Quantum Cognition: A comment to the paper entitled: A More Realistic Quantum Mechanical Model of Conscious Perception During Binocularly rivalry by Mohammad Reza Paraan, Fatemeh Bakouie and Shahriar Gharibzadeh.

Elio Conte

Quantum Cognition : A comment to the paper entitled : A More Realistic Quantum Mechanical Model of Conscious Perception During Binocularly rivalry by

Mohammad Reza Paraan,

Fatemeh Bakouie and Shahriar Gharibzadeh.

Elio Conte

School of Advanced International Studies on Applied Theoretical and non Linear Methodologies of Physics, Bari, Italy

Department of Basic Sciences , Neuroscience and Sense Organs, University Aldo Moro, Bari, Italy

Correspondence : elio.conte@fastwebnet.it

Abstract : I discuss briefly the foundations of quantum cognition taking as reference an article that appeared on Frontiers in Computational Neuroscience

Keywords: consciousness, quantum state, mixed state, probability distribution, dominance duration, quantum superposition principle, quantum collapse, quantum cognition , cognitive science

In Frontiers in Computational Neuroscience , general commentary , the authors M. Reza Paraan, F. Bakouie and S. Gharibzadeh ,in date 20 February , 2014**(**doi:10.3389/fncom.2014.00015) (Paraan M.R. et al, 2014) published a paper entitled A More Realistic Quantum Mechanical Model of Conscious Perception During Binocularly rivalry , discussing and criticizing the basic experimental and theoretical results that I and Khrennikov obtained (Conte E. et al.,2009) examining the possible role of quantum mechanics during the perception and the cognition of ambiguous figures.
First of all we retain that , in order to criticize the results of authors , it is appropriate that scholars are aware about all the articulated research that the criticized authors have explained about the matter so to be sure to have fully explored all the obtained results. This is the reason to report in references a long list of publications that such authors have realized (Conte E. et al.,2004, Conte E., 2007 ,Conte E. et al.,2009, Conte E.,2010a-c,Conte E. et al.,2010 d, Conte E.,2011a-c,Conte et al,2011d, Conte E., 2012a,c, Conte et al , 2012 b,d,e,f , Conte E. 2013 a-b,V.Laterza et al,2013, Khrennikov A.Y.,2010) . Unfortunately it may happen that scholars sometimes have not the opportunity to look at all the scientific production of another author and in some cases instead it may contribute to a better definition of his/her production.
The feature that such authors seem to outline , is contained in the following their sentence : “Technically, a wave-function is a superposition of all the real possible states of a quantum system. We believe that this is an inappropriate take on the problem which leads to inconsistencies within the model. The developers of these two quantum mechanical models believe that the actualization of each quantum state is equal to the activation of neural correlates of consciousness (NCC) of the corresponding perception; a state is actualized when a quantum system is measured (observed) and subsequently its wave-function “collapses” to that constituent state. Therefore, we believe that wave-function is not a legitimate representation, because it does not describe a real state of a system and is doomed to collapse, and on the other hand, specific NCC of MS (Mixed States duration) or that of indeterminate perception demand a distinct associated quantum state. Their model takes into account the periods when their subjects report indeterminate perception. Indeterminate perception resembles MS in that they are both mental states and are mediated by specific neural correlates. But Conte et al. represent indeterminacy state by the wave- function of the two-state system rather than an additional third quantum state. Technically, a wave-function is a superposition of all the real possible states of a quantum system. We believe that this is an inappropriate take on the problem

