# Consciousness, Subconsciousness, Theory of States of Mind and its Applications

**Alexander Ya Temkin**

**Abstract**

In this paper the general definitions of the concepts of consciousness, conscious and subconscious thinking are formulated. In the present article the central problem of the thinking that is how the thinking is governed is considered. It was established that it is governed not directly on the level of the set of thoughts, *i. e*., mind, but indirectly on the level of the metric space over the mind. This leads, in particular, to the quantum character of our logical thinking (quantum mind). Consequences of it are considered. In particular, this approach allows one to introduce and use the concept of representations like it is done in the quantum mechanics, as well as to define the mathematically based concept of the personality. This concept permits to introduce and to study symmetry properties of the personality and their influence intellectual activity of a person.

**Key Words:** conciousness, conscious, subconscious thinking, quantum mind, logical thinking

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## 1.Introduction

This is the first of three articles written mainly on the grounds of three chapters of the book (Temkin, 1999). We begin from the general definitions of consciousness, conscious and subconscious thinking.

**Definition**: Consciousness is the awareness of a person of its own thinking processes and the ability to govern them. it can be realized by the use of mind self-measurements (Temkin, 1999; ch.4).

**Definition**: *Conscious thinking is such thinking which is accompanied by measurements of thoughts arising and developping in the mind and by the transfer to thoughts information governing thinking* (Temkin, 1999; 2004).

Corresponding author: Alexander Ya Temkin
Address: Department of Physical Electronics, Faculty of Engineering, Wolfson Building, Tel-Aviv University, Ramat-Aviv, Tel-Aviv 69978, Israel
Phone: + 972 -3-9693098 (home)
e-mail: temkin@eng.tau.ac.il
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**Definition**: *Subconscious thinking is such thinking which is not accompanied by measurements of thoughts arising in the mind and by the transfer to thoughts information governing thinking*. Thus, conscious thinking on a certain subject occurs when the mind is concentrated on this subject, which means namely that it performs corresponding self-measurements, while subconscious thinking occurs in the opposite case. However, results (final or intermediate) of subconscious thinking may be detected when the mind transits to the state corresponding to its concentration on this subject of the thinking. Such a phenomenon is well known.

This definition of conscious thinking is very general and allows one to be filled with different content corresponding, for example, to different theories of consciousness. Indeed, results of measurements of thoughts must be interpreted by the mind to provide an information. This interpretation can be performed, in particular, on the grounds of the information obtained in previous experience and thinking, and stored in the memory. Taylor (1996b) writes: "The main thesis of the Relational Mind model is that *The conscious content of a mental experience is determined by the evocation and intermingling of suitable past memories evoked (sometimes unconsciously) by the input rise to the experience*". The processes mentioned in this citation can be realized by means of recall of corresponding thoughts from memories that initiates new thinking processes as result of the interaction between all thoughts (ACRs) existing in the mind, including those recalled from the memories. The "mental experience" is contained in memories, mainly those of the type $(\alpha, p)$, therefore, by this way it will be involved to the thinking. Therefore, measurings of thoughts participating in these thinking processes realize the task formulated in the abovementioned citation and in our definition of the conscious thinking.

Notice that the proposed theory naturally leads to the existence of different levels of consciousness (Temkin, 1999 § 4.7).

If two subjects of thinking are considered, then two options exist (Temkin, 1999). The first option corresponds to *two compatible subjects* of the thinking, while the second one corresponds to *two incompatible subjects* of the thinking. In the first case the mind is able to obtain information on thinking about both subjects and to govern them both, while in the second case it is possible with one of the two subjects only and therefore the mind cannot think on them simultaneously, or, at least, the simultaneous *conscious* thinking on them is impossible. Therefore the subjects can be classified into groups, each of which contains only compatible measurements. Naturally, some kinds of uncertainty and complementarity (Bohr, 1928; 1935; Lindenberg and Oppenheim, 1974) principles must exist between self-measurements of the mind, made by trial sets of thoughts relevant to different incompatible subjects. In other words, *concentration of the mind on different incompatible subjects of the thinking cannot be achieved*. An adequate mathematical formalism for the descriptions of such systems is based on an algebra of non-commuting operators acting upon elements of an abstract metric space representing states of the mind. The use of a metric space in the quantum theory of the mind is dictated by the fact that there is no grounds to use a normalized space that exists in quantum mechanics (Dirac, 1958). This formalism provides response to a very important question: how human thinking (including operations with memories) is governed? This response is as follows: the human thinking is governed *not directly* on the level of the topological space $(A^{(N)}, \mathrm{J}_N)$ (Temkin, 1999 § 3.3), *i. e., on the level of mind, but indirectly on the level of the metric space of states of the mind by probabilities of its different states* (not thoughts or sets of thoughts!). It will be considered in detail in (Temkin, 1999) and in the next Section of the present article.

