A Heuristic View of the Neurobiological Correlates of Classical and Quantum Neural Computing From the Perspective of Autistic Syndrome Disorders

Antonio Cassella

ABSTRACT

Anomalies in the discourse of *autistic* individuals and in their performance in ambiguous situations suggest that quantum neural computing, or the second attention, is impaired in autism. When nonautistic individuals face a dilemma, quantum divergence-coherence a) suspends the legitimacy of relevant prototypical knowledge conserved through classical neural computing, or the first attention; b) launches the implicit self into opposite directions; and c) simulates the consequences of clashing variants in the working memory fed by cerebellar microcomplexes. Conversely, quantum convergence-decoherence selects a useful or amusing variant to reduce the consequences of blind trial-and-error in readjusting the knowledge stored in the long-term memory banks of the cerebral cortex. In this article, a view of the psychological roots of quantum coherence-decoherence, injuries detected in autopsied brains of infants and adults with autism, and the application of modern control theory to cerebellar-brainstem microcomplexes lead to a preliminary heuristics on the complementarity of classical and quantum computing in the nonautistic brain.

Key Words: heuristic view, neurobiological correlates, quantum neural computing, autism

NeuroQuantology 2013; 2: 314-331

Introduction

This article attempts to bridge the gap between psychology and neuroscience and between the role of the cerebellum in the domain of motor control and its role in the domain of cognitive control. The main tool toward that aim is a psychological construct (Logos, or Λ) (Cassella, 2011). Logos was built on a re-interpretation of research on the performance of autistics in neuropsychological tests and readjusted through neuroanatomical evidence of synaptic plasticity damaged in autistic spectrum disorders (ASD) (Baumann and Kemper, 2006) and, especially, the work of Dr. Masao Ito (2011) along several decades on the interpretation of cerebellar long-term depression (LTD) in the synapses of Purkinje cells when climbing fibers and parallel fibers are stimulated simultaneously.

Logos balances the certainty of the information that classical neural computing conserves with the ambiguity that quantum computing confronts and dispels. Promising results arise from integrating the success of autistic individuals in unambiguous neuropsychological tests with their failure in dealing with ambiguous tests and polyvalent signs—that is, signs that point simultaneously

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Received Nov 9, 2012. Revised Nov 26, 2013.
Accepted May 12, 2013.
*e*ISSN 1303-5150

at clashing meanings (Cassella, 1997; 2000; 2002; 2008; 2011). The research accomplished here rests on four observations:

(1) Nonretarded autistics failed metarepresentational tests in which they had to select an untrue over a true belief (Baron-Cohen, 1995; Baron-Cohen *et al.,* 1985) and also failed attention-shifting protocols (Courchesne *et al.,* 1994; Landry and Bryson, 2004) passed by normal four-month-olds (Johnson, 1995); but they
(2) outdid controls in eye-blink conditioning trials (Sears *et al.,* 1994) and in passing recognition tests that involved the need to connect two representations (within the capacity for metarepresentation that develops before age six and a half years in normal children) (Cassella, 1997; Perner, 1991; Zaitchik, 1990);
(3) the speech of verbal autistics lacks polyvalent words (e.g., metaphor, pronouns, and the conditional "if") in which a sign may point at competing referents simultaneously (Cassella, 2000; 2002); finally,
(4) the swing from divergence to convergence in cerebellar microcomplexes (Ito, 2011) is similar to the move from coherence to decoherence in quantum computing (Lloyd, 2006).

The observations enumerated above imply that quantum neural computing (found *damaged* in ASD; and highlighted here with the use of bold) rests on two creepy principles in neural hyper-space. According to the *principle of ubiquity*, **a virtual object can lie in separate places at once**, and according to the *principle of coincidence*, **separate virtual objects can share the same space at the same time**. In contrast, classical neural computing (which the author found unharmed in ASD and emphasizes here through underlining) is supported by two no-nonsense principles in neural space-time. According to the *principle of locality*, <u>an object *cannot* lie in separate places simultaneously</u>; and according to the *principle of impenetrability*, <u>separate objects *cannot* share the same space at the same time</u> (Cassella, 2011).

Cassella (2011) termed **simultaneity**, or the **second attention**, the mode of neural computing harmed in ASD, which is guided by a quantum mode of computational logic in hyper-space, by which truth embraces falsity as 1 embraces 0. An example of the absurd ways of being of the second attention is the tension unleashed by Hamlet in thinking that Claudius is and is not guilty of the murder of the king (and Hamlet's father). The tension attached to coincidence and ubiquity within quantum coherence guides the Prince in his struggle to exit through quantum decoherence his dilemma at the very end of the play.

Conversely, the author ascribed to <u>sequence</u>, or the <u>first attention</u>, the capacity for <u>classical information processing</u>, which chooses truth over falsity in Hamlet; and falsity over truth in Claudius. Because the ***doubting*** Hamlet is both autistic and schizophrenic, he does not marry Ofelia or kill his uncle Claudius in Act I of the eponymous tragedy. Conversely, an example of the first attention is the gullibility of Hamlet's mother, Queen Gertrude, who believes that Claudius is innocent until the poison destined to Hamlet by the devious Claudius runs wild in her blood. Finally, Cassella hypothesized that although they seem to oppose each other, classical and quantum computing complement each other. For example, Gertrude's death precipitates Hamlet's decoherence into the final truth and the execution of Claudius. In Shakespeare's view, Claudius's devious *play with the truth to control the power of quantum neural computing* leads him to shame, whereas Hamlet's sober *play with the power of quantum neural computing leads him to the truth* and praise in future witnesses of his tragic story.

Shakespeare seems to suggest that the power of the second attention should be used with sobriety. For example, a good huntress will lean on quantum neural computing to ask forgiveness to her prey in the hyper-space of her second attention before bending and turning her bow (within stabilization and quantum coherence), adopt an unprecedented motor schema (within control and quantum decoherence), and shoot with impossible precision an arrow that will stop short the first attention of a wary prey in space-time.

After exposing for the first time (learning) the routines of their prey with the help of their artistic facet of the mind, knowledgeable hunters protect (long-term memory) newly arrived at knowledge through their classical or autistic facet of the mind. Still, progress in individuals and social groups arises only when individuals and whole cultures as well balance their power for quantum neural computing with their power for classical neural computing in reinventing the self by reinventing the other. (The use of humor, which escapes the cognition of autistic individuals, makes a safe and fit humanistic approach to achieve that mission.)

In this writing, the complementarity between the first and the second attention in spontaneous discourse, anatomical findings from autopsied brains of autistic individuals, theoretical features of quantum information processing in nature (Lloyd, 2006), and research on the neurobiological organization of cerebellar microcomplexes (Ito, 2011) suggest four falsifiable hypotheses:

- The complementarity of classical (first attention) and quantum (second attention) neural computing feeds humans' capacity (damaged in ASD) to face ambiguous propositions and detect intuitive solutions *ahead of* trial and error;
- the reciprocal empowerment of long-term potentiation (LTP) at mossy fiber-granule cells synapses and conjunctive long-term depression (LTD) at Purkinje cell synapses under the conjunctive stimulation of parallel and climbing fibers is similar to the balance between coherence and decoherence in the recursive quantum phenomena that occur at different levels in the distributed (simultaneously rigid and flexible) organization that drives the human mind and natural systems;
- within LTP, cerebellar divergence-coherence is sustained by the capacity of the basal ganglia for keeping at bay prototypical knowledge (stabilization); whereas cerebellar convergence-decoherence (through an overlap of LTP and LTD) also relies on the basal ganglia to arrive at the control needed to foresee the final position (forward model) of a wary target that may move in less-than-predictable ways or select the commands required to reach a specific position (inverse model); and
- the basal ganglia will augment stabilization only when control is deferred and vice versa (Ito, 2011) (for example, tuning a musical instrument before playing it).

The *background* deals with key observations in philosophy, psychology, quantum physics, and neuroscience in order to lay bridges among those fields of thought, in a way that may lead to a preliminary heuristics of the organization of the complementarity of classical and quantum neural computing in the human brain.