which leads to inconsistencies within the model”(Paraan M.R. et al, 2014).
Since a clear scientific comparison is always positive, add comments to previous assessments
a) I do not start with assumptions but with basic and robust elements of science and of knowledge that always I have demonstrated at theoretical and experimental level. The conclusion is that quantum mechanics is a God Giano.two faces , form on side looking at the matter and from the other to mental entities as they are involved in consciousness and during perception and cognition. The question has been explained in detail several times in my papers and recently Jansen (Jansen 2015) reinforced the argument in an excellent manner . Let us follow what he states :
“.Extra-mental reality can only be perceived by the brain with the help of sense organs, which transmit all information from extra-mental reality with the help of physical factors, such as electromagnetic waves for the eyes or other physical factors for all other sense organs. Physical factors are transformed by the sense organs into neural activity called sensory transduction. Light enters the eye as electromagnetic waves and stimulates sensory neurons in the retina, which transform the physical stimulation into depolarization of neurons and transmit their information to specialized brain regions. Mechanical waves enter the ear and stimulate specialized receptors, which transmit their activation to specialized regions in other brain regions. All sensory organs function in a similar way, since they are stimulated by physical factors and transmit their activity to their corresponding special brain
regions . With information perceived by all sensory organs, the brain constructs a mental representation of extra-mental reality. However, if the perception organs are inactivated such as by closing the eyes or the ears, there is no longer any direct physical contact between the extra-mental reality and its mental representation in the brain and then no observation of extra-mental physical events is still possible. Now the brain is cut from its outside environment and functions only with its memory, such as perceptions from the past encoded in the memory and retrieved again. The distinction between sensory perception through direct physical contact with the extra-mental reality and memorized perceptions of the past is very important, since pure bottom-up perception from sensory organs to the brain remain unchanged. The intensity of powerful light flashes or unsupportable noise cannot be voluntarily changed, whereas perceptions of the same events after their memorization become modifiable, for instance they can be forgotten or recalled a day later and do no longer induce the same pain feelings. Since memorized past perceptions can be cognitively modified, they allow rearrangements in the representation of extra-mental reality by imagining new situations, which
no longer correspond to prior perceived extra-mental reality. These functions are essential for imagining the future by reorganizing past memory perceptions in a different way and projecting them mentally into the future. Since the future is generally uncertain, it can only be imagined with potentiality. Thus several possibilities have to be imagined simultaneously, although with different probabilities, which correspond in humans to mental superposition
for the prediction of an unknown future.
The key features are : Since the future is generally uncertain, it can only be imagined with potentiality. Thus several possibilities have to be imagined simultaneously, although with different probabilities, which correspond in humans to mental superposition for the prediction of an unknown future.
This is precisely the quantum superposition principle of quantum mechanics applied to quantum cognition . Also ignoring the consistent number of times in which I have explained such basic concept , in Jansen we find again an illuminating and excellent exposition of the status of the matter According to my results I have to add only some observation and some light modifications but the standard requirement to acknowledge the essential role of the superposition quantum principle at the level of mental states cannot be questioned . Consequently , when I use the superposition quantum principle in quantum cognition , I am not

