The Significance of "Advanced" and "Retarded" Signals for a Transactional Interpretation of Ideomotor Action Control and Inter-Hemispheric Cortical Synchronisation

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Abstract
Ideomotor theory explains developmental and executive aspects of action control departing from the proposition that actually ongoing behaviour is sensorily guided by the anticipated consequences of its own future effects. The present paper discusses a view which is rooted, in opposition to the "computing" approach of the AI tradition, rather in the "tuning" view of J.J. Gibson and his followers, departing from the framework of a transactional interpretation of quantum brain dynamics. Based on the Wheeler-Feynman absorber theory, this approach accounts for advanced/retarded anomalous resonance coupling in brain dynamics in analogy to quantum entanglement effects between distant twin particles (Einstein-Podolsky-Rosen paradoxes, quantum non-locality, teleportation). Beyond the quantum mechanical micro scale, indices for similar absorber site driven resonance coupling effects have probably been found at the cosmological macro level too, namely, by the soviet astronomers Kosyrev and Nasonov. Hypothetically, their observations might be explained by a mechanism of anticipative resonance coupling with the advanced future positions of stellar objects expanding to the same time scale as their gravitational forces are retarded due to the limitations of light speed. As has been shown by Dubois, anticipation is needed in macro- and micro-cosmological feed-back loops in order to avoid entrainment towards a chaotic attractor. This argument seems applicable to an advanced resonance coupling solution for cortical synchronisation and ideomotor action control too. Neuronal loops are fed into a network of so-called synfire chains, the timing of which is critically dependent on anticipatory predictions of the next input in order to adjust their output in a way which stabilises non-linear brain dynamics. In order to get a synchronous visual flow in both left and right brain hemispheres, as is needed in order to account for the coherence of micro timing in binocular stereo vision, the temporally delayed information of the left and right eyes' visual hemifields, which are initially processed in different hemispheres, should be integrated with anticipated versions of their complements in order to close the time gap. From this point of view, popular experimental data, e.g. about iconic memory, backward masking and the Libet experiments under actual discussion, may be reinterpreted in line with the hypothesis of an absorber theory for quantum brain dynamics.
Keywords: Idemotor theory, transactional interpretation of quantum brain dynamics, cortical synchronisation, Kosyrev effect, inter-hemispheric communication

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1 Computing vs. tuning in the ideomotor approach

To anyone who ever played, or even only watched, a football game or a tennis match, it is evident that the player's task cannot be reduced to the aim of hitting the ball at its currently visible position. On the one hand, it takes time to register and to process the visual input, to generate and to carry out the motor commands etc. On the other hand, meanwhile, the ball has been continuing its flight and should be hit, instead of its sensorily processed location, at a certain future position where it is meant to arrive only when the player's foot or hand with the racket will have reached it. Nevertheless, in such fast games the player's usual report is the impression of having hit the ball just at the place where it was actually perceived. Therefore, a component of strong anticipation is involved not only in the player's performance, but also in the timing of his or her perceptual processing.

Indeed, a psychological theory, known as the ideomotor approach of perceptually guided action control and learning, is based on such an assumption [31]. A good illustration, e.g., is the development of a baby's sensory-motor behaviour which is apparently stochastic after birth, becoming more and more co-ordinated within a few months. Obviously, the brain's development should lead to a growing degree of synchronicity and coherence in the reverberating neuronal communications, as a prerequisite for smoothly cascaded sensory and motor processes. However, the baby's sensory-motor learning process lacks any kind of "robotic" regularity. Departing from the ideomotor approach it is concluded that the efferent commands to the bundles of muscles are initially chosen at random, the useful of them being selectively reinforced stepwise based on feedback of their anticipated afferent consequences, i.e. the desired visual changes induced by the muscular activity. Accordingly, the ideomotor theory explains developmental and executive aspects of action control departing from the proposition, that the actually ongoing behaviour is perceptually guided by the anticipated consequences of its own future visual reafferencing, based on the desired outcomes of the to be performed actions [15]. However, the neuronal signals, due to considerable transmission latencies, are "retarded" with respect to the actual state of the organism and its environment. Therefore, the question arises, how is the needed knowledge about the "advanced" future states gained by the visuomotor system?

Standard theory claims this to be a matter of computation. Knowing the past and its changes until the present, it is possible to anticipatively calculate its probable states in the future, i.e. to predict them by computing from memory about earlier experiences with similar situations. Alternatively, the present paper discusses a view which is rooted, in opposition to the "computing" approach of the AI tradition, rather in the "tuning" view of J.J. Gibson [11] and his followers. Proponents of this idea argue that an organism has to do no more computing than its environment has to do, because the sensory systems are conceived to be "tuned-in" to the relevant environmental information due to a certain kind of resonance coupling. Therefore, in the context of the ideomotor theory, the critical question is: What kind of mechanism might enable an organism, whose neuronal input transfer function is "retarded" with respect to the actual environ-

mental states, to be tuned in resonance with "advanced" perceptual changes, being caused only by the output of its own future locomotion which actually hasn't even started yet?