## 2. How the thinking is governed

One important problem is considered in this Section: *how the thinking is governed?* It was found that the human thinking is governed *on the level of states of mind*, but not on the level of the mind itself. In other words, the thinking is governed indirectly that influences essentially its laws, e.g., the character of the logic used by human beings, if namely the logical thinking is considered. The study of human thinking naturally leads to the use for this purpose of *general ideas* of the quantum theory (Temkin, 1982; Jahn & Dunne, 1987) originated from the physics of the micro-world that however are meaningful for a much wider field of the science. Our theory is built so that at first *the mind* is defined as a set theoretical concept (Temkin, 1999; Ch.4) and thereupon, the problem of measurement of the mind means measurements of this set and its subsets. In the present paper we found that compatible and incompatible pairs of such measurements exist like it is in the quantum mechanics. Thus, *under certain conditions* the states and behavior of this set (=mind) possess such properties that demand to describe them in the *spirit* of quantum theory, though *not obligatory namely by use of exactly the same mathematical formalism as in quantum mechanics*. In other words, the proposed new theory, being not an application of the quantum mechanics itself to the human thinking, is based on the same fundamental principles as the quantum mechanics, especially all those concerned with the connection between incompatibility of different types of measurements and the structure of mathematical formalism. Notice that discussions between physicists about the validity of the Copenhagen interpretation of quantum mechanics are not concerned with this theory just because of the fact that it is not the quantum mechanics. The author's point of view is that the Copenhagen interpretation is a principally new approach opening the way to science (not only physics) progress, no matter whether it is the only possible interpretation of quantum mechanics itself.

In the work of the author (Temkin, 1982) self-measurements of thinking processes and physical, geometrical and other quantities characterizing the state of a person A were considered and compared with measurements performed by another person B on A. It was found out that these measurements create two different reciprocally complementary realities. We postpone the detailed consideration of this phenomenon to the second article of this series.

In this chapter we continue the analysis, which was begun in our work (Temkin, 1982), focusing now our attention on different *self-measurements* of the mind. In this case different incompatible realities are created by different types of mind *self-measurements* (*i.e.,* when only one person is involved), but when his thinking may be concentrated on different subjects.

Let us consider in brief some basic aspects of measurements and their role in the theory, with the purpose of understanding how to construct a theory of human thinking, taking into account the peculiarities of self-measurements of the human mind. The point of view of modern physics is that measurements and their properties play a fundamental role in physical theory (Einstein, 1905; 1953; Dirac, 1958; Bohr, 1928; Heisenberg, 1930). Nils Bohr (1933; 1937) argued that this statement is also valid in microbiology. There are arguments that it is also valid in psychology and human thinking, in general (Temkin, 1982; Snyder, 1983a; 1983b; Penrose, 1989). The fundamental role of measurement in the theory comes from the fact that measurements may change uncontrollably the state of the measured system, which leads to the impossibility of simultaneous measurements of different quantities and thereby affects directly the structure of the mathematical formalism. For example, the system of Newtonian differential equations for a system of material points was replaced by the quantum mechanical formalism of algebra of non-commuting operators in the case of atomic systems just because of the incompatibility of measurements of conjugate variables. A measurement is supposed to be performed by a system consisting of measuring instruments and an observer. The task of the observer is to interpret results of the measurements. *Without this interpretation the measurements provide no information*. However, this task of the observer is not usually considered and not analyzed explicitly in physical theories. Only the collapse of the state vector in quantum mechanics reminds us of the *existence* of the observer supposed in the quantum mechanics. But, the work of Schmidt (1982) on this subject hints that *properties* of the observer are important and should be an essential part of the physical theory (*cf.* here Sec.7).