1. Background

Five steps of research are presented here: (1) the route that drove Cassella (1997; 2000; 2002; 2008) into devising a set of falsifiable hypotheses (Logos [or Λ]) on the psychological fundamentals of linguistic oddities in autistics; (2) key features of information processing in natural systems (Lloyd, 2006; Cassella, 2011); (3) anomalies found in anatomical exploration of autopsied autistic brains (Baumann and Kemper, 2006); (4) main characteristics of cerebellar microcomplexes (Ito, 1993; 2008); and (5) the relevance of cerebellar internal models under the provisions of modern motor control theory (Ito, 2011).

1.1 The psychological principles at the source of the odd behavior and anomalies in the discourse of autistics

The findings described in the Introduction to this article led Cassella (1997, 2000, 2002) to posit that autistics are blind to contrarian mental states in others because they cannot realize that polyvalent (or multifaceted) signs welcome separate meanings simultaneously. The ability to face polyvalent signs (within the kind of quantum neural computing that drives the second attention) allows nonautistic individuals to become another person or object *without* leaving the self behind.

The ubiquity of quantum coherence joins the coincidence of quantum decoherence in any sign that becomes polyvalent—for example, in the play by which a two-year-old pretends that a banana is a telephone. Indeed, the play with coincidence points at the dance of quantum coherence and quantum decoherence in the implicit self that *shares the same space with the implicit other without abandoning the space occupied by one's own individual body*.

Instead of becoming another person (a schizophrenic act that denies the univocal meaning that the other holds in space-time), the artistic facet of the mind may become the other in hyper-space without leaving the self behind. The capacity of neural quantum coherence for sharing the same space with other individuals and dividing, or multiplying, the self in the ghostly, or spiritual, act of going to several locations simultaneously implies that both quantum coherence and decoherence lean on the infinite speed that produces a cluster of multiple variations of a suspended prototypical tenet. Unlike schizophrenics, however, the artistic facet of the self will not give up to the temptation to become the other, as a pretending girl will not give away the sanity of her mind by becoming the real mother of her doll. Thus, decoherence into an unchanged reality or into a renewed reality is warranted at some point. Still, explorers of the infinite unknown cannot return to the finiteness of the known world unless the first attention in the companions left behind accept the treasures of new knowledge conveyed to the conscious self and the conscious other by the second attention. But others may be unwilling to approve, or unable to understand. Examples of the sad ways of decoherence are Hamlet's death after finding the truth of his father's death and the fact that Vincent van Gogh died alone and poor at the very edge of schizophrenic chaos.

The reason of van Gogh's contemporaries for rejecting his paintings while he was alive obeys the hypothesis that the first attention (a classical capacity for shared order that may lead to interpersonal confrontations or to a war inside the self in which the autistic facet will forever oppose the schizophrenic facet) is compelled by Natural Design to castoff the ghostly feats of ubiquity inherent in the second attention—abominable witchcraft, to the unbeliever. The first attention needs to believe that <u>an object cannot lie in separate places simultaneously</u> or that <u>separate objects cannot share the same space at the same time</u>; otherwise, there would be no way to observe the world and conserve what deem true in the long-term memory bank of the mind.

The three columns shown in Figure 1 exemplify both the differences and the complementarity between the first and the second attention. Classical computing (*either* the left *or* the right column) reveals the necessity of humans' autistic facet to achieve perfect control, to respect the law and legitimate authority, and to copy faithfully the beliefs shared by the members of the social group that welcomes the self. The autistic-like adherence of the first attention's to perfect control (left column) is in line with its schizophrenic dismissal of imperfection (right column). In a similar manner, classical computational logic embraces either one (1) or zero (0), but never ever both extremes simultaneously.

In contrast to the world of confrontations between right and wrong interpretations, aims, and actions depicted in the left or the right column, the middle column in Figure 1 reflects the inclination of humans' artistic facet for embracing less-than-perfect control, for transforming a dissimilarity into a new similarity, for striking an alliance with worthy opponents, and for embracing a lie and a truth at the same time—for example, in the made-up fantasy in which a girl becomes a mother to her doll. Humans' capacity for quantum computing may lay an imaginary bridge between separate people, interpretations, or societies. Such a quantum feat in the human brain replicates the superimposition of 1 and 0 in quantum information processing (Lloyd, 2006). (Readers are encouraged to notice that the second attention, or the artistic facet of the self, will accord with both the autistic and the schizophrenic aspects of the self because *it is both at the same time*).

The scaring reality of the condition of autistics shows that when quantum neural computing abandons classical neural computing, the autistic facet of the mind becomes insufficient to deal with a changing and challenging environment. Similarly, quantum computing is compelled to take advantage of the confrontations caused by the inflexibility of the first attention in trying to adapt the frame of knowledge of the self to surroundings which, although they may present some order and repetition, cannot be predicted at perfection. (Figure 2 indicates that humans' artistic facet [the middle column] would disappear if one made away with either the autistic [left column] or the schizophrenic [right column] facet of the self.) (Although mosquitoes are a nuisance, they are essential in keeping the web of life alive.)

Because they are mentally blind, autistics suggest that viable progress occurs when the first and the second attention empower each other. Truly, in nature, in civilizations, and in the individual mind, classical computing seems to rise first by opposing shared order to unwanted chaos. For instance, the Chinese philosopher K'ung-fu-tzu highlighted the ways of the first attention, exemplified by the need to protect the cohesiveness of Chinese kingdoms by conserving rituals, ethics, laws, and legitimate authority from illegitimate transformation.