2 Absorber theory and the transactional interpretation of QM

A straightforward answer to this question might be rooted in Cramer's transactional interpretation of quantum mechanics [2; 3], based on the Wheeler-Feynman absorber theory [32]. The absorber theory is aimed to account for seemingly anomalous spatio-temporal exchanges of quantum states at distance, without temporal transmission delay: i.e. quantum non-locality, entanglement or teleportation, as it was initially demonstrated by the ingenious experiments of Alain Aspect et al. [1], sometimes also termed the Einstein-Podolsky-Rosen (EPR) paradox [8]. Strangely, this paradox has been named after the "Gedankenexperiment" of a man, who did not even believe in the reality of this phenomenon. Einstein initially proposed it as a striking argument against the absurdity of the consequences of quantum mechanics. Thus, he intended to rule out "spooky" instantaneous action at distance, resulting in a "collapsing" wave function of a particle in a certain place, whose quantum state is correlated (entangled) to the state of another one being subject to a measurement in a rather different place at the same time. This kind of quantum correlation, evolving from the measurement of one of two distant "twin" particles, challenged the main lines of his own relativist approach and, moreover, the traditional "local" worldview of physics. As a consequence of the relativist view, the instantaneous – i.e. superluminal – "communication at distance" of particles in entangled states, due to the quantum mechanical measurement of one of the "twins", seemed to imply some kind of temporally backward signalling contrary to the normal flow of time and causality.

Departing just from this contradiction, the transactional interpretation [2, 3], based on the Wheeler-Feynman absorber theory [32] attempts to explain the EPR paradox, which is nowadays experimentally proven by manifold experiments, in a rather straightforward way. The proposed explanation is the hypothesis of an anticipative effect which is fed back from the "absorber" to the "emitter", i.e., coupled in between "retarded" and "advanced" components in the collapsing wave function of the quantum event under measurement, which appears to an external observer as a seemingly[1] time-reversed transaction. It is argued, that the mathematical reasons for doing so might be found in the standard quantum mechanic's procedure for calculating the so-called "collapse" of the wave function. This is done by multiplying a complex number (cos t + i sin t) by its conjugate (cos t – i sin t). Since the angle t represents time[2], a change of the sign of the imaginary

[1] In fact, the "back-in-time effect" is understood by the absorber model to result as an illusion from the point of view of the external observer, since in the relativist framework the light beam from it's inner aspect has zero time flow and no spatial extension. Thus, the absorber theory is an attempt to unify the relativist and the quantum mechanical paradigms.

[2] More precisely, time is represented here by omega t, with omega as a constant 2Pi/T (with T as the time period) which transforms the temporal periodicity into the phase of an oscillatory "angular time" corresponding to circular revolutions in radiants.

part in the complex conjugate number mirrors the angle against the real axis, with the result of changing the angular rotation direction of time flow. Similarly, this argument is applied, as it will be discussed below, by Peter Marcer and Walter Schempp [24; 26; 25] in order to give an account to quantum holography within the framework of phase conjugate optics.

3 The Libet experiment and the "free will" debate in neuroscience

Departing from the absorber theory, one might ask for neurophysiological evidence in favour of a quantum transactional analogue[3] corresponding to the ideomotor theory of sensory motor control and cortical synchronisation of the underlying brain processes. In such a context, the frequently discussed Libet experiments might be considered [22]. These experiments show an appearingly paradoxical time difference between an action which is already under way, on the one hand, and the decision making occurring, as it seems, later[4] than the action onset itself. In the experimental setting, an observer is instructed to decide "by free will" within a certain interval the actual moment to press a button and to fix the time of decision making (in a control condition also of executing the action) by observing a clock. Certain physiological data (EEG, EMG) are recorded resulting in the paradox that these parameters give an earlier response (up to 500 msec) than the estimated time of making the decision itself. This is especially curious in the context of subsequently collected data from similar experiments with so-called transcranial magnetic stimulation (TMS) of the motor cortex, evoking unwillingly forced finger-movement responses, the estimated timing of which did not show the typical temporal reversal [12, 13]. Therefore, the Libet experiments are very popular nowadays, since their interpretation in the framework of standard theory, according to some theorists, seems to give rise to the conclusion about the non-existence of free will. The neuronal circuitry, as it is argued by leading neuroscientists, autonomously does the whole job for itself, whereas the mentally timed feeling of having made the decision act comes later, due to the compartmental architecture of the brain rather than being induced in advance by an act of "free will"[5].