In the relativity and quantum mechanics, in exception to the theory of the quantum Universe (Hartle & Hawking, 1983; Fukuda, 1989; 1991; Mensky, 1991; Zeh, 1986; 1988), an observer equipped with measuring instruments studies physical bodies *which can be only objects of such study* because they are not able to measure their own physical quantities and to interpret results of these measurements.

In contrast to such primitive systems, a human being is able to measure characteristics of his own state including his own thinking processes (Temkin, 1982; 1999; Chs.3-4). The concentration on a certain subject of the thinking means that the content of measuring thoughts corresponds to this subject. Under this condition the mind obtains the maximum of information on its thinking processes about the chosen subject. As it was shown (Temkin, 1999; Chs.3-4), the set of all possible self-measurements of a mind can be classified as a number of subsets (corresponding to the concentration of mind on different subjects of thinking) such that two measurements are compatible, if they both belong to the same subset, and incompatible, if they belong to two different subsets. In the latter case uncertainty principles exist between different kinds of measurements made by a person measuring his own mind. Therefore the relevant mathematical description of the human mind should be based on algebra of non-commuting operators. In other words, the theory of the human mind should be quantum in nature. However, as we shall see here in Sec. 3, it cannot be identical to the mathematical formalism of the quantum mechanics of atomic particles.

When human thinking is compared with information processing by computers, the computer seems to be a symbol of certainty, reliability, exactness and perfection as opposed to the human brain that functions imperfectly, uncertainly, unreliably and not exactly. However, when in (Temkin, 1999; Ch.4) a computer was compared with the human brain, it was unexpectedly clarified that the extremely high operation rate of computer's electronic devices (which seems to be computer's very important advantage) when compared with the operation rates of neuronal, synaptic, etc. processes of the human brain, does not lead to the computer's superiority over the brain, but, rather, to the brain superiority over the computer with regard to some important aspects of high level information processing. Could the uncertainty of our thinking also not be a shortcoming of the human brain, but its advantage over computers? In the present work we try to answer this question as well as find the origin of the uncertainty of human thinking and how it affects the theory of thinking.

## 3. Metric space of states

What is the main difference between the quantum theory of states of mind and quantum mechanics? The representation of micro-system states by elements $\psi$ of normalized spaces in quantum mechanics is based on the interpretation of the $|\psi^{*}\psi|$ as the probability density and on conservation laws of mass and charge of a particle. Such arguments do not exist in our quantum theory of states of mind, and therefore there is no reason to use normalized spaces. Hence, we shall use a metric space to represent states of the mind. In each metric space the distance $\rho(\psi_0,\psi)=\rho(\psi,\psi_0)$ between each two points $\psi_0$ and $\psi$ exists, is positive for two different points, is equal to zero, iff these points coincide, and satisfies the triangle inequality

$$\rho(\psi,\psi')\leq\rho(\psi,\psi_0)+\rho(\psi_0,\psi')$$

(Kolmogorov & Fomin, 1963; Čech, 1966). Normalized space is a particular case of metric space because in such a space the distance can be defined by use of norm. Hilbert space used in the quantum mechanics is, in its turn, a particular case of normalized spaces: in Hilbert space the scalar product of two vectors is defined, then the norm of a vector is defined as its scalar product with himself in degree 1/2. To construct the theory of states of mind the concept of probability of a state of mind must be defined as it is done in quantum mechanics for states of micro-systems. The existence of the distance $\rho$ between two states of mind allows us to define the notion of the probability of states represented by points $\psi$ of a metric space relative to a point $\psi_0$ of the same space. This probability is defined and normalized differently in the following three cases having the analogies in the quantum mechanics of atomic systems:

### 1) $\psi$ *is an isolated point of a countable set*

Then the minimum distance $R_{min}(\psi)\leq\rho(\psi_0,\psi)$, exists between the considered point and other points of this set ($\psi_0$ is a selected point of this space). The relative probability ( *i.e.,* depending on the choice of $\psi_0$) $w(\psi_0,\psi)$ of the state $\psi$ is defined by the relation:

$$w(\psi_0,\psi)=Q^{-1}R_{\min}(\psi)\rho^{-1}(\psi_0,\psi), \tag{1}$$

where $Q$ is the normalization constant. If all permissible states of the mind are isolated points of the considered countable set, $Q$ is defined by the relation $(\psi\neq\psi_0)$:

