result of an interaction between electrical and magnetic phenomena. Rather, such a result would support the existence of a deeper phenomenon governed by triune non-Abelian group algebra, which would be consistent with the requirements of accommodating ego-based, drive-based and object-based approaches (Mender, 2001).

If Bose-Einstein statistics do indeed account for the predictions of Object Relations theories, then, if we follow the Penrose-Hameroff Orch OR model used as a basis for Zizzi and Pregnolato’s (2010) model of quantum logic and metalanguage for schizophrenia, we might expect to see bosonic effects within microtubular quantum computation. Quantum computation within microtubules is fundamentally different from classical computational logic, in that the fundamental unit of information within classical computational logic is the bit, while the corresponding unit in quantum computational logic is the qubit. Truth within the classical binary logic of the bit can be illustrated through the logical connective XOR, whereby either A or B is true, but A and B cannot be both true or both false simultaneously. The symbol of the logical connective XOR is ⊕ (Cocchi et al., 2012).

This can be represented by the table:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>A⊕B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
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Where ‘i’ is true and ‘o’ is false.

Within quantum logic, however, truth values are governed by the following equation:

\[ |\alpha|^2 + |\beta|^2 = 1 \]  

Where ‘α’ and ‘β’ are complex numbers called probability amplitudes, whose probabilities sum to one, and ‘i’ represents ‘true’.

The theoretical model that can be used to situate these systems of abstract logic into the human brain is the Penrose-Hameroff Orch OR model. According to this model, quantum computation occurs in the microtubules and, after the loss of coherence due to ‘objective reduction’, classical computational logic takes over. We might propose that this classical logic is the logic of the ‘ego’ (Mender, 2001; 2013). Whether the classical bit displays the truth value ‘o’ or ‘i’ is related to the quantum logic occurring before loss of coherence, where the qubit displays both ‘o’ and ‘i’ as superposed states. Which of these states wins out after loss of superposition is linked to the probability amplitudes associated with ‘o’ and ‘i’ before loss of superposition.

Recent research has used this quantum logic to provide accounts of certain mental disorders. For example, the schizophrenic mode of thought might be evidence of a failure to switch from quantum logic to classical logic.
in the realm of the ‘ego’ (Zizzi & Pregnolato, 2010), and the negative mood experienced by those suffering from Major Depressive Disorder (MDD) might be due to an underlying process of quantum logic where the dominant mode is that of the Quantum NAND (‘and not’) (Cocchi et al., 2012). The latter part of this paper will attempt to apply more specifically the idea of quantum logic to the Object Relations of Anorexia Nervosa.

The key claim of Object Relations theorists is that significant others in our daily and early life can have a crucial unconscious influence on our mental health. This occurs through the process of internalisation, whereby these significant others become unconscious ‘objects’ within the client’s psyche. The term ‘object’ is to be understood in interpersonal relationship to the ‘subject’ whose psyche is in question (Gomez, 1997). Klein, for example, speaks of the crucial influence of the internalisation of the mother’s breast in early life. In what she calls the ‘schizoid position’, the infant in the first six months of life relates to the ‘good breast’ and the ‘bad breast’ on an unconscious level as if the two were separate things, where the presence of a ‘bad breast’ that is depriving the baby of milk is experienced as creating a persecutory anxiety. Resolution of this developmental stage leads on to the ‘depressive position’, where one realises that the ‘good breast’ and ‘bad breast’ were unified all along, giving rise to feelings of guilt and fear of abandonment for how one has treated the ‘breast’ while it was perceived as the ‘bad breast’. For Klein, these ‘positions’ are not just a part of early childhood, but reappear through adult life- even very near its end (Couve, 2007) and can be seen as the cause of much mental illness (Klein, 1997).