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[3] At present, it is far from clear whether this analogy has to be conceived only as a useful heuristics or whether there is something in common in the presumed brain's and the quantum mechanical "absorber" behaviour. However, the present paper discusses this idea from an intendedly speculative view, looking for certain conclusions which could be drawn, giving the transactional explanation the preliminary credit of a working hypothesis.

[4] At least under acceptance of the chronometric conditions of these experiments, involving the procedure of judgment-based assignment of the subjective decision time – as it is shown on the observed clockwork – to the reaction time, the time course of EEG, EMG and other parameters.

[5] The whole debate, of course, is probably obsolete in several aspects, as has been frequently discussed, as far as it is applied to the topic of free will since the experimental procedure is not able really to give a decisive answer to the controversy. One of the problems is that the conclusions drawn are anchored in the "physicalist" chronometric arguments of a physics and psychophysics of the 19th century which has been shown obsolete by quantum mechanical revolution, as it is argued in the present paper too.

Alternatively, departing from Cramer's transactional interpretation [2; 3], Fred Alan Wolf has argued the Libet experiments' results to come out of a quantum mechanical absorber effect [33] which can be accounted for in the terms of the Wheeler-Feynman theory. Indeed, visual processing, on the one hand, takes time up to 500 msec. However, the ideomotor locomotion control requires, on the other hand, a temporally much closer sensory-motor interfacing loop (at best a one to be just in time, i.e. as close as possible to dt=0). Therefore, a straightforward idea has been proposed as a solution for this conflict. It was argued that the interrelations between certain brain states associated with the sensory-motor processing control and the underlying external events are entangled much the same way as the absorber and the emitter are entangled in a quantum correlated transactional state. Thus, the retarded brain processes might serve as an internal absorber for an advanced up to 500 msec component of the sensory signals. Accordingly, the transactional results of sensory processing are – in analogy to non-local quantum absorber states – supposed to be dated back, then, into their "entangled" temporal context of the ongoing external events.

So the question arises: Are quantum absorber effects, as the sketched above ones likely to occur within our biological tissue, "inside" of the neuronal system? Nowadays such effects are preferentially searched for at the "microscopic" scale of sub-cellular nano-structures. This has been proposed by several authors, associated with the ideas, e.g., of micro black holes in the neuronal tissue [27], of quantum computations within the microtubuli skeleton [14] interpreted as a non-classic wave guiding system, of the DNA as a biophotonic quantum holographic non-local processing system [10] etc. However, in the present context, under the hypothesis of an absorber-type explanation for ideomotor behaviour control, we are concerned with the argument of a decoherence interval, being, e.g. in the Libet experiment, far too long in comparison with the usual quantum time scale.

Complementary to the rethinking of brain processes at sub-cellular nano-scale, the present paper additionally proposes to take the risk of having a look at some preliminary evidence about rather long-range non-locality effects. These can be found, if the reported evidence is valid, even on a light-year wide cosmological scale. The cosmological scale is argued to be of relevance with respect to the issue of visual consciousness in view of the presumed non-local aspects of brain processing ("cosmic consciousness"). Consider, e.g., an observer dependent alternating registration of wave vs. particle aspects of transmitted radiation, the source of which is hidden behind a light years away gravitational lens (a so-called Einstein-cross) as a cosmological variant of the EPR paradox: Is this an observation-induced absorber effect, i.e. a transaction to an event, the origin of which is dated "back in time" some millions of light years ago?

Thus, an intendedly speculative look "outside" the nervous system – namely, into the outer space – is included in the context of the present paper as a "side step" in order to provide us with an example of a rather "macroscopic" absorber-type quantum phenomenon which is probably hidden behind a rather striking result of soviet astronomy, concerned with the so-called Kosyrev effect.

4 The Kosyrev effect

The Andromeda nebula is the centre of our neighbouring galaxy which is located at a distance of about 2,5 million light years away. Although unseen without a radio telescope, in projective size its spiral arms form the apparently biggest stellar object on the firmament. Altogether it appears to be about six lunar diameters wide and cannot be mistaken for any other stellar object. In the end of the seventies, the Soviet astronomers Nicolai Kosyrev and Victor Nasonov performed a series of observations of stellar objects, mainly of the Andromeda galaxy, using the facilities of a great reflector telescope [21]. However, instead of the usual ocular lens system they inserted into the focus of the reflector a newly developed special CCD-type sensor. This detector consisted of a matrix of ultra sensitive piezo-electric crystals which were grown in an orbital station under conditions of nearby zero gravitation[6]. Convinced that their device was highly sensitive to ultra weak gravitational fluctuations[7], Kosyrev and Nasonov used it to scan a spatial profile of the gravitational signals of stellar objects, notably the ones of the Andromeda galaxy.