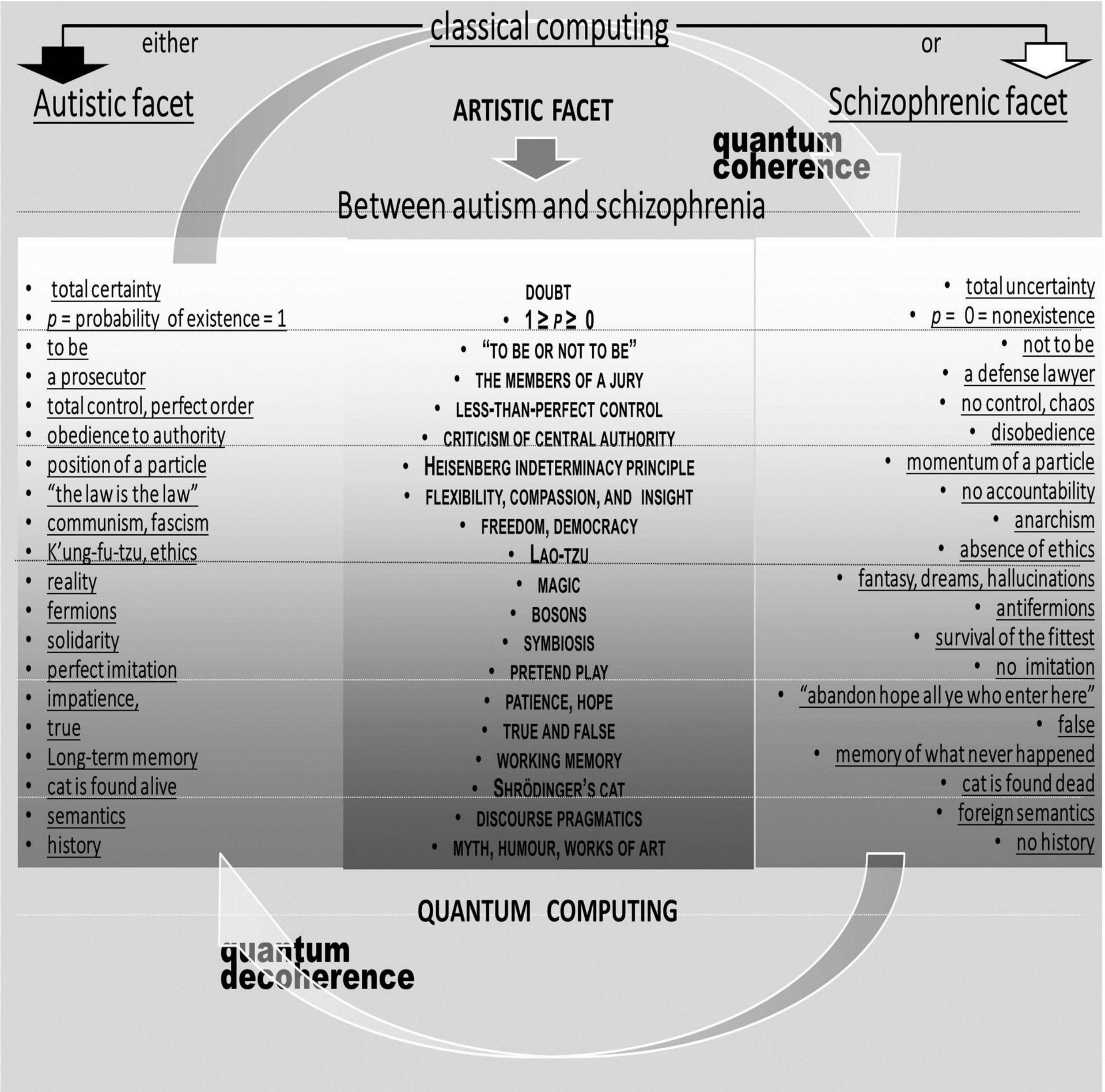

Figure 1. The COMPLEMENTARITY of classical and QUANTUM computing. Autistics and the autistic facet of nonautistics dwell in space-time—the finite mental reality that classical neural computing conserves within the long-term memory bank of the association cortex through the intermediation of the first attention. In space-time, the autistic facet of the self rejects the schizophrenic facet as order rejects chaos. In contrast, quantum neural computing wanders hyper-space—the spectral domain explored by the second attention. In the infinity that infuses hyper-space, the creative intelligence exposed by the artistic facet of the self-nurtures **learning** by embracing being and nonbeing, order and chaos, and autism and schizophrenia simultaneously. Although classical neural computing centers on either 1 or 0, quantum neural computing goes along with 1 and 0 at the same time (*P* = probability of perfect control of a view or an intended result.

However, Lao-tzu, an older teacher, observed that—as necessary as they seem to be—the inflexible dispositions guarded by the first attention cannot be sustained without the before-the-facts hypotheses generated by the second attention. The mythical encounter of Lao-Tzu and K'ung-fu-tzu on a mountain (a symbol of quantum computing) can be taken as a metaphorical representation of the opportunities for development that arise out of the balance of quantum and classical computational logic in nature and the mind (Cassella, 2011).

1.2. A brief appraisal of the complementarity of quantum and classical computational logic in the world at large

Quantum scientists are mystified by the fact that the "relationship" between disconnected subatomic particles located originally in the same pair is conserved instantaneously notwithstanding their physical separation. That phenomenon, called entanglement, implies that quantum information processing is supported by an infinite "speed" in nonlocality (Lloyd, 2006). Other clues on the ability of subatomic particles to "travel" beyond the speed of light in nonlocal, or quantum hyper-space are

(a) a ubiquity-prone facet of **quantum superposition** (Icke, 1995) that invites virtual particles to dwell in independent locations simultaneously (an example to the matter is the feat of an electron or a photon to cross two openings at the same time) (Feynman, 1985);
(b) a coincidence-prone facet of superposition by which an electron and a positron exist unseen behind the same photon, or a photon interferes with itself along the separated constituents of a ray of light (Cassella, 2011); and
(c) the implications by the symmetry theory that fermions (particles associated to matter) can transform into bosons (particles associated to energy) by undergoing a 180 degrees rotation in a nonlocal dimension (Icke, 1995).

Bothered that his equation on the wave function of a particle was criticized by Henrik Lorentz and "misused" by Max Born under the notion of the probabilistic superposition of quantum states, Ernest Schrödinger devised a thought experiment to demonstrate that Born's theory was ridiculous: After one hour of having introduced a cat in a locked box, random radioactive decay will or will not release a poison that would kill the cat; that is, after an hour has elapsed the cat is either alive or dead, a possibility that Schrödinger deemed absurd. Born replied that quantum coherence is absurd but *real in the mind of potential observer,* since they will never know the real situation of the cat unless they opened the box by resorting to quantum decoherence. As with Parmenides who criticized Heraclitus's embrace of what is and what is-not, Schrödinger criticized Born integration of opposite states in the same sign by way of quantum superposition, without understanding that cat alive or cat dead are equivalent to Hamlet's "to be or not to be" before he finds out that Claudius killed the former king. A reasonable time has to pass between coherence and decoherence, within the amusing instant that links the beginning of act I and the end of act III in *Hamlet*.

Although he never intended it, Schrödinger's thought experiment indicates that quantum ambiguity rests on infinite velocity in the thought of observers capable of devising thought experiments submerged in the properties of ubiquity and coincidence attached to quantum superposition. (Similarly, quantum superposition in Heisenberg's mind led him to manifest that the infinite speed attached to the simultaneous observation of the location [e.g., cat alive] and the speed [e.g., cat dead] of a subatomic particle is impossible in space-time [Heisenberg's uncertainty principle]).

Accordingly, Einstein's theory of special relativity *rejects* the possibility of observing an infinite speed—which is consistent with the impossibility of **ubiquity** in space-time. Similarly, Pauli Exclusion Principle (electrons that share same quantum state will not meet in the same subatomic orbital) implies that coincidence also *is impossible* in space-time.

These considerations lead to hypothesizing that natural information processing leans on the reciprocal empowerment of perfect control (within classical computing) and less-than-perfect control (within quantum computing). Three additional situations may be considered: (a) Feynman (1985) asserted that **massless subatomic particles** set an anchor on invariant prototypes (particles with mass); (b) colliding interpretations joined through **discourse pragmatics** (in irony, for example) are anchored to invariant prototypes conserved through semantics (Cassella, 2000; 2002); and (c) **the generation and the evaluation of mutually exclusive variants in cerebellar microcomplexes** rely on the invariance of prototypical interpretations stored in the cerebral cortex (Ito, 2011).

Unlike the rigid programming of present-day computers, which force on the machines the choice of 1 over 0 (or 0 over 1), a quantum qubit in a theoretical quantum computer will choose simultaneously 1 and 0, or a cause and its effect—a fantastic feat that becomes a door to the bridge of quantum coherence fed by the infinite speed inherent in nonlocal hyper-space. The manufacture of an artistic computer, however, has been hindered by our inability to control decoherence, by which qubits abandon nonlocal hyper-space and harden into a "dead or alive cat" in local space-time (Lloyd, 2006).

Although a quantum computer capable of finding new information on its own has nowhere been envisioned or built, the CNS in human brains is capable of entertaining coherence in neural nonlocality (the middle column in Figure 1), formulate a novel piece of knowledge bordering schizophrenia (the middle column in Figure 1), and decohere back into observable locality (the left column). A comprehension of how the CNS achieves that magical act may lead scientists toward exposing the neurobiological fundamentals of the quantum mode of information processing damaged in ASD.

Seven-year-old Mozart, for example, was able to figure out a new minuet in the same way Van Gogh integrated strings of different colored materials into a painting. The artistic intuition of Van Gogh and Mozart implies that any sign (e.g., an empty piece of cloth, a block of marble, a blank sheet music, the set of different letters in any alphabet, or the words listed in any dictionary) may hide an infinite number of accounts about witty inaccuracies, which the artistic self in any person (damaged in the brain of autistic individuals) may convey into locality with a purpose to help others, amuse others, or help himself by abusing others.

1.3. A summary of major deficits in the autistic brain

Through a special anatomical examination of the brains of twelve autistic children and eight adults, Bauman and Kemper (2006) came to the proposal that brain damage in autism centers in the limbic system, brainstem nuclei and the cerebellum. Those researchers found out that (a) cerebellar hemispheres in autopsied brains showed a significant decrease in the number of Purkinje cells irrespective of chronological age, (b) following perinatal or postnatal Purkinje cells damage, the customary loss inferior olivary neurons *was absent*; (c) although neurons in the cerebellar nuclei and the inferior olive of the brains of individuals younger than age 12 were greatly distended, they were suitable in their number; (d) neurons of cerebellar nuclei were weak and fewer than normal in adult subjects; and e) the inferior olivary neurons gathered more to the periphery than near the center of nuclear convolutions. All that led Bauman and Kemper to the hypothesis that in autistic individuals a genetic glitch disturbs the neural circuitry between the cerebral and the cerebellar cortex before the 28th week of pregnancy and that their disturbances may continue into adulthood.