using an ad hoc procedure that one uses since quantum mechanical model in cognition in an empirical mode gives better results respect to classical cognitive models but because this is a consequence of the fact that quantum foundations enter in brain dynamics at cognitive level as basic and fundamental structure. Let us indicate what I have to modify in Jansen statements . The first is an observation useful as confirmation : the brain has constantly a basic function , it is that one to arrange and/or to conjecture about the future . It is its basic performance . Jansen says : "With information perceived by all sensory organs, the brain constructs a mental representation of extra-mental reality."
I specify in detail : brain realizes a superposition of mental states as evidenced in particular in (Conte 2014b and Conte 2015) and thus a final mental representation. Finally, when this author uses the term "imagining" I would substitute it with "arranging" outlining in detail that the basic brain dynamics is constantly based at mental level on arranging a future perspective. Finally, when this author says that the future is generally uncertain I would substitute this term with that one of indeterminate .
b) Does consciousness respond to the basic quantum rules?
Here we have unquestionable answer of course discussed in detail elsewhere
Some considerations about the mechanism of perception are necessary. The human eye is very sensitive but we examine here if we may see a single photon? We retain that under some definite conditions , the answer may be positive . The sensors in the retina respond to a single photon. Of course we have that neural filters only enable a signal to reach the brain to trigger a conscious response when at least about five to nine photons arrive within less than 100 ms. If we could consciously see single photons we would experience too much visual noise in very low light, so this filter is a necessary adaptation, not a weakness. The retina has two types of receptors, cones and rods. The cones are responsible for colour vision and are less sensitive to low light than the rods. In bright light the cones are active and the iris is stopped down. This is called photopic vision. When we enter a dark room, the eyes first adapt by opening up the iris to allow more light in. Over a period of about 30 minutes, there are other chemical adaptations that make the rods become sensitive to light at about a 10,000th of the level needed for the cones to work. After this time we see much better in the dark, but we have very little colour vision. This is known as scotopic vision. The active substance in the rods is rhodopsin. A single photon can be absorbed by a single molecule that changes shape and chemically triggers a signal that is transmitted to the optic nerve. It is possible to test our visual sensitivity by using a very low level light source in a dark room. The experiment was first done successfully by Hecht, Schlaer and Pirenne in 1942. They concluded that the rods can respond to a single photon during scotopic vision.In their experiment they allowed human subjects to have 30 minutes to get used to the dark. They positioned a controlled light source 20 degrees to the left of the point on which the subject's eyes were fixed, so that the light would fall on the region of the retina with the highest concentration of rods. The light source was a disk that subtended an angle of 10 minutes of arc and emitted a faint flash of 1 millisecond to avoid too much spatial or temporal spreading of the light. The wavelength used was about 510 nm (green light). The subjects were asked to respond "yes" or "no" to say whether or not they thought they had seen a flash. The light was gradually reduced in intensity until the subjects could only guess the answer. These authors found that about 90 photons had to enter the eye for a 60% success rate in responding. Since only about 10% of photons arriving at the eye actually reach the retina, this means that about 9 photons were actually required at the receptors. Since the photons would have been spread over about 350 rods, the experimenters were able to conclude statistically that the rods must be responding to single photons, even if the subjects were not able to see such photons when they arrived too infrequently..In 1979 Baylor, Lamb and Yau were able to use toads' rods placed into electrodes to show directly that they respond to single photons. Of course just thirty three years ago they observed that the solution is already at hand ((see Conte 2014 and references therein for all the mentioned authors).
As previously said , we have given demonstration recently that binocular vision and/or binaural hearing raise interesting explanations at the level of consciousness . As Woo outlined in 1981 ((see Conte 2014 and references therein for all the mentioned authors). and as of course it is well known , since the stimuli that the two eyes receive, are compared in the brain to yield depth and motion,

since the vision of split brain subjects shows clear left –right differences , we may conclude that we are subconsciously aware , some of time, of which eye sees which. This is the central point . In fact, it follows immediately that we may perform an experiment in a dark room. . We may arrange the signal so that it reaches one and only one of our eyes. In the case of such experiment , we are normally unaware which eye has actually seen the signal . In this condition we are forced to acknowledge that there is a state of the consciousness which corresponds to what we have previously indicated as quantum superposition principle , in fact it responds to a coherent superposition of seeing the signal by the right eye and seeing the same signal by the left eye. As previously outlined the rods must be responding to single photons. Since the light quantum coming into the left eye would excite the left retina , which excitation can in turn be checked. It would seem that even in principle there can be no interference between the wave function ψ_r corresponding to seeing a flicker by excitation of the right retina . A similar reasoning may be developed by us for ψ_l . We have not so much alternatives in the arising conclusion . The whole visual system is so tightly correlated that there exists a state of awareness ψ_0 which is a coherent superposition of ψ_r and ψ_l with the same energy for the total system. This is the quantum superposition that we mentioned previously and this experiment evidences in a robust manner that our consciousness responds consequently to the basic quantum rules . The wavefunction, as previously explained , develops its basic role .

The second point . Still according to Woo in 1981 , when we turn to human observers and conscious awareness the flickers, we may compare the number N_0 of signals seen in a given time interval when the same quantum may pass through either eye with the sum N_l+N_r , where N_l is the number of signals seen when the light path to the right eye is blocked and similarly we may reason for N_r . The total number of photons directed to open eyes in the latter case is arranged in a manner to be equal to that directed to both eyes in the binocular run and for the same time. The present techniques may help us in reducing unexpected negative effects reducing the number of photons involved until there are only enough quanta to excite one retina at a time The arising result of the experiment is

$$N_0 = N_l+N_r$$

as we expect in the classical case ? No, we expect

$$N_0 \neq N_l+N_r$$

including the quantum role

.