To their astonishment, the both astronomers reported to have registered the spiral profile of the galaxy not only at Andromeda's observed proper location, i.e. the place of the source of electromagnetic radiation, which in fact was sent out 2,5 million years ago. Additionally, they reported to have observed the same profile also at two distinct subsequent locations too. One of them was the position which the Andromeda galaxy, according to calculations of its displacement's direction and velocity parameters, should have reached nowadays, "here and yet", so to speak, at its apparently instantaneously transmitted actual position. This was a fairly unexpected observation, since it clearly seemed to be in conflict with the basics of Albert Einstein's relativistic cosmology. According to Einstein, the velocity of light sets an upper limit to any kind of signal or matter transmission in space. However, even more astonishingly, Kosyrev and Nasonov registered one more of Andromeda's profiles at a third location, which the galaxy will have reached, departing from today's predictions, in a far away future. This third piezo-detected profile was spatially located just the same 2,5 million light years ahead as the actually observable conventional radiation is temporally delayed. Thus, as compared to the ordinarily observable position, the future one appears to be in a "space-time mirrored" state, since it corresponded reciprocally – i.e., with an "opposite sign" – to the temporally delayed spatial position of the actually observable light signal. Apparently, the Kosyrev effect seemed not to depend on conventional electromagnetic radiation, since it persisted even after shielding the telescope with a metallic cover.

All in all, the Kosyrev effect is one of the most strange, far from being accepted by the majority of astrophysicists, stellar phenomena which have been ever reported. The re-

[6] The effect of the zero gravitational influences on the growth of the crystal as a prerequisite for its appropriate functioning as a gravitation detector is presumably its increased sensitivity. Possibly, the "innate" bias for the to be detected influences is less under weightless conditions of growth.

[7] In Kosyrev's own theoretical thinking, the details of which are out of the scope of this paper, gravitation is intimately linked with hypothetical physical properties of time, such like its "temporal density" aspect.

ported evidence about this phenomenon is nowadays far from established[8] and there exist only a few attempts of replication by other observers [19, 20]. Is this only a curiosity at the margins of the cosmological observations' history? Or does it provide, alternatively, a major hint for the way, how the dynamic revolving equilibrium states of our universe are synchronised in a similar way, as it is argued in the present paper[9] for the dynamic equilibrium states of oscillation-based neuronal communication processes in the brain too? Does it provide, last not least, the argument for an alternative hypothesis about the regulation of resonant tuning-based anticipatory ideomotor action control?

5 Anticipatory synchronisation of oscillators in hierarchy

The solar system and the whole universe consists, in principle, of an architecture of hierarchically intertwined coupled oscillators. The same architecture of oscillators in hierarchy is also underlying bio-regulatory processes, as the enzymatic metabolism, the control of the heart rate and blood circulation as well as the brain's and neuronal system's dynamics and, last not least, the loop-synchronization aspects of ideomotor behavioural control too. In such a coupled oscillators' system, as has been shown by the theory of non-linear dynamics, delayed feedback loops can exhibit a condition for the emergence of chaotic attractors, as an outcome. One may easily get a "sensory" impression of this type of regulation problems with the help of a coupled-oscillators system as it is sold in gimmick shops, a so-called "chaos-pendulum". Such a device usually consists, on the one hand, of a regularly oscillating primary pendulum (whose cosmological analogue might be, e.g., the sun-earth rotary system). On the other hand, the construction involves a secondary sub-pendulum (comparable, e.g., to the earth-moon rotary system), whose oscillations are, in contrast, totally chaotic. Fortunately, however, chaotic pendulum dynamics has never been observed in the interactions of our sun, its planets and moons.

Therefore, according to the framework of anticipatory regulation as it has been developed by Daniel Dubois[10] [7], our universe has to cope with a problem of regulatory stability which has been hitherto ignored. The reason for this, apparently, is hidden in Isaac

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[8] The relevance of the Kosyrev effect in the context of ideomotor action control and neuronal communication and synchronisation processes depends, among other factors, on the verification or falsification of the underlying astronomical findings. Accordingly, the conclusion drawn is at present a rather preliminary one, which might be better understood as a to be discussed heuristics than providing the basics of a comprehensive theory.

[9] In our paper's context, we discuss only the consequences of Kosyrev's findings in a way, in which they appear "taylored" in order to fit as complementary as possible to the standard relativistic and/or quantum cosmology. Kosyrev's own theoretical ideas as an issue of discussion about the physical properties of time – e.g., as a source of "anti-entropic" radiation, which is in intimate relationship with gravitational forces of different temporal density, coming out of stellar objects due to their angular momentum of rotation – are out of the scope of this paper.