Other three pieces of relevant knowledge were revealed by Rodier and Arndt (2006): 1) In analyzing Sears et al (1994) eye-blink conditioning trials (EBC) carried out by comparing autistic subjects with mental age matched normal controls, Rodier and Arndt observed that the former developed the conditioned response significantly faster than did normal subjects; 2) they also conveyed the observation by Stanton et al. (2001) that rats exposed to valproic acid during neural tube closure developed dislocated neural circuits in their cerebellum/brainstem and a rapid acquisition of EBC; and 3) they finally emphasized the fact that the exceptional show of autistics in EBC was opposite to their dismal behavior in the "shift/disengage" protocol (SD) (Landry and Bryson, 2004).

In the "shift" stage of the SD protocol, the subject first fixes his or her attention onto a group of flashing lights, which subsequently go off and reemerge in a different part of the visual field. All normal controls and autistic subjects as well, refocused their attention into the new location of the stimulus. The "disengage" stage, however, presents a significant change in that the original stimulus stays on while an equivalent stimulus arises in a different part of the visual field. In that stage, autistic subjects failed to refocus their attention or were slower than controls.

The four findings reported above led Rodier and Arndt to hypothesize that the abnormalities found in the limbic system and forebrain of autistics are consequences of a prenatal irregularity in the development of neural circuits in the cerebellum and brainstem.

1.4. Main features of cerebellar microcomplexes

An insinuation of the enigmatic role of the basal ganglia-brainstem-cerebellum (BG-B-C) in aiding cognitive operations initiated by the association cortex may be extracted by a feline's ability to stalk a wary prey before attacking it. Under quantum coherence-stabilization, the BG-B-C of a leopard, for example, will suspend known habits and automatic judgment, gather information on the prey, posit possible ways of attack and escape, and select a promising variant under quantum decoherence-control, resulting in a resolute and accurate attack. All that implies an implicit capacity to *remember the future*, which seems an absurd, yet factual, conclusion.

Figure 2 shows an example of a motor control circuit in the human CNS. The communication circuit represented there suggests that neuron assemblages in the limbic system, brainstem, cerebellum and basal-ganglia rearrange the info initiated by the motor cortex under commands issued by the premotor cortex. (Figure 5 integrates and augments the perspectives shown respectively by Figure 1 and Figure 18 in Ito [2011, pp. 2 and 42].)

Upon looking at the effects of cerebellar disorders—for example, the quivering linked to intention tremor and the loss of accurate movements, Ito (2011) posited that the cerebellum aids the formulation of smooth movements by averting potential fluctuations and by using an internal feedback system *independent of information conveyed by the senses*.

Ito (2011) emphasized the fact that Purkinje cells—the sole output of the cerebellar cortex—lessen their hold on cerebellar nuclei near the end of the learning process. In fact, Ito et al. (1982) had detected in the early eighties that *conjunctive stimulation* of climbing and parallel fibers decreased the firing index of Purkinje cells—a sign of synaptic plasticity termed conjunctive long-term depression (LTD).

In relation to LTD, Ito (2011, p. 87) highlighted the fact that new circuits surface from parallel-fiber synapses that were desynchronized at the beginning of the learning process throughout the synchronization associated with long-term depression of 97% of Purkinje cells. To the matter, Ito supported Albus's (1971) hypothesis that synchronization occurs in the cerebellum when LTD depresses the synapses responsible for errors.

An additional significant finding is that the inferior olive provides surveillance of the change from desynchronization to synchronization in the cerebellar cortex toward the construction of a memory trace in a *microcomplex* (Figure 3). The cerebellum welcomes about 5000 microcomplexes (Ito, 1993), or neuronal assemblies that gather elements of the vestibular nuclei, the cerebellar nuclei, and the cerebellar cortex (Ito, 2011).

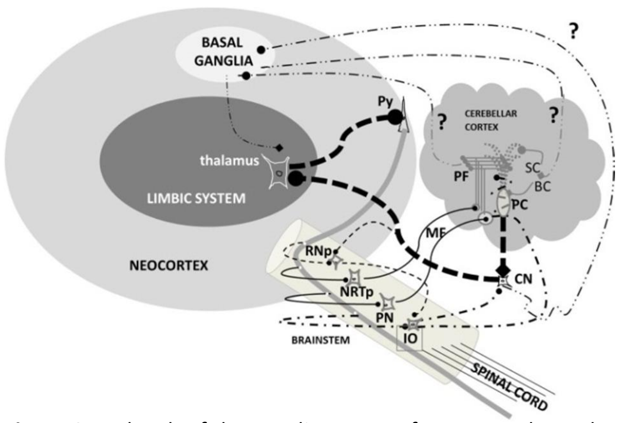

Figure 2. A sketch of the re-adjustment of a motor schema by the cerebellum-brainstem-basal ganglia. In the sketch , axons from pyramidal cells (Py) propel collaterals to four brainstem nuclei: (1) the nucleus reticularis tegmenti pontis (NRTp) and (2) the pontine nucleus (PN) connect to the cerebellar cortex as mossy fibers (MF) afterwards transformed into parallel fibers (PF), which synapse with Purkinje cells (PC); (3) the inferior olive (IO) directs a single climbing fiber to a single Purkinje cell; and (4) the parvocellular red nucleus (RNp) apprises the inferior olive about signals from pyramidal cells and cerebellar nuclei (CN). Purkinje cells are the only identified outlet of the cerebellum. They inhibit (quantum coherence) and release (decoherence) involved cells in the cerebellar nuclei. The latter neural assemblies lean on the limbic system in rearranging signals to the pyramidal cells that initiated the conscious movement. (Connections between the cerebellum and the basal ganglia [BG] continue being conjectural [Bostan *et al.,* 2010]); ● = excitation; ◆ = inhibition.) (Reproduction of this drawing is kindly awarded to the author by the Editors of the Comprehensive Guide to Autism within Springer Science + Business Media.)

Within divergence, a) one mossy fiber can excite 400-600 granule cells (Ito, 2011); b) axons from granule cells divide into two parallel fiber collaterals; and (c) a single parallel fiber may excite 300 Purkinje cells. By contrast, one Purkinje cell may be excited by 180,000 parallel fibers within convergence.

Climbing fibers provide a surveillance of both, divergence through long term potentiation (LTP) at mossy fiber-granule cells synapses and convergence into conjunctive long-term depression (LTD) at parallel fiber-climbing fiber synapses with Purkinje cells. Modern control theory may be used at length in the study of BG-B-C microcomplexes.

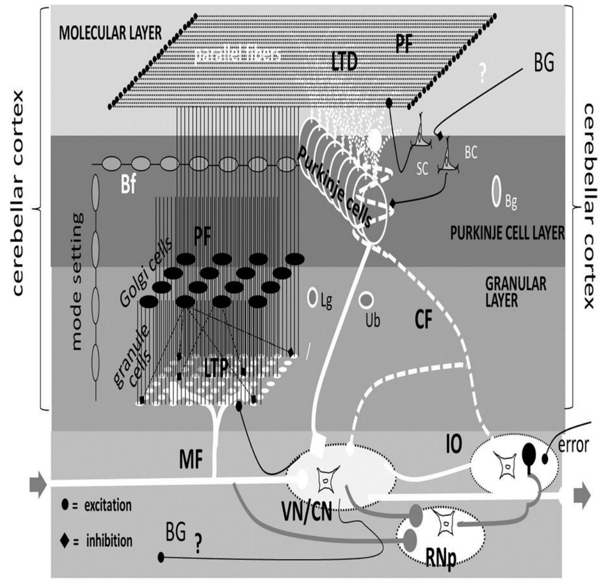

Figure 3. A sketchy drawing of the passage of information from divergence to convergence in a cerebellar microcomplex. In a microcomplex, the information conveyed by mossy fibers to the cerebellar cortex undergoes divergence (LTP) followed by convergence (LTD) when climbing fibers and parallel fibers are stimulated in conjunction. (LTP, long-term potentiation; LTD, conjunctive long-term depression; MF, mossy fibers; Bf, beaded fibers; Lg, Lugaro cells; Ub, unipolar brush cells; PF, ascending parallel fibers; SC, stellate cells; BC, basket cells; Bg, Bergmann glia; CF, climbing fibers; IO, inferior olive; VN/CN, vestibular and cerebellar nuclei; RNp, parvocellular red nucleus; BG, basal ganglia.) (Figure 7 represents the author's interpretation of Color Plate V in Ito [2011]; ● = excitation; ◆ = inhibition.) (Reproduction of this drawing was awarded to the author by the Editors of the Comprehensive Guide to Autism within Springer Science + Business Media.)