Another important feature Starting with 2003 we have performed for the first time in world a lot of experiments having the finality to establish the presence of quantum interference during perception and cognition of ambiguous figures in humans. Such experiments have given definitive quantum evidence and discovery about the arising quantum interference effect and thus about the role of quantum mechanics at this perceptive and cognitive level . Thanking such obtained experimental verifications conducted by using ambiguous figures, Stroop effect, cognitive anomalies as conjunction fallacy , studies on priming , studies on quantum interference in integration of cognition and emotion in children , and , basically , a verification that using logic statements we obtain the same behavioural kind of quantum interference as in the standard case using material objects in physics , I have concluded about the logical origins of quantum mechanics . In my modest approach it seems to me that quantum cognition has arisen as appropriate field of investigation with valuable interest of scholars in the world also in consideration of the fact that my coauthors and I have produced for the first time such experimental verifications . I will limit to explain here the correct meaning that I have to attribute to one of such performed experimentation with the finality to indicate the correct interpretation that must be given. When we see an ambiguous figure , using Woo words, the brain makes a bet. In front of the ambiguous figure we usually make an immediate , involuntary choice and see it in either one way or the other. The crucial point : the fact that upon continued exposure the interpretation often oscillates back and forth , leads the theoretician to admit that at some point the consciousness obeying as previously explained to quantum rules , is in a superposition of the two modes , of the two alternatives which corresponds to the different interpretations and to the possible existence of quantum interference effects from the two modes. We hope that by this explanation I have evidenced that this is the correct interpretation of the experiments that we performed. Other similar interpretations , if based as example on analogies, should not be taken in consideration

c)First of all consider the problem under the technical profile : in principle, the sentence about superposition of states of these authors is actually a basic foundation of quantum mechanics. .

However, depending on an experiment , one neglects by inessential (for this experiment) degrees of freedom and proceed with those determining the experimental probabilities. We outline : those determining experimental probabilities.
We strongly outline that this is also the basic approach in quantum information theory : instead of representing quantum algorithms in the infinite dimensional Hilbert state space describing all existing degrees of freedom, in quantum computing, the scholars operate with a finite number of qubits and this is precisely the standard methodology considered in our paper .
Still, we have to evidence the fundamental importance of wave function and of the superposition principle in quantum mechanics .
It is not matter that can be liquidated so simplistically and an example will perhaps be useful to illustrate the depth of its content . If , in quantum mechanics , the system is in sates described by the wave functions ψ_1 and ψ_2 , it may be also in states described by the wavefunction obtained from ψ_1 and ψ_2 by the linear transformation

$$\psi = a_1\psi_1 + a_2\psi_2$$

What is the serious mistake that we risk committing if we look at the previous equation simply as a sum !
The superposition of states in quantum mechanics is conceptually a different thing respect to considering it as a simple sum as it could be a superposition of oscillations in classical physics. . As example , in classical physics the superposition of an oscillating component by itself, implies a new oscillation having an amplitude greater or lesser . In addition , and it is here the basic matter, in classical theory we may have oscillating states of “quiet” where the oscillation amplitude is everywhere equal to zero. Instead , in quantum mechanics we have that the wave function is zero if and only if we have that the state is missing. One may understand that the reason of such basic difference is due to the intrinsic and irreducible “indetermination” that is at the basis of this theory. As demonstrated in all our various papers previously quoted , quantum mechanics has basic and peculiar features relating our perception, cognition and consciousness .
c) The aim of our elaboration was to estimate the presence or not of the so called quantum interference term. The reason is that when ascertaining the presence of such term , we conclude that we are in presence of a net violation of the classical Bayes theorem
$p(A=+1)=p(B=+1)p(A=+1/B=+1)+p(B=-1)p(A=+1/B=-1)$ and
$p(A=-1)=p(B=+1)p(A=-1/B=+1)+p(B=-1)p(A=-1/B=-1)$ since the presence of a quantum interference term appears . Quantum interference terms unequivocally evidences the presence and the basic role of quantum mechanics in the arranged investigation.
The authors recall so frequently the concept of “intermediate perception “ (Paraan M.R. et al, 2014) . This is in fact the reason to perform an experiment reaching for an existing or not quantum interference term. Quantum mechanics runs in fact about the basic concept of simultaneously