Klein is but one Object Relations theorist, and her ideas are far from universally accepted even within the Object Relations community. Nevertheless, the above example relates how, within Object Relations thinking, the internalisation of external interpersonal influences as ‘objects’ within the unconscious psyche is seen as a key explanation of mental distress. In specific relation to Anorexia Nervosa, Lawrence has claimed that the anorexic’s symptom could be an attempt to control an internal mental situation concerning herself and her family, whereby she experiences herself as never having fully differentiated herself from her mother and where the paternal influence is shunned as an attack on this mother-daughter dyad (2001). It is also suggested that it could be a defence against an ‘intrusive object’. Originally, this ‘intrusive object’ is the Mother, from whom the daughter remains psychically undifferentiated. Later, however, food takes the Mother’s place, since food is seen as representing the Mother (Lawrence, 2002). Much of Lawrence’s analysis is questionable, given that it rests upon controversial notions such as the Oedipus complex, the meaning and validity of which have been subject to much doubt and criticism over time (Deleuze & Guattari, 2004; Lacan, 2005). Yet the essential notion of Object Relations- that significant others in one’s life may be internalised in one’s unconscious psyche as ‘objects’ in such a way as to influence one’s conscious mental state and health- can be expanded on with reference to contemporary quantum theories of mind in order to enrich both disciplines.

Here, then, we shall build on these observations in relation to Anorexia Nervosa and in light of the theoretical contributions of Mender (2001, 2013). If Anorexia Nervosa is related to the internalisation of external personal influences at an unconscious level, we can conceive of this in terms of Mender’s ‘sociable’ bosons and in reference to the specific question: ‘am I fat?’. This question can be taken to be posed by a fictitious “Internal Observer” within the quantum computation process, perhaps analogous to Stapp’s “abstract ego” (Stapp, 2012) which, within the framework of quantum gravity, intervenes at the Planck scale and ‘measures’ the process of quantum computation from within (Zizzi & Pregnolato, 2010).

Here perhaps is the key question in Anorexia Nervosa. The predominant mental symptom of Anorexia Nervosa, apart from the obvious physical emaciation, is a continuing conviction, despite reality, of being fat, especially prevalent when one looks in the mirror (Moreno-Dominguez et al., 2012). We can relate this to the ‘ego’ by saying with Freud that ‘the ego is first and foremost a bodily ego’ (Freud, 2003), and by noting with Lacan the importance of the ‘mirror stage’ (Lacan & Fink, 2002) in ego development. We can also link this account with probabilistic notions of quantum logic by noting that an anorexic will often have ‘good days’ and ‘bad days’, meaning
that, depending on his/her mental state, s/he might sometimes see the emaciated reality when s/he looks in the mirror. We can also add in notions of “massive parallelism” in relation to quantum computing (Zizzi & Pregnolato, 2010) and of holonomic memory (Pribram, 1971) to render this account more complete.

To begin with, we can view the question ‘am I fat?’ in terms of both bits and qubits.

Perceived in terms of bits, the question will have one answer: ‘yes’ or ‘no’. Perceived in terms of qubits, it will have multiple answers—both ‘yes’ and ‘no’—that correspond to multiple probability amplitudes. In classical logic, when an anorexic looks in the mirror and sees an obese form, the answer to this question in his/her head is ‘yes’; the statement ‘I am fat’ is given a truth value of ‘1’ in the classical logic described above. In unconscious quantum logic, however, the answers ‘yes’ and ‘no’ are superposed on top of one another. This can be represented in metalinguistic terms by the Quantum AND, formulated by Cocchi et al. (2012) as the connective of quantum superposition:

\[ |\not-A\_a \& \text{B} \iff |\not-A \text{ and } |\not-B \]  

Where ‘\(A\)’ and ‘\(B\)’ represent probability amplitudes, ‘\(A\)’ and ‘\(B\)’ represent respectively ‘fat’ and ‘not fat’, and ‘\(\iff\)’ means ‘if and only if’.

The probability amplitudes represent the various probabilities that either A or B will gain truth value in classical logic once coherent superposition is lost and the relationship between A and B becomes governed by the classical logical connective of exclusive disjunction XOR. Exclusive disjunction means that two propositions can neither be both true nor both false at the same time. This implies that, if the probability amplitudes at the quantum level could be altered, the frequency with which an anorexic looks in the mirror and perceives his/her body as obese will also alter, as the probability of the classical answer ‘yes’ to the question ‘am I fat?’ arising will also alter.