1.5. Basic characteristics of control models

Ito (1993) thought of the advantage of applying the ways of modern control theory (Figure 4) to an understanding of the mysterious neural circuits in the cerebellum when he proposed that the cerebellum uses *internal models* to replace the feedback provided by the peripheral sensory organs. Ito (2011) specified that forward and inverse models in the cerebellum reflect *body* or *motor* schemata conserved in the temporoparietal cortex. Ito's proposition may be summed up in stressing that trajectories replicated in the cerebellum are anchored to disposable *copies* of *origina*l prototypical trajectories conserved in the temporoparietal cortex.

A *forward model* (Figure 5A) mimics the input-output of the controlled object, is positioned between the output and the input of the controller, is assigned motor signals, and computes sensory signals. An *inverse model*, by contrast, (Figure 5B) mimics the output-input rapport of the controlled object, is positioned between the input and the output of the controller, is assigned spatial coordinates, and computes motor commands. The fact that the inverse model does not call for a role by the ventrolateral thalamus [VL] suggests an implicit choice [possibly, through the basal ganglia] of the commands needed to reach a desired location in space and time.

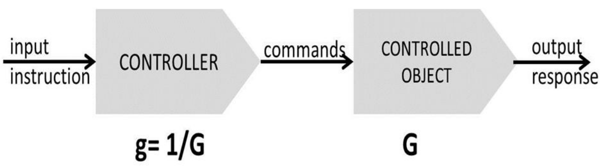

Figure 4. The mechanics of modern control theory. A control systems consists of a controller (g) acting on a controlled object (G). For example, in a local network of the CNS, a controller in the pre-motor cortex receives input instructions from the pre-frontal cortex about a goal or a trajectory, which will lead the controller to generate appropriate commands. The controller may operate with or without peripheral information.

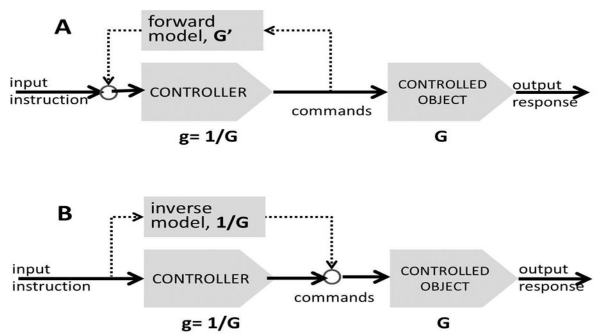

Figure 5. Two modalities of internal models in the cerebellum. A forward model predicts the state of an observed system (for example, the position that a moving gazelle will have next), whereas an inverse model calculates de commands necessary to acquire a determined position (for example, the commands that will lead a leopard to cross the path of a prey it is stalking).

The Discussion crosses the steps articulated in the Background in the effort to discover coherent relations between the psychological and the neurobiological correlates of quantum neural computing.

2. Discussion

The hypotheses and facts expressed so far carry on through four steps. The first step deals with the success of autistic individuals in rigid neuropsychological tasks and in eye-blink conditioning (EBC) trials compared to their failure in flexible tests and their difficulties to pay attention to mutually exclusive stimuli simultaneously. The aim of the comparison is detecting hints of human's ability to superimpose the second attention, which was found damaged in autism (Baron-Cohen, 1995; Baron-Cohen *et al.,* 1985), onto the first attention, which was found spared in autism (Cassella, 1997; Perner, 1991; Zaitchik, 1990).

2.1. The difficulty of perceiving or conceiving opposite stimuli at the same time

Nonretarded autistics exceed the performance of normal subjects in Zaitchik Photo Task (Perner, 1991; Zaitchik, 1990)—pass Proper Self (Cassella, 1997; 2000) which evidences their intact capacity for meta-representation. Still, they fail false belief tests (Baron-Cohen, 1995; Baron-Cohen *et al.,* 1985). False belief is passed by 50% of normal four-year-old preschoolers who have acquired the capacity to meta-represent. In a similar manner, autistic subjects outperformed controls in eye blink conditioning (EBC) tests and equaled their performance of in the "shift" phase of the shift/disengage (SD) protocol. Although autistics outperformed controls in EBC, they underperformed controls in attention-shifting tests passed by normal four-month-olds (Johnson, 1995)—for example, cross-modal attention-shifting tests (Courchesne *et al.,* 1994) and the "disengage" phase in the shift/disengage protocol (Landry and Bryson, 2004). The above observations sustain the conclusion by Rodier and Arndt (2006) that the center of damage in the brain of autistics in damage autistics' impairment is located in the brainstem and the cerebellum.

The quantum computing feature by which prototypical knowledge is re-formulated in cerebellar microcomplexes arises from a comparison of the superior performance of autistics in EBC with their less-than-normal performance in the SD protocol.

When unrelated stimuli compete for the attention of the self (e.g., the disengage phase in the SD protocol), a valuation from quantum neural computing is critical. The reason why autistics performed worse than their controls in changing the focus of their attention in the disengage phase is that they could not see the original cluster of lights and the competing cluster **simultaneously** (in their minds). By contrast, autistic individuals and autistic rats performed faster than controls in EBC because their power to **doubt** the repetitive validity of a novel association was weakened by an impairment of their quantum computing.

In EBC, climbing fibers from the inferior olive inform Purkinje cells and the interposed nuclei in C1/C3 about the unforeseen incidence of the air puff. In a similar manner, the tone pip signal is conveyed to the interposed nuclei and to Purkinje cells by mossy fibers from the pontine nuclei.

The lack of quantum neural computing in their brain precludes autistics from experiencing doubt when they detect the association between the air puff and the tone pip. Conversely, because nonautistic controls do have an inclination for ambiguity, climbing fibers from the inferior olive *defer* their agreement to the legitimation of the repetitive contiguity of the tone pip and the eye blink, which is the cause of their underperformance in relation to autistic experimental subjects.

In the shift/disengagement protocol, however, nonautistics' penchant for doubt compels their climbing fibers to give an equal value to mutually exclusive stimuli in hyper-space—which is an illogical proposition. Similarly, quantum neural computing allows normal controls to see separate stimuli simultaneously in the quantum circuitry of their minds as if they could observe both faces of a coin simultaneously—a feat the implies an infinite speed.

As the capacity for infinite speed is impaired in variable degrees in ASD subjects, the first attention becomes a prison to them. The mind of autistic individuals, then, cannot comprehend the complementarity between quantum and classical neural computing that results in the formulation of new knowledge along the quantum passage from coherence to decoherence. Similarly, that complementarity escapes the mind of nonautistic individuals in which the second attention is underdeveloped or remained dormant (the case of brain-washed subjects).

The point of it all is that *autistics will always surpass controls in inflexible tasks which do not call for the aid of neural* *quantum computing* (The EBC protocol, together with classical and operant conditioning, in which the rigidity of an association is augmented through time, is a fit example of that view). Conversely, autistics are slower than controls in the disengage phase of the SD protocol and fail false-belief tests because they cannot divide their monolithic attention among stimuli that hit their senses or their intellect simultaneously.

The findings and reasoning exposed previously lead to the central hypothesis that the CNS of human and nonhuman animals alike welcomes two domains of neural computing, a classical and a quantum one. Moreover, notwithstanding the fact that they seem to oppose each other, the first and the second attention may complement each other in the individual in which they are lodged if he or she is educated by caretakers since early infancy to face neither too difficult nor too easy challenges toward a creative solution in which the self becomes neither a tyrant nor a victim to the other. Within a win-win outcome, then, the successful self is the self who sublimates a confrontation into an **alliance**—as with crossing an infinite chasm by way of a virtual bridge that defeats gravity and the laws of thermodynamics.

The formulation of a bridge between psychology and neuroscience, for example, may be helped by reviewing a list of significant features of the complementarity of classical and quantum neural computing, or between the first and the second attention in the search for new knowledge ahead of trial and error, or Skinnerian operant conditioning.