existing potential states marked from irreducible indetermination.
Let us use an example to explicit the matter .
There is a basic and well known experiment in quantum mechanics (Conte E., 2013). Electrons are produced from a source and move toward a wall with two slits. Let us admit that we install a device that runs as detection screen. It is posed behind the wall and in this manner we may record whether or not the electron hits at a point *x* along the wall.
Let us examine different experimental cases. Close the first slit, the slit 1. The probability p(x) with which the electron hits different positions *x* is given by a shaped distribution with the maximum at 1/2d that is the position on the screen directly from slit 2.
Now we open the slit 2 and close the slit 1 , . than p(x) has a shaped distribution with maximum at the point x= -1/2d .We call p(x/2) the probability the particle hits point *x* when slit 1 is closed. It went through the slit 2. Similarly we call p(x/1) the probability the particle hits point x when slit 2 is closed.
Now we open both the slits. The probability distribution p(x) becomes with a maximum centred at x=0 and it has the well known superimposed interference fringes that we well know. Call this probability distribution for two open slits with p(x/1,2) . This is the probability the particle reaches *x* given it can travel through slit 1 or slit 2.
The problem that at this point is posed and relates the question of the intermediate perception may discussed in the following terms : we expect some relation between p(x/1),p(x/2) and p(x/1,2).
We have to write :
p(x/1,2)=p(x/1,(1,2))p(1/(1,2))+p(x/2,(1,2)p(2/(1,2))
As correctly outlined by Bordley (Bordley ,1983) and by us (Conte,2013) , usually by our standard reasoning we commit here a serious error that of course does not escape to quantum mechanics when we estimate quantum interference . This is the reason we performed such kind of experiment . The error that we commit is that we assume the following relation to hold
p(x/1,(1,2)= =p(x/1) and p(x/2,(1,2))=p(x/2) .
This is the crucial error that we commit.
We cannot admit that p(x/1,(1,2) =p(x/1) and we cannot admit that p(x/2,(1,2))=p(x/2) since these two basic relations contains in p(x/1,(1,2) and p(x/2,(1,2)) more respect to p(x/1) and to p(x/2) " a factor of knowledge " about an existing indeterminate state (corresponding to the indeterminate perception in the case of the present discussion) that , at our first inspection, according to our classical reasoning ,it seems that should not affect our results and actually it has the greatest role since our perception and cognition as well as MS (in the case of our experiment) have a relevant role according to quantum mechanics. In fact , accepting p(x/1,(1,2)= =p(x/1) and p(x/2,(1,2))=p(x/2) we lose our possibility to quantify , if existing , the quantum interference term that instead represented the basic research in our experiment. The indeterminate perception just relates researching for existing quantum interference term as we actually did in our experiment thus not introducing the limitations that the authors instead retained to outline (Paraan M.R. et al, 2014).
Of course we may convince ourselves performing a final experiment as recently outlined by us (Conte,2014) and in this paper . We repeat : "The human eye is very sensitive but can we see a single photon? We retain that under some definite conditions , the answer may be positive . The sensors in the retina respond to a single photon. Of course we have that neural filters only allow a signal to pass to the brain to trigger a conscious response when at least about five to nine arrive within less than 100 ms. If we
could consciously see single photons we would experience too much visual noise in very low light, so this filter is a necessary adaptation, not a weakness. The retina at the back of the human eye has two types of receptors, known as cones and rods. The cones are responsible for colour vision, but are much less sensitive to low light than the rods. In bright light the cones are active and the iris is stopped down. This is called photopic vision. When we enter a dark room, the eyes first adapt by opening up the iris to allow more light in. Over a period of about 30 minutes, there are other chemical adaptations that make the rods become sensitive to light at about a 10,000th of the level