It is the proposition of this paper that the unconscious Object Relations of Anorexia Nervosa affect the probability amplitudes of the Quantum AND in relation to the logical proposition ‘I am fat’, and that these effects have a notable impact on semi-classical pre-conscious logic of the anorexic mind. We may propose the existence of three different psychological states—the quantum unconscious, the semi-classical pre-conscious and the classical conscious (Kircher, 2003). These states may correspond directly with the process of consciousness creation described by the Penrose-Hameroff OR model (Hameroff, 2007). The underlying logic of certain mental disorders may be explained within this framework: for example, schizophrenia may represent a failure to pass through the semi-classical pre-conscious, such that the conscious experience of a schizophrenic remains trapped in the logic of the quantum unconscious (Zizzi & Pregnolato, 2010). Similarly, Anorexia Nervosa may be seen as a situation in which the client is stuck in the semi-classical state of pre-conscious logic, where the classical logic of her ‘ego’ exists simultaneously alongside the superposed quantum states of ‘fat’ and ‘not fat’. This might account for the fact that some anorexics report their mental life to be a constant struggle to stay within consciousness, against ‘voices’ that embody the emaciating wishes of Anorexia Nervosa and the client’s desire for food (Fathallah, 2006). This would also support the old psychoanalytic idea that eating disorders are related to a weak and under-developed ‘ego’ that never fully differentiated itself from its ‘objects’ (Krueger, 2002a; Lawrence, 2001, 2002; Bruch, 1973). It is also true that, in many anorexics, the ‘voice’ corresponding to the anorexic desire to be thin is the stronger of the two. These ‘voices’ might correspond to the ‘objects’ stored Bose-Einstein-coherently in the quantum unconscious, whose past condemnations of greed and gluttony have been permanently stored as memory traces. These traces might affect the probability amplitudes of the superposed qubits ‘fat’ and ‘not fat’ at the level of quantum unconscious logic, which have a notable effect on her daily mental experience, especially when she looks in the mirror or thinks about her body.

This account may become more intelligible when we consider the role bosons might play in memory formation and the emergence of consciousness within both Orch-OR and QBD/TBD. The nature of a boson is that there may be an unlimited number of bosons within the same quantum state, conceived as a given vector in vector space. Before coherence is lost, whether by measurement in the standard Copenhagen
interpretation or by ‘objective reduction’ in the Penrose-Hameroff formulation, the outcome of this measurement or reduction may only be given as a probability distribution. A boson on its own in a quantum state would have its own wavefunction. The wavefunctions of bosons within a shared quantum state might coherently influence the overall wavefunction of the overall quantum state. It is possible, as will be seen below, that Object Relations memories might be stored as memory traces consisting of multiple “sociably” cohering bosons. Thus, the memory of an ‘object’ particularly relevant to Anorexia Nervosa, stored as bosons within the overall quantum state, might influence the overall wavefunction probability amplitude associated with the truth value ‘yes’ in relation to the question ‘am I fat?’ The result is that precipitant expression of the answer to the question ‘am I fat?’ is aberrantly biased within the post-decoherence classical logic of the ego. If we also consider the often pre-conscious nature of the anorexic psyche, we can also see how this results in the relative strength of the ‘voice’ associated with the anorexic desire for thinness, existing as a relic of unconscious quantum logic alongside the ‘ego’s classical functioning. In the semi-classical logic of the pre-conscious anorexic psyche, the force of the idea that one is fat comes from the fact that both the classical logic of the ‘ego’ and the quantum logic of the unconscious has in the first instance crystallised on, or in the second instance is leaning towards, an abnormally skewed answer in relation to the question ‘am I fat?”

If the unconscious is seen as operating according to quantum computational logic, then we need not limit this logic to the domain of the individual microtubule, but must also consider the effect of “massive parallelism” (Zizzi & Pregololato, 2010). This notion refers to superposed relations among quantum states distributed throughout the brain, such that we are now looking at an effectively macroscopic phenomenon, related to the idea of holographic memory proposed by Pribram (1971). Such a notion would fit well both within both an Orch-OR account of bosonic Object-Relations memory and within a Quantum Field Theory (QFT) account, such as QBD or TBD (Stuart, Umezawa & Takahashi, 1978; 1979; Jibu & Yasue, 1995; Vitiello, 1995; 2003).