$$Q=\sum_{\psi\neq\psi_0}R_{min}(\psi)\rho^{-1}(\psi_0,\psi) \tag{2}$$

With this choice of $Q$ the probability is normalized as follows:

$$\sum_{\psi\neq\psi_0} w(\psi_0,\psi)=1 \quad (3)$$

**2)** $\psi$ ***is a point (but not an isolated one) of a countable set***

Consider the neighborhood of the point $\psi$ having the radius $R(\psi)$. It contains an infinite countable set of points $\psi'$. Let $\Gamma_R(\psi)$ be the maximum linear density of states along lines connecting $\psi_0$ and $\psi$, $F(\psi)=\lim_{R\to 0}[\Gamma_R(\psi)]^{-1}$, when $\lim_{R\to 0}[\Gamma_R(\psi)]^{-1}\geq\rho(\psi_0,\psi)$, and $F(\psi)=\rho(\psi_0,\psi)$, when $\lim_{R\to 0}[\Gamma_R(\psi)]^{-1}<\rho(\psi_0,\psi)$. Now define the relative probability of a state $\psi\neq\psi_0$ by the expression:

$$w(\psi_0,\psi)=Q^{-1}F(\psi)\rho^{-1}(\psi_0,\psi),$$

where the normalization constant $Q$ is determined as follows:

$$Q=\sum_{\psi_0\neq\psi}F(\psi)\rho^{-1}(\psi_0,\psi)+\sum_{\psi\neq\psi_0}R_{min}(\psi)\rho^{-1}1(\psi_0,\psi) \quad (5)$$

to normalize the total probability to 1, if all permissible states consist of a countable set (the second summation is done with respect to all isolated points of this set).

**3)** $\psi$ ***is a point of a continuum set***

Let $M$ be a closed measurable subset of this set and the point $\psi_0\not\in M$. Then the relative probability of the subset can be defined as follows:

$$w(\psi_0,M)=Q^{-1}q_M F(M)\rho^{-1}1(\psi_0,M), \quad (6)$$

where $\rho(\psi_0,M)\neq 0$ is the distance between point $\psi_0$ and subset $M$ (Kolmogorov & Fomin 1963),

$$F(M)=\begin{cases}\lim_{R\to 0}\Gamma_R^{-1}(M),\ if\ \lim_{R\to 0}\Gamma_R^{-1}(M)\rho^{-1}1(\psi_0,M)\leq 1\\ \rho(\psi_0,M),\ if\ \lim_{R\to 0}\Gamma_R^{-1}(M)\rho^{-1}1(\psi_0,M)>1,\end{cases}$$

$$R=\rho(M,\psi'), \quad (7)$$

$\psi'\not\in M$, but can be any point in the neighborhood of $M, q\neq 0$ for any $M$ is the measure of the subset. Thus, in the general case of the set of all possible states containing countable and continuum subsets, as well, the formula (5) must be generalized as follows:

$$Q=\sum_{M\not\ni\psi_0}Q_M F(M)\rho^{-1}1(\psi_0,M)+\sum_{\psi\neq\psi_0}F(\psi)\rho^{-1}1(\psi_0,\psi)+$$
$$+\sum_{\psi\neq\psi_0}R_{min}(\psi)\rho^{-1}1(\psi_0,\psi) \quad (8)$$