needed for the cones to work. After this time we see much better in the dark, but we have very little colour vision. This is known as scotopic vision. The active substance in the rods is rhodopsin. A single photon can be absorbed by a single molecule that changes shape and chemically triggers a signal that is transmitted to the optic nerve".
For details see Philip Gibbs 1996.http://math.ucr.edu/home/baez/physics/Quantum/see_a_photon.html and references therein) It is possible to test our visual sensitivity by using a very low level light source in a dark room. The experiment was first done successfully by Hecht, Schlaer and Pirenne in 1942. (Hecht S,1942). They concluded that the rods can respond to a single photon during scotopic vision. In their experiment they allowed human subjects to have 30 minutes to get used to the dark. They positioned a controlled light source 20 degrees to the left of the point on which the subject's eyes were fixed, so that the light would fall on the region of the retina with the highest concentration of rods. The light source was a disk that subtended an angle of 10 minutes of arc and emitted a faint flash of 1 millisecond to avoid too much spatial or temporal spreading of the light. The wavelength used was about 510 nm (green light). The subjects were asked to respond "yes" or "no" to say whether or not they thought they had seen a flash. The light was gradually reduced in intensity until the subjects could only guess the answer.
They found that about 90 photons had to enter the eye for a 60% success rate in responding. Since only about 10% of photons arriving at the eye actually reach the retina, this means that about 9 photons were actually required at the receptors. Since the photons would have been spread over about 350 rods, the experimenters were able to conclude statistically that the rods must be responding to single photons, even if the subjects were not able to see such photons when they arrived too infrequently.
In 1979 Baylor, Lamb and Yau (Baylor D.A. ,1979)were able to use toads' rods placed into electrodes to show directly that they respond to single photons.
As previously said , we have given demonstration recently that binocular vision and/or binaural hearing raise interesting explanations at the level of consciousness . As Woo outlined in 1981(Woo C.H.,1981) and as of course it is well known ," since the stimuli that the two eyes receive, are compared in the brain to yield depth and motion, since the vision of split brain subjects shows clear left –right differences , we may conclude that we are subconsciously aware , some of time, of which eye sees which ". This is the central point . In fact, it follows immediately that we may perform an experiment in a dark room. . We may arrange the signal so that it reaches one and only one of our eyes. As previously said, the result of such experiment is under our hands : in the case of such experiment , "we are normally unaware which eye has actually seen the signal . In this condition we are forced to acknowledge that there is a state of the consciousness which corresponds to a coherent superposition of seeing the signal by the right eye and seeing the same signal by the left eye. As previously outlined the rods must be responding to single photons. Since the light quantum coming into the left eye would excite the left retina , which excitation can in turn be checked. It would seem that even in principle there can be no interference between the wave function ψ_r corresponding to seeing a flicker by excitation of the right retina . A similar reasoning may be developed by us for ψ_l ". We have not so much alternatives in the arising conclusion . "The whole visual system is so tightly correlated that there exists a state of awareness ψ which is a coherent superposition of ψ_r and ψ_l with the same energy for the total system.". In this manner we arrive to the central question.
Still according to Woo in 1981 , when we turn to human observers and conscious awareness the flickers, we may compare the number N_0 of signals seen in a given time interval when the same quantum may pass through either eye with the sum N_l+N_r , where N_l is the number of signals seen when the light path to the right eye is blocked and similarly we may reason for N_r . The total number of photons directed to open eyes in the latter case is arranged in a manner to be equal to that

directed to both eyes in the binocular run and for the same time. The present techniques may help us in reducing unexpected negative effects reducing the number of photons involved until there are only enough quanta to excite one retina at a time The arising result of the experiment is

$$N_0 = N_l + N_r$$

as we expect in the classical case ? No, we expect

$$N_0 \neq N_l + N_r$$

including the quantum role that is the correct answer. I have considered this argument also previously in this paper but it seems to me that to repeat may be useful.

Finally the wave function as I use it in quantum cognition is an abstract entity that represents a “factor of knowledge” that is to say a rough but first time mathematical representation of a mental conscious state.

We suggest the readers to read in detail our papers that appeared recently on psychology (scirp.org)

References

Baylor D.A.,Lamb T.D.,Yau K.W. ,Responses of retinal roads to single photons, *J. Physiol.* 288,613-634.