2.2. An examination of psychological features in the reciprocal empowerment of the first attention and the second attention

Key psychological features of the complementarity of classical and quantum neural computing may be appreciated in the following list:

- The door to the coherence phase of quantum neural computing opens when an ambiguous situation challenges the self;
- when the artistic facet of the self enters a quantum opening, relevant prototypical knowledge conserved in the long-term memory bank of the autistic facet is suspended unconsciously;
- the schizophrenic facet of the artistic-implicit self denies virtually relevant copies of prototypical tenets made by the autistic facet;
- the quantum act of denying recursively a copy of a rigid schema opens up a quantum field between an original “autistic” copy and its multiple “schizophrenic” negations;
- the implicit self groups the potential solutions to the problem at hand (for example, the need to choose a roof exacts the field: prototypical house ~ wigwam ~ yurt ~ igloo ~ ∞) into a cluster anchored to the copy of an original schema.
- by virtue of virtual simulations, the artistic facet of the self evaluates the implications of independent variants at the same time.
- *before* the divergence unleashed by quantum coherence is over, quantum decoherence starts a process of convergence by way of recursive integration;
- at a certain point, a specific variant is chosen and introduced into the working memory of suspended space-time (for example, the new commands that a controller will send to a controlled object);
- the choice of a potentially fit variant does not undo the alternative options conserved in the schizophrenic working memory of the self.
- the variant chosen must remain separated from long-term, prototypical memory while errors are evaluated in the physical or mental space-time shared with the other;
- when *the other* consents or discards to the appeal or the efficacy of a new idea found at the very edge of madness by another person, quantum decoherence *ends*.
- Multiple coherence-decoherence relations may take simultaneously in the CNS and in society at large.

Summing up, the implicit self (a) negates recursively a copy of an original tenet by way of quantum coherence, (b) formulates conflicting variations, and (c) evaluates their consequences. Before the coherence phase ends, d) decoherence starts up recursive integration, e) formulates a potentially fit solution to the problem at hand; f) introduces the solution into space-time; checks on the errors evaluated by a particular solution; and g) offers the newly arrived schema to the autistic facet of the self, which will guard it in its frame of prototypical, unchangeable knowledge—after exacting a promise of gain without pain.

The trick of quantum neural computing in nature and the mind is the use of virtual copies of a cerebral schema in order to make fun of the principles of mental space-time. Thus, although separate objects cannot share the same space at the same time, nor can an object exist in more than one place simultaneously in perceived space-time, their **virtual avatars** in nonlocal hyper-space **can** violate in peace and fun the laws of thermodynamics.

2.3. Echoes of the complementarity of classical and quantum computing in the architecture of microcomplexes

According to Ito (2011), the inferior olive realizes the role of a teacher keen to reducing the number of errors in space-time. The author extends the role of the inferior olive to the **surveillance of amusing errors made in hyper-space**. In addition, the author hypothesizes that the inferior olive provides advice to implicit self on the proper time at which quantum neural computing must be superimposed on classical neural computing. The inferior olive, then, starts computations by appraising the involved microcomplexes and the basal ganglia of problematic situations that imply the quantum formulation of competing variations of a prototypical schema (quantum coherence). Similarly, the inferior olive orders the cessation of quantum computing when a fit alternative is encountered within decoherence (Figure 6).

The SPQR (Senatus PopulusQue Romanus) defeated Hannibal by empowering young Scipio Africanus who, before escaping Cannae, learned how the Carthaginian general massacred 80,000 legionnaires by doing the opposite of what a Roman general would have done. In contrast, the Roman Consul in command at Cannae, Gaius Terentius Varro, was sent to early retirement in Sicily after been told that "*errare humanum est, sed perseverare in errorem stultum est*" (any human being may make a mistake, but whoever makes the same mistake repeatedly is a fool.) To that purpose, a speculation is advanced that the internal feedback offered by cerebellar microcomplexes provides Homo sapiens with adaptive moves in neural hyper-space in order to reduce the consequences of irreversible errors in space-time. Hypothetically, recursive denial by the basal ganglia assists quantum coherence/stabilization in cerebellar microcomplexes providing for competing variants and simulating their consequences in space/time. While coherence is still going on, recursive integration by way of decoherence/control allow LTD of 97% of Purkinje cells and the disinhibition of just the cerebellar nuclei that keep in transient store the right solution to a problem.

In words related to control theory, one may hypothesize that quantum decoherence helps the implicit self enters control after a potentially amusing or useful *interpretation* (*forward model*) or an *answer* (*inverse model*) is chosen among variations generated and evaluated through coherence-stabilization. Quantum neural computing, then, allows nonautistic individuals to make mistakes in hyper-space so as to appreciate their funny side or understand the virtual usefulness of a schema *before* making mistakes in the reality sacred to classical computing.

Because quantum neural computing sets anchors on classical neural computing, cerebellar microcomplexes bear with virtual copies of the knowledge guarded by the first attention (perhaps, simple spikes in Purkinje cells satisfy the rigidity of classical computing). The fact the electrical synapses of climbing fibers switch among rhythmic, random, or synchronous modes of vibration accords with the ways of quantum computing when they float between repetitive order and schizophrenic chaos before achieving a synchronous mode. (In a similar manner, members in a social group, and parts in a system may move rhythmically [repetitive knowledge], at random [individual independence-chaos], or achieve a new synchrony [a novel construct of shared order]). The author posits that the **freedom** to decide which mode of vibration is best when facing a less-then-perfect challenge escapes the cognition of autistic individuals. A look into Ito's (Ito, 2011) wonderful compendium of research, knowledge, and perspectives on the role of the cerebellum suggests that beaded fibers (Figure 10) may constitute the channel through which the basal ganglia under the surveillance of the inferior olive conveys to the cerebellar cortex the need to combine classical and quantum neural computing.

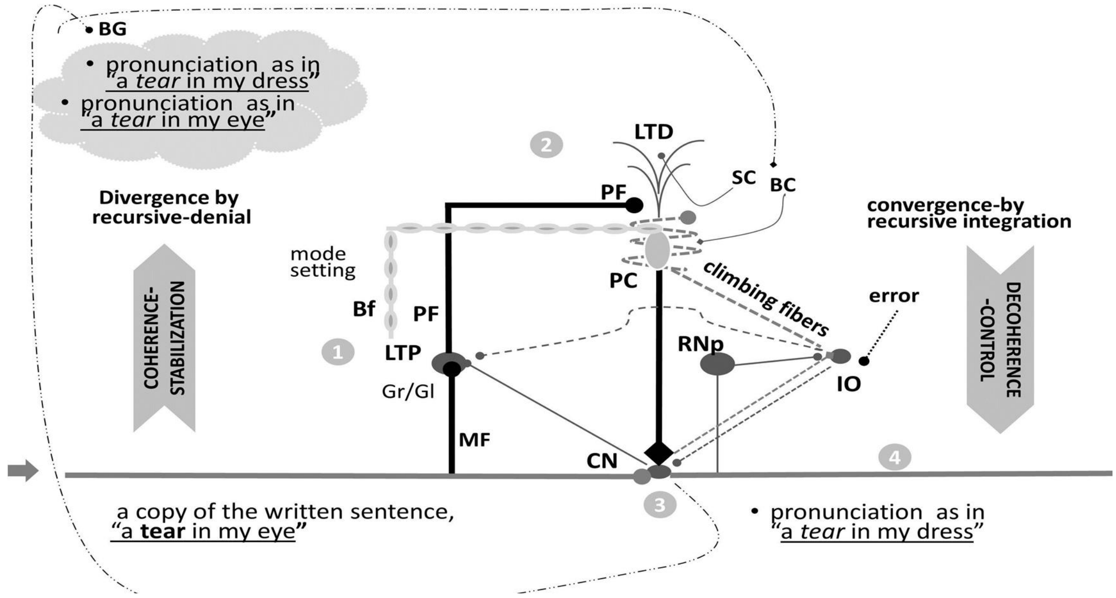

Figure 6. A diagram of the distributed organization of quantum computing in a cerebellar microcomplex. Within COHERENCE-STABILIZATION, (1) the basal ganglia (?) assist the recursive denial of a copy of a prototypical schema (e.g., the written word "tear") in formulating competing alternatives (e.g., the sound of *tear* as in "a *tear* in my eye" as opposed to the sound of *tear* in "a *tear* in my dress") through LTP at mossy fiber-granule cell synapses and (2) mimic their implications in space-time. Subsequently, DECOHERENCE-CONTROL culminates into conjunctive long-term depression (LTD) in Purkinje cells when basal ganglia and the inferior olive (3) lock unpromising variants (e.g., "a *tear* in my eye") and (4) fit variants (e.g., "a *tear* in my dress") unlocked. (MF, mossy fibers; Gr/GI, granule/Golgi cells; Bf, beaded fibers; PF, parallel fibers; PC, Purkinje cells; SC, stellate cells; BC, basket cells; BG, basal ganglia; RNp, parvocellular red nucleus; IO, inferior olive; CN, cerebellar nuclei; ● = excitation; ◆ = inhibition.) (Reproduction of this drawing is kindly awarded by the Editors of the Comprehensive Guide to Autism within Springer Science + Business Media).