The summation with respect to subsets $M$ in (8) should be made only over a system of reciprocally non-intersecting subsets, which means that for any two subsets of this system $M'$ and $M''$ would be $M'\cap M''=\varnothing\frac{1}{2}$. The mind was defined as a certain set of "raw material" for thoughts only, without thoughts (the exact matematical explanation of what are thoughts and "raw material" for thoughts see (Temkin, 1999; Chs.1-3) ). (4) Therefore, according this definition, the mind has only one state. Let us now to change the terminology and keep the term *mind* also for the set containing the "raw material", as well as thoughts. The mind that does not contain thoughts, but only "raw material" we shall call *mind in its ground state*, while the mind containing also thoughts we shall call *mind in its excited states*. Therefore, the state of the mind, as well as $\psi$, the point of the metric space of states representing it, is function of thoughts' distribution like $\psi$-function of an electron is function of its co-ordinate or linear momentum or, better to say, as Fock's column is function of particles' configuration (Fock, 1932). The meaning of the relative probability becomes clear: $w(\psi_0,\psi)$ means the probability of such a distribution at a chosen state $\psi_0$. The three considered cases have the analogy in the quantum mechanics of atomic systems. In the quantum mechanics a countable set of states corresponds to bound states, while the continuous spectrum corresponds to an infinite motion of parts of the considered system. What could this mean in our theory? An analogue of bound states, e.g., hydrogen atom, would be stable systems of thoughts, so to say, "atoms" and "molecules" (even "polymer molecules") of thinking. To clarify whether such states exist, how they influence the thinking (e.g., the logic), to search for such states and to study them, represent an extremely interesting and attractive field of research of human thinking. Represent each observable quantity A by an operator $\hat{A}$ acting on points of the metric space of states of the mind. Notice that there is no reason to demand that operators used in the quantum theory of mind would be Hermitian ones. Their eigenvalues therefore may be complex numbers. The definition of the relative probability by formulæ (1), (4) and (6) allows us to define the observed value of the observable A as follows:

$$\bar{\rho}(\psi,\hat{A}\psi) \overset{def}{=} S_{\psi}\, w(\psi_0,\psi)\rho(\psi,\hat{A}\psi), \qquad (9)$$

where symbol $S$ is written to be concise and means the three types of summation appearing in the formula (8). The summation is supposed to be done with respect to all $\psi \neq \psi_0$.

The general expression (9) of the observed value is different from the quantum mechanical one because in quantum mechanics the Hilbert space is used, in which the scalar product exists. While the quantum theory of the mind deals with the metric space where the scalar product is not defined in the general case. The expression (9) defines the observed value of an observable as the average value of the distance to where the points of the metric space are displaced by the operator $\hat{A}$, but not the average value of the operator $\hat{A}$ itself, contrary to the quantum mechanics rule. Operators $\hat{A}_1$ and $\hat{A}_2$ commute, iff the corresponding observables are measurable simultaneously, and they do not commute in the opposite case. Despite points $\psi$ of the metric space of states of the mind depend on the thoughts as the electron wave function depends on its co-ordinates or linear momenta, as it was mentioned above, it is impossible to use points $\psi$ of this metric space to find the probability of a certain set of thoughts, contrary to the quantum mechanics of the atomic particles where the probability distribution of co-ordinates (or linear momenta) is expressed as $|\psi^*\psi|$. Only the probability of a point $\psi$ of a countable set or of a subset of continuum can be defined, *but of point or subset of the metric space itself, not of arguments of these functions, i.e., not of sets of "raw materials"*. Thus, dealing with the necessity of the *metric space* it must be remembered that the thinking is governed by relative probabilities of states of the mind, i.e.more indirectly than the behavior of an electron is governed by its wave function. The recollection of thoughts from the memory is a good demonstration how the metric space of states of the mind acts.

In (Temkin, 1999; Ch.2) two types of the memory were defined. Let us consider now how the recollection process is represented in terms of states of the mind. When the mind performs the recollection of a thought or a set of them stored in a memory, the state of the mind is changed as a result of the appearance of a new thought (or thoughts) and will be represented by a point $\psi_1$ of the metric space of states. Generally speaking, this thought (or thoughts) is not obligatory an exact copy of the memory content. Let us now repeat this recollection process using different trial sets of thoughts. Each time the act of the recollection creates a certain state $\psi_n$ of the mind. If at least one Cauchy sequence exists in the set $\{\psi_n\}$, then the recollection by use of the considered set of trial sets of thoughts is possible. If there is a number of Cauchy sequences in the set $\{\psi_n\}$ *having the same limit*, the result of the recollection would be independent of the choice of Cauchy sequence. Otherwise it would not be known whether the result of the recollection has to do with the stored thought.

## 4. Relative probabilities and thinking process; the origin of the quantum logic

If two different points $\psi_1$ and $\psi_2$ representing two different states of the mind have the equal relative probabilities $w(\psi_0,\psi_1)=w(\psi_0,\psi_2)$, how does it influence the thinking process? Let $\psi_0$ represents a state of the mind created at a certain step of the thinking process. Let one of these two states of the mind $\psi_1$ and $\psi_2$ can be created as a result of the next step, i.e. that there are two and only two possible issues of the next step of the reasoning. Both these issues are equally probable because $w(\psi_0,\psi_1)=w(\psi_0,\psi_2)$.