Bordley, R.F. (1983) Modeling quantum behavior with standard (nonquantum) probability theory. *Journal of Mathematical Physics* 24, 2411-2421. doi:10.1063/1.525622

Bordley, R.F. (1997) Experiment-dependent probabilitiesin quantum-mechanics and psychology. *Physics Essays*, 10, 401-406. doi:10.4006/1.3036426

Conte, E., Khrennikov, A.Y.,Todarello,O., Federici, A., Mendolicchio, L., and Zbilut, J.P.(2009). Mental states follow quantummechanics during perception and cognition of ambiguous figures. *Open Syst. Inf. Dyn.* 16, 85–100.doi: 10.1142/S1230161209000074

Conte, E. (2010a) A proof of Von Neumann’s postulate in quantum mechanics. In: Quantum Theory Reconsideration of Foundations 5, American Institute of Physics,New York, 201-205

Conte, E. (2010b) A reformulation of von Neumann’spostulates on quantum measurement by using two theorems in Clifford algebra. *International Journal of Theoretical Physics*, 49, 587-614.doi:10.1007/s10773-009-0239-z

Conte, E. (2011a) An investigation on the basic conceptual foundations of quantum mechanics by using the Clifford algebra. *Advanced Studies in Theoretical Physics*, 5, 485-544.

Conte, E. (2011b) On the logical origins of quantum mechanics demonstrated by using Clifford Algebra: A proof that quantum interference arises in a Clifford algebraic formulation of quantum mechanics. *Electronic Journal of Theoretical Physics,* 8, 109-126.

Conte, E. (2011c) On the logical origins of quantum mechanics demonstrated by using Clifford algebra. *NeuroQuantology*,9, 231-242.

Conte, E. (2012a) What is the reason to use Clifford algebra in quantum cognition? Part I: “It from qubit” on the possibility that the amino acids can discern between twoquantum spin states. *NeuroQuantology*, 10, 561-565.

Conte, E., Todarello, O., Federici, A., Vitiello, F., Lopane, M. and Khrennikov, A.Y. (2004) A preliminary evidence of quantum like behaviour in measurements of mentalstates. In: Quantum Theory: Reconsideration of Foundations 2, Vaxjo University Press, Vaxjo, 679-702.

Conte, E., Todarello, O., Federici, A., Santacroce, N., Laterza, V. and Khrennikov, A.Y. (2012b) May we verify non-existing dispersion free ensembles by application ofquantum mechanics in experiments at perceptive and cognitive level? *Neuroquantology,* 10, 14-19.

Conte, E. (2012c) Advances in application of quantum mechanics in neuroscience and psychology: A Clifford algebraic approach. Nova Science Publishers, New York.

Conte, E., Santacroce, N. and Federici, A. (2012d) A possible quantum model of consciousness interfaced with a non-lipschitz chaotic dynamics of neural activity (Part I) and (Part II). *Journal of Consciousness Exploration and Research,* 3, 905-936.