The neural plasticity that results from the superimposition of quantum on classical computing should apply both to sequential schemata about the movement of body parts in the arena of motor control and sequential schemata-representations in the cognitive arena. In the domain of motor control, for example, the basal-ganglia synchronize opposite body elements and muscles in composing a movement. An example is the synchronization in the movements of a huntress to the unpredictable movements of her prey. In a like manner, a hypothesis may be raised that the implicit self resorts to the quantum capability by the basal ganglia in order to manage the tension between copies of opposite temporoparietal representations in order to find a solution in ambiguous situations born out of the interaction with others.

Dealing with the quantum features that support the denial of a motor action (e.g., in teasing) may help view the quantum path that the CNS follows in dealing with the denial of a representation (for instance, in pretend play). The next step details children's dependence on quantum information processing when they decide to tease others. In that case, copies of motor schemata driven by an inverse model of control are integrated with copies of body schemata driven by a forward model (The capacity for representation is not required to perform an act of teasing).

2.4. The use of inverse and forward models in the dance of classical and quantum computing

Both the forward and the inverse model are involved in arm movements (Ito, 2011). Recall that the forward model calls for sensory-like instructions in predicting the outcome of an instructed operation (Figure 5). In contrast to that, the inverse model resorts to motor-like instructions in computing the commands necessary to realize a position-instructed operation. That said, knowledge of the role of each of the two models can gain from analyzing along the precepts of control theory the relationship of the inverse and the forward model when a person tries to tease another person.

As an example, let us analyze the gracious wittiness of a two-year-old little girl who offers chocolate to a guest and suddenly withdraws her arm when the gentleman almost touches the unforeseen gift. Certainly, the aid of her undivided attention fed by classical computing would be sufficient to implement the deceitful schemes of the little actress if the child were used to kindly offer candy to the same guest week after week. In that situation, the autistic facet of the girl would lean on the invariant knowledge stored in a body-forward schema kept whole in her temporoparietal cortex to calculate where the guest will go and use an inverse-motor schema to go there. After that, she would employ an inverse schema to make her customary present of chocolate. Assuming instead that the little actress knew well that the same person cannot be fooled twice, one may envisage that she adored making fun of unaware visitors. However, she will succeed only by paying her divided attention and quantum neural computing capabilities to the impulsive moves and approaches of her potential target.

As a consequence, one may posit that the little girl's act of teasing an unaware subject would include the following actions and interpretations by her implicit self:

1) the formulation through mirror neurons of exact copies of body and motor schemata stored in her temporoparietal cortex;
2) the transmission to specific microcomplexes of the invariant copies
3) the arrival of those copies at the intended microcomplex as forward or inverse internal models;
4) the microcomplex involved would use the copies of forward or inverse schemata—or forward and inverse internal models—as fixed points to which the implicit self will attach a cluster of conflicting variations produced by the tension between the prototypical center and the multiple denial of the truth it represents near the edge of schizophrenic chaos;
5) the selection among conflicting variations attached to a central *forward* model to envisage where the target will go;
6) the selection among independent variants referred to a prototypical inverse model so as to transport the self into that position;
7) the selection of a subsequent variation of a true inverse model to move the arm holding the chocolate toward the position that will be reached by the moving target;
8) the dance by the joint attention of the child between variations of forward and inverse models to shift her attention between the eyes and hands of the target and her own eyes and hands;
9) the dance of clusters of forward and inverse variations in her effort to incorporate movements of her hand with movements of the hand of the visitor; and
10) the selection of an inverse variant geared to retract her arm at the last millisecond.

An unaware and unsuspecting guest will lean only on the classical computing that feeds his autistic facet. In contrast, the teasing actress would combine quantum and classical computing at every instant.

After considering the abnormalities detected in the discourse of verbal autistics (Cassella 2000; 2002), the author suggests that:

- the CNS relies on classical computing to make copies of temporoparietal body and motor schemata and locate them as forward or inverse models in specific microcomplexes;
- quantum computing in the basal ganglia helps microcomplexes to deny recursively the relevant forward or inverse models in producing competing solutions (for instance, the separate pronunciations and meanings of the word "tear" in "a *tear* in my dress" and "a *tear* in my eye" shown in Figure 10);
- microcomplexes evaluate the space-time consequences of chosen variations;
- the basal ganglia lean on recursive integration to produce a new potential solution to the intended aim.

As with the difficulty in predicting the moves of an unaware target that the implicit self of a teasing toddler overcomes through quantum computing, within a spontaneous dialogue, the autistic facet of the self cannot predict what the interpretations of a nonautistic participant will be. That is why people involved in a spoken or written dialogue resort to the discourse pragmatics enlivened by quantum neural computing in order to readjust semantics, syntax, and expressive forms. Pragmatics relies on quantum computations in order to refer clusters of potential utterances that others might say (forward internal model) and potential answers or questions that the conscious self might say (inverse internal model) to copies of body and motor schemata conserved by classical computing in the association cortex.

Thus, after reading the message "a *tear* in my eye," written by her mute and crying daughter, a nonautistic mother will take the girl to the emergency room to suture the *tear* in her eye, whereas an autistic mother will offer her daughter some facial tissue.

Conversely, the memory of an enchanting piece of true comedy by an authentic clown, Peter Sellers, may show why humans' reliance on body and motor schemata preserved by classical neural computing stand at the root of the social clumsiness of most autistics. When two Americans meet, for example, classical computing would lean on motor schemata to shake hands. In contrast, when two Hindus meet, classical computing would exact different motor schemata which would encourage them to bow slightly to each other while both bring at chest height the joined palms of their hands.

Acquired and conserved motor schemata will cause hilarious consequences when a Hindu meets an American for the first time: The American would extend his right hand whereas the Hindu would bow—an awkward state of affairs. The situation gets worse when humans' autistic-like capacity for learning by literal imitation and trial and error suggests the Westerner to adopt the motor schema of the Hindu by predicting, under a body schema that the Hindu will bow again. The problem is that the Hindu too will adopt the Westerner's motor schema and predict that his counterpart will extend his hand again. Thus, on the second attempt, the Hindu will extend his right hand and the Westerner will bow; the third attempt would duplicate the first one; the fourth attempt, the second one; and so on, until exhaustion will do away with both characters.

At this point one might conclude that when one faces a challenge never seen before, casual movements may provide better results than known habits. Indeed, classical computing can provide either known answers through the autistic side of the mind or random answers through the schizophrenic side. Classical computing can use only the body or the motor schemata stored in the association cortex or the ones it copies from others through mirror neurons. Only the **artistic** side of the self, which oscillates freely between autism and schizophrenia, can provide new adaptive answers.

3. Concluding comments

An integration of the superior performance of autistics in rigid tasks (for example, EBC trials) and their dismal performance in flexible tasks (e.g., the SD protocol) leads to three hypotheses:

1) Classical computational logic drives autistics and the autistic facet of nonautistic individuals to copy, through mirror neurons, schemata maintained whole by repetitive trials. As a consequence, autistics and the autistic side of the mind of nonautistics will deal well with situations in which intruding stimuli or mental representations will respect two ordinary rules of space-time: <u>An object cannot lie in separate places simultaneously</u>; and <u>separate objects cannot share the same space at the same time</u>.
2) Quantum computational logic will readjust classical computational logic by inviting the artistic facet of the self to deal with polyvalent signs that embrace contrasting meanings at the same time. The artistic use of metaphor, irony, puns, and pronouns is proof to the quantum ways of the second attention. In contrast, autistics will be unable to deal with situations in which ambiguous stimuli—either sensations or mental representations—are dealt with by two eerie principles of neural hyper-space: **Separate virtual objects can share the same space;** and **a virtual object can lie in separate places simultaneously**. Finally,
3) Classical and quantum neural computing, which drive the second attention—will complement and enrich each other in spontaneous dialogues and progress.