[10] The author has tried to adopt selected issues from the work of Daniel Dubois in order to discuss corresponding topics of the present paper. However, the view presented here, as has been stated, is intendedly speculative about analogies between brain synchronisation, the theory of ideomotor control, the absorber theory and the cosmological basics of the Kosyrev effect. Therefore, the full responsibility for the presented view rests – here and in the following text sections – by the author.

Newton's differential equations describing the planets' periodically revolving movements. Since the underlying differentiation process dx/dt assumes a temporal delay approximately equal to zero, Newton's equations are implicitly based on the assumption of an infinite speed of gravitational signal transmission. However, in the light of Albert Einstein's relativistic physics, gravitational forces should have a finite transmission speed too, less or equal to the velocity of light c. If so, the gravitational signals were to travel at least about one second from earth to moon and about eight minutes from sun to earth; on their way back, again, the same temporal delays should accumulate. Instead of Newton's infinitesimally small dt, thus, a considerable amount of delta t has to be taken into account in the solar system's regulatory feedback loops, not to speak of the galactic and extra galactic measures of spatial and temporal distance.

With respect to the topic of the present paper, it should be admitted that this problem is neither an exotic star-away issue down in the far depth of the universe, nor is it just an issue of funny gimmick-pendulum toys. Since, in fact, all bio-regulatory processes, e.g., human and animal metabolism, heart rhythm and blood circulation, and – last not least – the brain's and the nervous system's exhibitory/inhibitory balance are based on an architecture of hierarchically coupled harmonic oscillators with non-linear dynamics, thus, the delayed feedback problem and its consequence of the system's fading away into chaos appears to be almost the same in all these cases.

Daniel Dubois gives an impressive illustration of the regulatory problem with delayed feedback loops in coupled harmonic oscillatory systems, which is especially appropriate within the context of ideomotor behavioural control [4]. Considering the example of a robot's arm, trying to grasp for an object in rotary motion, he argues that the cycle of registering and processing the input, generating and executing the motor commands etc., takes a certain amount of time. So it may easily come out that this delay with an amount of minus delta t is in harmonic relation to the temporal cycling of the to be grasped object's revolutions. In this case the trials of the robot to grasp for the object may become systematically erroneous or even chaotic according to the standard Feigenbaum scenario [9]. The same problem, however, should apply to the sun, when trying to "grasp" for the revolving earth in a delayed position and, similarly, to the earth itself, with respect to the moon's delayed position. So why then, one might ask, is the moon stable in its revolutions around the earth as well as the earth around the sun and the sun around the galaxy?

If delayed feedback is a chaos-inducing condition, then, on the contrary, the anticipated (foreseen) future state after the delay, fed forward into the system's regulation, Dubois proposes, is a condition for its "dechaotization". Obviously, this may be also considered to be a major advantage of the ideomotor action control theory, as it has been introduced in the opening section of this paper. In fact, the robot's arm's control and similar control processes become smooth and regular after introducing an anticipative (incursive/hyperincursive) term into the discretized feedback equations. Thus, these equations were reformulated by Dubois, using instead of the state parameters of the delayed position, (i.e. the state at "– delta t"), now the parameters of an anticipated future state, corresponding to the absolute value of the delay time, but with an inverse sign (i.e., the state at time "+ delta t"). Therefore, the oppositely signed anticipating feed-forward on

the one hand neutralizes the delayed feedback on the other hand, and the resulting dt equals to ± zero.
In a model-based calculation, Daniel Dubois was able to show for the planet Mercury that this idea seems to be applicable to cosmology too [6]. Using the discretized Newtonian equations, retarded in correspondence to a negative delta t based on the velocity of light as the speed of signal transmission (a delay of about –1,8 minutes), his calculations resulted in big rosettes of "epicyclical" cycloid revolutions of the planet's orbit which, in fact, have never been observed. Inserting, however, into these equations a set of advanced parameters corresponding to just the same interval but with an inverted temporally positive sign (delta t of about +1,8 minutes ahead), this feed back from the system's own anticipated future state was able to come out in some nearly ideal trajectory, only marginally deviating from the Newtonian, whose ultra-small rosettes were consistent with the recorded astronomic observations of many decades. As has been mathematically proven by Dubois, anticipation appears to be needed in order to avoid planetary resonance driven coupling to a chaos attractor.
Since the reported evidence about the Kosyrev effect is not sufficient for decisive conclusions at present, its significance as an argument in the context of the discussed topics has to be regarded as a speculation, to be verified or falsified by future investigations, e.g. in the lines of the work of Korotaev [19, 20]. As a hypothesis, however – which may be understood, at least, as a useful analogy –, its possible role for a common basic anticipatory mechanism in the framework of a quantum-transactional absorber-type regulating system[11] might be discussed. Observed at different – macroscopic, mesoscopic, microscopic – levels of the universe, this anticipatory mechanism might be argued to provide the hyperincursive solution for tracking a circularly moving object in a similar way as it has been shown for the "ideomotor" control of the robot's arm and, maybe the synchronism of oscillatory regulation in the neuronal system.