Conte, E., Khrennikov, A.Y., Todarello, O., De Robertis, R., Federici, A. and Zbilut, J.P. (2012e) On the possibility that we think in a quantum mechanical manner: An experimental verification of existing quantum interference effects in cognitive anomaly of conjunction fallacy. In: On the Borders of Complexity , Nova Science Publishers, Inc., Hauppauge, 149-163.
Conte, E., Santacroce, N., Laterza, V., Conte, S., Federici, A. and Todarello, O. (2012f) The brain knows more than it admits: A quantum model and its experimental confirmation. *Electronic Journal of Theoretical Physics*, 9, 72-110.
Conte, E., Khrennikov, A.Y., Todarello, O., De Robertis, R., Federici, A. and Zbilut, J.P. (2011d) On the possibility that we think in a quantum mechanical manner: An experimental verification of existing quantum interference effects in cognitive anomaly of conjunction fallacy. *Chaos and Complexity Letters*, 4, 123-136.
Conte, E. (2010c) The possibility that we think in a quantum probabilistic manner. *Neuroquantology*, 8, 3-47.
Conte, E., Todarello, O., Laterza, V., Khrennikov, A.Y., Mendolicchio, L. and Federici, A. (2010d) A preliminary experimental verification of violation of bell inequality in a quantum model of Jung theory of personality formulated with Clifford algebra. *Journal of Consciousness Exploration and Research*, 1, 831-849.
Conte, E., Khrennikov, A.Y., Todarello, O., Federici, A. and Zbilut, J.P. (2009b) On the existence of quantum wave function and quantum interference effects in mental states: An experimental confirmation during perception and cognition in humans. *Neuroquantology*, 7, 204-212.
Conte, E., Khrennikov, A.Y., Todarello, O., Federici, A. and Zbilut, J.P. (2008a) A preliminary experimental verification on the possibility of Bell inequality violation in mental states. *Neuroquantology*, 6, 214-221.
Conte, E. (2008b) Testing quantum consciousness. *Neuroquantology*,6, 126-139.
Conte, E., Todarello, O., Federici, A., Vitiello, F., Lopane, M., Khrennikov, A.Y. and Zbilut, J.P. (2007) Some remarks on an experiment suggesting quantum-like behaviour of cognitive entities and formulation of an abstract quantum mechanical formalism to describe cognitive entity and its dynamics. *Chaos, Solitons and Fractals*, 31, 1076-1088. doi:10.1016/j.chaos.2005.09.061
Conte, E. (2013a) What is the reason to use Clifford algebra in quantum cognition? Part II: Information, cognition and the principle of existence are intrinsically structured in the quantum model of reality. *NeuroQuantology*, 11, 34-46.
Conte, E. (2013b) Are information, cognition and the principle of existence intrinsically structured in the quantum model of reality? *Advanced Studies in Theoretical Physics.*
Conte, E. (2014) Answer to Giancarlo Ghirardi: Quantum Superpositions and Definite Perceptions: Envisaging New
Feasible Experimental Tests. A Novel Proposal for Quantum Mechanics, Perception and Cognitive Science**?** *International Journal of Theoretical Physics.*
http://dx.doi.org/10.1007/s10773-014-2259-6
Conte E.(2015) Additional Comments Added to an Our Recent Answer to G. Ghirardi , *Journal of Modern Physics* , 6 , in press.
Conte, E. (2014b). Can Current Quantum Cognition Studies Give Indication on the Manner in which Human Cognition Arose ab Initio? *Psychology*, 5, 798-800.
http://dx.doi.org/10.4236/psych.2014.58090
Conte, E. (2013a). A Clifford algebraic analysis gives mathematical explanation of quantization of quantum theory and delineates a model of quantum reality in which information, primitive cognition entities and a principle of existence are intrinsically represented *ab initio* , *World Journal of Neuroscience*,3, 157-170, DOI: 10.4236/wjns.2013.33021
Hecht S., Shlaer S., Pirenne M.H.(1945) , Energy, Quanta and Vision ,
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2142545/pdf/819.pdf

Conte E. What Path Monitor: A Brief Note on Quantum Cognition and Quantum Interference, the Role of the Knowledge Factor, Psychology, Vol.6 No.3, Pub. Date: February 26, 2015
DOI: 10.4236/psych.2015.63029

Conte E. , R. F Lucas **,**First Time Demonstration of the Quantum Interference Effect during Integration of Cognition and Emotion in Children
World Journal of Neuroscience Vol.5 No.2, Pub. Date: April 30, 2015
DOI: 10.4236/wjns.2015.52011

Laterza V., Todarello O. ,Conte E.(2013) On the possibility to identify quantum interference effects on the single human subject during cognitive performance by using Stroop Effect : The perspective of clinical application of the quantum cognitive model , *International Journal of Research and Review in Applied Sciences ,* 16-4,1-5

Jansen F.K. (2015),Quantum Mechanics is not Physical Reality But Mental Potentiality Because of the Law of Non-Contradiction, *Neuroquantology*, 13,1,1-10

Paraan M.Z., Bakouje F., Gharibzadeh S.(2014**)** A More Realistic Quantum Mechanical Model of Conscious Perception During Binocularly rivalry, *Frontiers in Computational Neuroscience* ,8, 1-2, doi: 10.3389/fncom.2014.00015

Philip Gibbs 1996 Can a Human See a Single Photon?
.http://math.ucr.edu/home/baez/physics/Quantum/see_a_photon.html and references therein

Khrennikov, A. (2010) Ubiquitous quantum structure. Springer, New York. doi:10.1007/978-3-642-05101-2

Woo C.H. (1981), Consciousness and Quantum Interference-An experimental Approach., *Foundations of Physics* , 11,933-944