Here, Nambu-Goldstone bosons are already given a crucial role in the explanation of memory. These two latter theories consider the brain to be a water dipole field, where the symmetry lost when it enters its vacuum state is preserved as a trace by condensates of coherent Nambu-Goldstone bosons called “symmetrons”. Due to their near-zero energy state, these are easily excited out of the vacuum when sensory input matches the stored memory traces (Das, 2009; Globus, 2010). QBD is an especially promising system for the understanding of bosonic memory as a basis for Object Relations, as it views consciousness as the result of excitation out of the vacuum state in response to sensory stimuli (Jibu et al., 1993). This would allow us to see how unconscious Object Relations memories stored in Nambu-Goldstone bosons could have a direct impact on the content and experience of conscious mental health.

We can therefore use this idea to develop a Quantum Object Relations approach to Anorexia Nervosa. Freud suggested the existence of the ‘superego’ or ‘ego-ideal’, conceived as an internalised conscience based on parental and, later, societal moral authority (Freud, 2003). This notion reflects the attitude often held by an anorexic that it is somehow morally wrong to be ‘fat’ or ‘greedy’. As a source of this feeling, we can suggest the mother who passes on her “psychology of femininity” (Orbach, 1989) or simple body insecurity by the way she interacts with her infant daughter (Lemma, 2009), or the father who lays down moral condemnation for being “greedy”, thus including this as a carnal sin in the symbolic order of Law and Language resulting from entry into the symbolic order (Lacan, 2007), or more generally a society that, in the child’s later life, makes it clear to her that being thin is the key to social acceptance (Orbach, 1989; McKinley, 2002). Each of these, in common psychoanalytic parlance, may be seen as internalised ‘objects’ within her unconscious, whose love and support the ‘subject’ fears losing. We may find this fear of loss of support behind such typically psychoanalytic ideas as the ‘depressive position’ and ‘schizoid position’ (Klein, 1997). Each of these ‘objects’ - mother, father, peers- may have been internalised in the bosonic memory of the later Anorexic, such that these moral imperatives, frozen in time within her unconscious, begin to influence her quantum primary processing...
logic. This naturally increases the probability of the question ‘am I fat?’ being answered with an aberrant response ‘in the classical logic of her ego.’

There are limitations to the approach outlined above: for example, it does not indicate why certain people react in this way to such family and societal influences while others do not. We might be able to answer this by reference to serotonin uptake in anorexic individuals and the related genetic factors described above. If microtubules are relevant to quantum computation, we can point to a direct link between tubulin and serotonin that might support a link between the neuropsychological serotonin-based account of Anorexia Nervosa and the QOR approach outlined above. This link might come in the form of Gsα proteins, one example of which is Gq/11α. This is linked to serotonin by the way in which it couples to serotonin receptors 5-HT2A to 5-HT3C, and is also linked to tubulin by the way in which it receives guanine nucleoside phosphate (GTP) from tubulin in order to facilitate signal transduction (Cocchi et al., 2010). This protein-protein interaction between tubulin and Gq/11α, as well as other Gsα proteins, can be seen as a crossroads between mental and classical phenomena. Genetic alterations in the classical functioning of the relevant serotonin receptors might also lead to alterations in the Gsα protein cycle that links these receptors with tubulin. If this is the case, then we may have found a mechanism by which those who are born with the lower expressing allele of the serotonin transporter gene SLC6A4 identified by Stoltenberg et al (2012) experience alterations in tubulin function as well as alterations in serotonin function. These alterations in tubulin function might give rise to the alterations in primary processing quantum logic and the associated macroscopically coherent bosonic condensates that have been connected with Anorexia Nervosa in this paper.