6 Absorber-type effects in cortical synchronisation

Returning to the issue of ideomotor regulation and synchronisation in the nervous system, it should be admitted that the functional structure of stereo vision shows up some features relevant in the context of the present discussion. Anatomically, the visual nerve, transferring the optic signals into the brain, is only partially crossed over with respect to the addressing of brain hemispheres via the so-called chiasma opticum. The crossing is true only for the nasal (inner) sites, with respect to the focus of fixation of the visual field of each eye which is connected to the contra-lateral brain hemisphere. Alternatively the temporal (outer) site of the visual field of both eyes is fed into the same-sited ipsi-lateral hemisphere. In other words, from both eyes the visual signal about the right half of the visual world is transmitted first via the left lateral geniculate

[11] Note that the Kosyrev effect shows just the desired properties: Departing from the velocity of light as a transmission speed c, with a convergence on a temporal interpolation of dt= +/-0, the anticipatory spin off into the future (+ delta t) appears to be advanced by just the same amount (1,5 million light years) ahead, as the ordinary signal (- delta t) is retarded.

body (LGN) into the visual cortex of the left brain hemisphere. At the same time, vice versa, the left half of the visual world is transmitted via the right LGN into the right visual cortex. Only afterwards, the information about left-hemispheric and right-hemispheric hemi-fields' vision is re-united via contra-lateral connections through the corpus callosum (CC). That means, the contra-lateral visual signals from the opposite hemisphere are, in the absorber terminology, "retarded" with respect to one another. It is suggested here that the visual system performs a correction for this delay, sending an "advanced" copy of its own input from each hemisphere to the contra-lateral counterpart, much the same way, as it as been discussed above in the context of the coupled-oscillator problem.

There is a perceptual phenomenon in the binocular vision, the so-called Pulfrich effect [29], which may be interpreted in accordance with this idea[12]. Occluding one eye with a dark sun-glass while looking at a pendulum swinging in line with a parallel trajectory in front of the observer, the following phenomenon might be perceived. Apparently, the pendulum motion is seen to deviate from the fronto-parallel plane, describing a rotation in three dimensional depth. The effect is based on the induction of delayed retino-cortical transmission rates by the unilaterally darkened visual input. Inducing, therefore, a spatio-temporal shift between the left and the right eyes stimulus patterns, this is interpreted by the stereo vision system as a depth parallax giving rise to the three-dimensional rotary movement. Every time the pendulum crosses the fixation focus, it is turning from the left to the right brain hemisphere, or vice versa. The result is an additional retarding moment which should be anticipatively counterbalanced by an advanced signal component.

Our brain's micro architecture may be conceived in analogy to a hierarchically intertwined system of harmonic oscillators. Neuronal loops are organised into a network of so-called synfire-chains revolving with a delay of up to 500 msec, however meeting at the same neuronal cell with an accuracy of less than 1 msec. The timing of synfire chains is critically dependent on anticipatory predictions of the next input in order to adjust their output in a way which stabilises the non-linear brain dynamics. In fact, our brain's inter-hemispheric communication, as it is desired in order to account for micro timing of stereo vision – exemplified in the Pulfrich phenomenon –, might be based on an absorber-type "tuning into the future" mechanism which is comparable to the proposed one for the quantum cosmological scale. In order to get a synchronous visual flow in both left and right brain's halves, integrating the temporarily delayed information of the left and right eyes' hemi-fields which are initially processed in different hemispheres, anticipation is needed in order to close the time gap.

There is another issue to be considered here, namely, the perceptual deficiency occurring in the context of so-called amblyopia [16]. Associated, as a rule, with strabismus, amblyopia means unilateral losses in visual acuity due to deficits in central visual proc-

[12] There is, of course, a textbook standard explanation to the Pulfrich effect, stating that the visual effects stem from memory and retrieval procedures which are even additionally more retarded in time, since the underlying calculation must wait for the inter-hemispheric transfer's backward loop. However, the present explanation has the interesting for the ideomotor view feature of producing "just in time" output, the anticipated effects of which were advanced via an absorber-type mechanism.

essing rather than peripheral optical damage. As has been shown for the amblyopic cat by the research group of Singer at the Max-Planck Institute Frankfurt, this is not due to losses in the visual brain channels per se but rather to deficits in their co-operative processing. In fact, it is the coherence (synchronisation between neuronal processing at different loci) which is preserved for the good eye vs. lost for the lazy eye [18; 23; 30]. This is interesting with respect to the issue of holographic processing in the brain, as it has been proposed by Karl Pribram [28] and other authors: Coherence of the neuronal processing is just a prerequisite for the presumed holographic (or holochoric) brain states. However, standard neuroscience has decisively argued against holography as a brain process departing from the finding that the nervous system cannot guarantee for a linear transmission of the phase since it has been shown to perform in a rather non-linear way. In other words, different time courses of retarded neuronal transfer functions in different neuronal circuits were argued to destroy the required phase locking of the neuronal signals.