Three inferences are warranted:

A. When they refocus their attention in the shift phase of the SD protocol, classical neural computing compels normal controls and autistic subjects to <u>respect</u> the principles of space-time;

B. quantum computing brings normal controls to violate virtually the principles of space-time in the hyper-space of their mind when they distribute their attention between dislocated stimuli in the disengage phase of the SD protocol; and
C. the complementarity between classical neural computing within invariant memory and quantum neural computing within **adaptable learning** feeds the equilibrium between conservation and renovation in the mind of all living beings and all natural systems.

The fact that the basal ganglia of autistics suffer prenatal damage (Sears *et al.,* 1999) and the assumption that an impairment of quantum neural computing stands at the center of ASD imply that the BG-B-C assists vertebrates in adapting to surroundings that cannot be predicted at perfection. **Less-than-perfection** in the BG-B-C may be responsible for an augmentation of stabilization (Ito, 2011).

The author posits that stabilization is produced when the self-attempts to adjust the tension that arises when the mind (or any system in nature) is split by centripetal and centrifugal forces simultaneously—a situation that results when one's attention becomes divided between opposite stimuli or schemata. An example may be inferred from an aphorism that Heraclitus from Ephesus (near modern Selçuk in Turkey) offered 25 centuries ago: "*The bow is the source of life and death.*"

In a bow, tension is obtained when the archer tries to unite opposite locations (the extremes of the bow) into the same location at the same time—within a balance between ubiquity and coincidence. In the field of cognitive control, the tension created by the implicit archer in the self when trying to separate and join simultaneously the autistic and the schizophrenic facet of itself reflects the attempt to resolve an internal or an external confrontation. Similarly, in the field of motor control, a metaphorical—and yet real—bow, presumably in the BG-B-C, invites motor neurons to draw power by stretching and relaxing opposite groups of muscles simultaneously.

Quantum divergence may be linked to virtual ubiquity; and quantum convergence to virtual coincidence. Both divergence and convergence must overlap within the implicit self as they overlap in the mind of a real archer. Consider that *a single mossy fiber may excite 400-600 granule cells, which divide each into a split parallel fiber that, in its turn, may excite 300 Purkinje cells (extreme divergence and the gates to basal ganglia stabilization)*; also, that *one Purkinje cell may be excited by 180,000 parallel fibers (extreme convergence and the gates to cerebellar control).* The two facts show that quantum neural computing in a microcomplex balances stabilization and control in the mind of the guitarist that plucks the chords of his guitar and the vocal chords that generate the words of his song.

Sometimes, precision is the result of interminable practice, especially in a solo concert. In a duel between accomplished Sumo champions, however, repetition is not an option. Once a new sequence is launched into space-time, it will need to obey the irreversibility imposed by the laws of thermodynamics.

Obedience notwithstanding, one may hypothesize that the laws of thermodynamics were violated by Mozart, when he composed a minuet in a minute, because he corrected errors in the hyper-space of his cerebellar-brainstem microcomplexes through an uncharted aid from the basal ganglia.

Of course, errors will be made in space-time by the most brilliant mind. No doubt, Mozart destroyed some musical sheet. Similarly, couples that apologize to each other and forgive each other the mistakes they make will cause a reciprocal improvement in the capacity of their own microcomplexes and basal ganglia to deal with less-than-perfect situations.

In a discussion between husband and wife, for example, quantum stabilization will select among variations of forward models in helping the self-predict what the other will say and among variations of inverse models to decide one's own answers. Control, however, will be lost and gross errors made when quantum coherence does not precede decoherence—which is equivalent to the act of the policeman who shoots a bullet at the air of the lungs of a thief instead of shooting it at the air above the thief. As it seems, forward and inverse models will be integrated through quantum neural computing in the mind of persons who do not attempt to achieve total control without looking first at contextual clues. Within a spontaneous dialogue, for example, the implicit self will resort to coherence-stabilization in assessing through variations of a forward schema whether the self was praised or was censured by an interlocutor by means of an irony addressed to the self. Likewise, stabilization-decoherence in her mind will lead an individual to select an inverse model toward quantum control—as with a witty answer. Of course, classical neural computing might lead her to recreate a motor schema—without the intervention of a cerebellar microcomplex—by which she will slap decidedly the face of her interlocutor.

As it seems, the control expressed by Purkinje cells when they release an entertaining or a specific variant stored temporarily in the cerebellar nuclei, follows an analysis provided by the basal-ganglia/cerebellum/brainstem neural network (BG-B-C) that deals with cerebellar microcomplexes. Mistakes will be made; and reality checks will show if the chosen forward or inverse model was a fit or an unfit one. Thus, a final decoherence into classical computing is warranted only after taking into account the evaluation provided by the inferior olive.

In the movie *The War of the Arrows,* for example, a warrior shoots his only arrow at the neck of a relentless Manchu soldier who hides behind the hero's sister. In the BG-B-C of the warrior, long term depression, in which most synapses of Purkinje cells parallel fibers are silenced, would point at the fact that ubiquity and coincidence in the stabilization provided by the basal ganglia has given sway to cerebellar control, that the explicit and the implicit self are in balance, that the conscious archer in space-time and the unconscious archer in hyper-space have reached an agreement, that a keen controller has selected and provided irretrievable commands to a controlled object within a deadly inverse model, and that a ballistic arrow will be shot and cross the neck of his relentless enemy in obedience to the principles of locality and impenetrability, or the impossibility of **coincidence** and **ubiquity** in visible reality: The implacable Manchu warrior is killed by the dying Korean controller's last neural and physical controlled object shot in observable space-time and neural hyperspace **simultaneously**.

Ito (2011) evoked the metaphor of a matrioska-doll to express the mode of recursive nesting by which a controller will act as a controlled object under a more encompassing internal model. Ito's insights lead to the hypothesis that the complementarity between classical and quantum computing in the distributed hierarchy of the CNS can readjust any component, at any level, between gene expressions and complex neural circuits.

The anatomical findings of Bauman and Kemper (2006) and Bostan et al. (2010) that the prefrontal cortex, the limbic system, the brainstem, the cerebellum, and the basal-ganglia of autistics suffer damage imply that both the explicit and the implicit self are out of balance in ASD. In particular, the variable decrease in the number of Purkinje cells in the cerebellar cortex of ASD subjects points to variables degrees of prenatal damage of neural quantum computing in the basal ganglia and in different microcomplexes. Along human development, central damage in the autistic brain may extend to the limbic system and the prefrontal cortex. The author posits that the lack of the superimposition of quantum neural computing onto classical neural computing in the autistic brain will cause a dearth of synapses, which would twist the normal development of the cerebro-cerebellar communication loop and the ability to implement LTD in reference to the respective microcomplexes that are responsible for cognitive operations.

Presumably, the heuristics on the neurobiological roots of autism and creative intelligence provided in this article (especially, the assertion that quantum computing is anchored to classical computing) can be falsified. For example, if functional Magnetic-Resonance-Imaging [fMRI] methods were applied to a nonautistic girl in relation to an act of pretend play—for example, playing with a doll—the signals will differ from an act in which the girl were using her doll as it were just an object. Discrimination between classical from quantum computations can be obtained by subtracting the signals generated in the two acts.

The enthusiasm by parents and teachers to educate autistics through applied behavioral analysis (ABA) methods has been increasing in late years. The author's view is that ABA is absolutely necessary, insufficient, and even counterproductive in some situations. For example, it is easy to teach an autistic to pass an intersection when the light is green and to stop when the light is red; but teaching autistics the meaning of the yellow light needs something more than ABA. Some mistakes can be fatal, yet society at large will benefit from the action of mirror neurons to learn from others' successes and mistakes.

J. B. Skinner and Thomas Edison, for example, showed the world that all animals are prone to learning from the mistakes that the explicit self makes in observable space-time. In addition to valuing the essential capability for discriminating between gain and pain in operant conditioning, Carl Gustav Jung and Nicholas Tesla showed that nonautistic animals value another mode of learning, which escaped the minds of Skinner and Edison: the capacity to learn from virtual errors made in hyper-space.

We laugh heartily at Peter Sellers' acts of clumsiness because some artist laughed in her mind when she wrote the script of Peter Sellers' movies. The psychological and neurobiological heuristics (Logos) commented in this article invites the thought that laughing about mistakes made both in space-time and in hyper-space enriches the **complementarity** of **talent** and respect in scientists, leaders, and commoners surrounded by unprecedented challenges.

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