Recent experimental work looking at the relationship between serotonin and quantum logic has been undertaken by Cocchi et al. (2012), who based their work on the observed correlation between platelet membrane viscosity and serotonin concentration, specifically looking at Major Depressive Disorder (MDD) and symmetry-breaking. Such an examination is relevant to our present discussion, given that Anorexia Nervosa is correlated with elevated lifetime diagnoses of depressive disorders (Duvvuri, Bailer & Kaye, 2010). Using a ‘B2’ index to measure the sum of the percentages of Arachidonic Acid, Linoleic Acid and Palmitic Acid in platelet membrane fatty acids, they found that those suffering from MDD scored a mean rating below zero on the B2 scale, while healthy individuals and those suffering from Psychosis and Bipolar Disorder scored a mean rating of above zero. Proceeding on this basis, and using the λρ1 variant of quantum field theory, the authors showed how a positive B2 value corresponds to unbroken symmetry, while a negative B2 value corresponds to broken symmetry. Such a finding might be relevant to our present discussion on Anorexia Nervosa, given the importance of symmetry-breaking in the Nambu-Goldstone boson account of memory found in QBD and TBD, and given the way in which Cocchi et al. (2012) link such a concept directly to altered serotonin function.

Yet before proceeding in this vein, we must recognise the several limitations in this research and in its relevance to our present discussion. Firstly, while it is known that Anorexia Nervosa correlates with greater lifetime morbidity for anxiety and depressive disorders, this fact implies that it is not limited to comorbidity with MDD, meaning that an Anorexic may just as easily also suffer from Bipolar Disorder which, according to Cocchi et al’s findings, would have a positive B2 value and would thus lack any unbroken symmetry. Secondly, even limiting ourselves to Cocchi et al’s discussion of MDD, it is not altogether clear that a negative B2 value does correlate so clearly with the condition, given that several of those individuals who were diagnosed with MDD scored a B2 value of 0 or 1. While this is still low, it would preclude us from finding any broken symmetry in their cases. With this in mind, it is respectfully submitted that the present state of experimental research with regard to the symmetry breaking described by Cocchi et al. (2012) is not in sufficiently conclusive a state to draw any real conclusions from their examination of MDD over to our discussion of Anorexia Nervosa. However, a more detailed microscopic model of the B2-indexed symmetry breaking in MDD has been promised (Cocchi et al., 2012) and is awaited with eagerness.

This lack of conclusiveness does not detract from the novelty and utility of the
b Bosonic QOR approach delineated above, however. Earlier in this section, we noted that Mender, in his criticism of the current biopsychosocial paradigm of psychopathology, detailed its inability to account for the impact of social and psychological interventions on the cause and cure of mental disorders (2010). We can now see how a bosonic QOR approach might ameliorate this situation by providing a quantum-coherent neurological base—either in the brain’s microtubules or water molecules—for understanding how social and parental influences, especially in early life, can impact upon the unconscious probabilistic quantum logical processes underlying Anorexia Nervosa. This is especially so when we consider the way in which the different wavefunctions of sensory information, self-tuning and memory interact in TBD (Vitiello, 1995; 2003; Globus, 2010). While the ideas delineated here represent only a start in this direction, and further work will be needed to see how and if serotonin does relate to the symmetry-breaking so central to QBD/TBD, and how and if we can demonstrate an empirical link between genetically varied serotonin function and altered quantum logic, it is felt that this start is valuable in itself, if not at least as the basis of a potential rapprochement between neuroscientific and psychoanalytic approaches to Anorexia Nervosa through the medium of quantum theories of mind.

**Conclusion**

Current psychological understanding of Anorexia Nervosa in particular and mental disorder in general, is seriously deficient, as shown by the arguments raised by Mender (2010) in relation to the biopsychosocial model of mental illness and by the failure of even the best treatments currently available to show significant improvements in the mental and physical health of anorexics. Despite the evidential problems faced by the Hameroff-Penrose hypothesis, Stapp’s model and TBD, and despite the lack of falsifiability of Bohm’s quantum ontology, these theories remain valuable attempts at providing a framework in which Quantum Theory and neuroscience can come together, and, if further evidence is forthcoming, could well constitute the start of a new paradigm in mental health. In this light, it is a valuable exercise to review in what way these theories could impact our understanding of specific mental conditions such as Anorexia Nervosa, both as a guide to further research and as a source of insight for the present work of psychotherapists, and in this context, it is hoped that the Quantum Object Relations (QOR) approach to Anorexia Nervosa sketched out above could provide the basis and starting point for such work.

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