In contrast, it is argued from the view of the absorber theory that a transaction between advanced neuronal states might compensate for the retarded ones, resulting in a temporal zero shift of neuronal processing. The neuronal transmission circuits, accordingly, might be conceived in analogy to an arrangement of standing waves in time and space. In fact, such a transactional interpretation is incorporated in the concept of quantum holography, as it has been proposed by Marcer and Schempp [24; 26; 25] based on a neuronal mechanism of phase conjugate adaptive resonance. With respect to amblyopia this could imply, as a hypothesis, that the losses of neuronal processing coherence shown in the physiological recordings of the strabismic cat may be due to deficits in the advanced (absorber-type) component of visual processing, leading to a breakdown in the coherence of the reverberating time loops of neuronal synfire chains. Here, an absorber type behaviour of the so-called mirror neurones might be proposed as a hypothesis: departing from the assumption of an anticipatory non-locality mechanism in the nervous system [5], these units may be conceived to constitute a kind of "time-mirror" function [17]. This is nowadays, of course, a speculative assumption which needs further investigation in order to be proved.

7 Outlook

Taken together, as a hypothesis, the reported macroscopic, mesoscopic and microscopic absorber effects are suggested to provide us with an analogy between the resonant transactional control mechanisms on a cosmological, neurophysiological and quantum mechanical scale, the intrinsic nature of which is open to further research. Neuronal anticipative tuning on the level of ideomotor behaviour control, departing from the framework of a tuning alternative, is contrasted as an explanatory construct against the usual accounts being exclusively based on anticipative "on-board" cortical computations. The main difference, departing from the presented alternative view, is rooted behind the supposed content of sensory-motor learning processes: It is argued here that the learning effort is aimed at an enlargement of the absorber span of anticipative action control by self-induced re-afferences absorbed from the body's own immediate-future

locomotion state. Thus, the usual limitations of this ideomotor absorber span (of about 500 msec, as is suggested by the Libet data [22]) may be due to life-long learned habits of our hand- (or leg- reaching) everyday-life action control zone. It may be speculated that this zone can be considerably enlarged out of the range of our "hand-reaching space" by intensive training, e.g. in fast sport games as table tennis, or even in the art of tzeng-buddhist strong-bow training: From a transactional ideomotor approach, the trick is here to adjust the muscles of the arms and hands controlling the strong bow by the feed-forward of an absorber-effects coupled back from the one of a multiple of possible future states, in which the arrow has hit the centre of the target.

References

1. Aspect, A. & Grangier, P. (1986) Experiments on Einstein-Podolsky-Rosen-type correlations with pairs of visible photons. In: Penrose, R. & Isham, C.J. (eds.) Quantum concepts in space and time. Oxford: Oxford University Press
2. Cramer, J.G. (1986) The transactional interpretation of quantum physics. Reviews of Modern Physics, 58, 647-688
3. Cramer, J.G. (2001) The transactional interpretation of quantum mechanics. In D.M. Dubois (ed.) Proceedings of the Fourth International Conference on Computing Anticipatory Systems, AIP Conference Proceedings, 573, 61-76
4. Dubois, D.M. (1998) Incursive Anticipatory Control of a Chaotic Robot Arm, Computing Anticipatory Systems: CASYS - First International Conference, edited by D. M. Dubois. Published by The American Institute of Physics, AIP Conference Proceedings, 437, 406-417
5. Dubois, D.M. (2000) Non-locality Property of Neural Systems Based on Incursive Discrete Parabolic Equation. International Journal of Computing Anticipatory Systems, 7, 233-244
6. Dubois, D.M. (2004) Anticipative effect in relativistic physical systems, exemplified by the perihelion of the Mercury planet. Vigier IV Symposium, September 15th to September 19th
7. Dubois, D.M., Nibart, G. (2000) Towards a Computational Derivation of a Dual Relativity with Forward-Backward Space-Time Shifts, International Journal of Computing Anticipatory Systems, Publ. by CHAOS, vol. 5, pp. 25-37
8. Einstein A., Podolsky B., Rosen N. (1935) Can Quantum-Mechanical Description of Physical Reality be Considered Complete? Phys. Rev. v.47, p.777-780
9. Feigenbaum, M.J. (1978) Quantitative universality for a class of nonlinear Transformations. J. Statstical. Phys., 19, 25 -52
10. Gariaev, P.P., Birshtein, B.I., Iarochenko, A.I., Marcer, P.J., Tertishny, G.G., Leonova, K.A., Kaempf, U. (2001) The DNA-wave Biocomputer. In: Dubois, D.M. (ed.) CASYS – International Journal of Computing Anticipatory Systems, Liege: CHAOS ASBL, Vol. 10, 290-310
11. Gibson, J.J. (1979) The ecological approach to visual perception. N.Y.: Houghton Mifflin

12. Haggard, P. & Magno, E. (1999) Localising awareness of action with transcranial magnetic stimulation. Exp Brain Res, 127, 102–107
13. Haggard, P., Clark, S., & Kalogeras, J. (2002) Voluntary action and conscious awareness. Nature Neuroscience, 5, 382-285.
14. Hameroff, S. (1998) Funda-mentality: Is the conscious mind subtly linked to a basic level of the universe?. Trends in Cognitive Sciences 2(4):119-127
15. Hoffmann, J., Stöcker, C., & Kunde, W. (2004) Anticipatory Control of Actions. International Journal of Sport and Exercise Psychology.
16. Kämpf U, Muchamedjarow F, Seiler T. (2001) Unterstützende Amblyopiebehandlung durch Computerspiele mit Hintergrundstimulation: Eine placebokontrollierte Studie. Klinische Monatsblätter für Augenheilkunde; 218: 243 –250
17. Kämpf, U., Mascolus, W., Muchamedjarow, F., Shamshinova, A. & Kaschenko, T. (2006) Coherence induction via phase conjugate adaptive resonance coupling: computer generated sinusoidal grating patterns as a background stimulus in Amblyopia treatment. Journal of Psychophysiology, 20(2), 149
18. König P., Engel A.K., Löwel S., Singer W. (1993) Squint affects the synchronzation of oscillatory responses in cat visual cortex. Eur. J. Neurosci., 5: 501-508
19. Korotaev S.M., Serdyuk V.O. & Sorokin M.O. (2000) Effect of macroscopic nonlocality on geomagnetic and solar-ionospheric processes. Geomagn Aeron; 40: 323-330.
20. Korotaev S.M., Serdyuk V.O., Nalivayko V.I., Novysh A.V., Gaidash S.P. & Gorokhov Yu.V. (2003) Experimental estimation of macroscopic nonlocality effect in solar and geomagnetic activity. Phys Wave Phenomena; 11(1): 46-54.
21. Kosyrev, N.A., Nasonov, V.V. (1980) Properties of time found by astronomical observations. Academy of Sciences of the USSR, Problems of cosmological research, 9
22. Libet, B., Wright, E.W., Feinstein, B. & Pearl, D.K. (1979) Subjective referral of the timing for a conscious sensory experience. Brain, 102, 193-224
23. Malsburg C von der, Schneider W. (1986) A neural coctail-party processor. Biol Cybernetics, 54, 29-40
24. Marcer P., Schempp W. (1997) Model of the Neuron working by Quantum Holography, Informatica 21, 5 19-534.
25. Marcer P., Schempp W. (1997a) The Model of the Prokaryote cell as an Anticipatory System Working by Quantum Holography, Proceedings of CASYS 97, 11-15, August, HEC-Liege, Belgium, International Journal of Computing Anticipatory Systems, v.2, 307-315.
26. Marcer P., Schempp W. (1998) The brain as a conscious system, International Journal of General Systems, 27, 1/3, 231-248.
27. Pitkänen, M. (2001) Biosystems as macroscopic quantum systems. In: Dubois, D.M. (ed.) CASYS – International Journal of Computing Anticipatory Systems, Liege: CHAOS ASBL, Vol. 10, 368-383
28. Pribram K.H. (1991) Brain and Perception; Holonomy and Structure in Figural Processing, Lawrence Eribaum Associates, New Jersey.
29. Pulfrich, C. (1911) Stereoskopisches Sehen und Messen. Jena, Fischer Verlag

30. Roelfsema P.R, König P., Engel A.K., Sireteanu R., Singer W. (1994) Reduced synchronization in the visual cortex of cats with strabismic amblyopia. Eur. J. Neurosci., 6, 1645-1655
31. Stöcker, C., & Hoffmann, J., (2004) The ideomotor principle and motor sequence acquisition: tone effects facilitate movement chunking. Psychological Research, 68, 126-137
32. Wheeler, J.A. & Feynman, R.P. (1945) Interaction with the absorber as the mechanism of radiation. Rev. Mod. Phys., 17, 157-181
33. Wolf, F.A. (1989) The timing of conscious experience: A causality-violating two-valued transactional interpretation of subjective antedating and spatial-temporal projection.