The states $\psi_1$ and $\psi_2$ correspond, generally speaking, to two different distributions of sets of thoughts that can be reached at the next step of the reasoning. This situation is like the one in the probabilistic quantum logic, but not exactly. As we have just seen, the thinking process development depends on relative probabilities *of states of the mind*, but not on the probabilities of sets of thoughts themselves. This is a very new situation which leads to a "subjectivisation" of the logic: different minds have, generally speaking, different pairs of the considered probabilities $w(\psi_0,\psi_1)$ and $w(\psi_0,\psi_2)$ corresponding to the distributions of possible results of the same step of the reasoning. Therefore the development of the thinking process could be different for different persons. This is a very important distinction between *statistical inferences of the quantum mind* and those usually considered in the theory of probability and quantum mechanics, where probabilities of inferences are the same for all persons. We return now to the considered example and add one more statement (or statements) that inserts an intermediate step of the reasoning creating a state $\psi_{01}$ of the mind so that from the state $\psi_0$ the mind transits to the state $\psi_{01}$, and only thereupon to one of the states $\psi_1$ and $\psi_2$. Let $w(\psi_{01},\psi_1) \neq w(\psi_{01},\psi_2)$. Then that issue will be preferable, which corresponds to the state of the mind with the largest probability relatively to $\psi_{01}$. Thus, a way must be found to make considered relative quantum probabilities of different issues at each step of the reasoning different as much as possible with the purpose to reduce the indeterminacy of the reasoning. The quantum logic was studied by Birkhoff & Neuman(1936), Bergmann (1947), Chari (1977), Heelan (1970), Orlov (1982), Roman & Rumbos (1991), but it was not clarified that it originated from the nature of the human mind. The conclusions made above remain valid also when the neighborhood of $\psi_0$ contains more than two points representing states of the mind corresponding to distributions of possible issues of the next step of the reasoning. If the set of these points possesses a symmetry, *i.e.,* they have the same probabilities relatively to $\psi_0$, it should be broken (as in the case of two points) to reduce the indeterminacy of the reasoning. Let us mention one more situation leading to uncertainty of the reasoning. It is possible that two (or more) different distributions of inferences correspond to the same state $\psi$. If this state is to be created at the next step of the reasoning, then these two (or more) inferences have the equal probabilities. To eliminate this uncertainty is possible by changing the reasoning using a new knowledge or to change the structure of the mind by learning (*cf.* Temkin, 1999; Ch. 4) so that these two (or more) distributions of inferences correspond to different $\psi$. This means, one of purposes of the development of the scientific theories and learning should be the elimination of such situations when one state of the mind corresponds to more than one distribution of inference chains.

## 5. Representations

We shall say that the *mind serving as the measuring equipment+observer is in a certain representation , if it performs self-measurings when it is concentrated upon a certain subject of the thinking*. This concept of representation is the analogy of the representations in quantum mechanics, *e.g.*, co-ordinate and linear momentum ones. The principle difference between the representations in the quantum mechanics of the micro-world and in the quantum theory of the mind is that in the first case the observer is the same for all representations, only measuring devices are different. While in the second case there are *different observers for different representations* because the change of the concentration of the mind means also the change of its state, i.e. the mind that interprets measurements made in one representation is not the same as the mind that did it being in another representation. Therefore, one cannot be sure that all the information accepted and processed by the mind in the 1st representation would be translated without changes and losses into terms of another, the 2nd representation, and would be kept by the mind being in this new state. The considered information may be lost and distorted once again at the inverse transformation $2 \to 1$, and so possibly it will not be reproduced exactly and completely after these two subsequent transformations

$1 \to 2 \to 1$. This means the product of a transformation and its inverse one, generally speaking, is not equal to the unit transformation. Therefore transformations between different representations of the mind do not form a group, at the best they may form a semi-group because not each transformation has the inverse one.

## 6. Personality

**Definition**: *The personality of an individual in a certain representation of his own mind is a subset of his metric space of states representing all possible states of his mind at a given source set* $A_S$ *when the mind is concentrated in accordance with the considered representation*. (The definition of the source set see (Temkin, 1999; Sec. 1.2)). According to the definition of relative probability, the structure of this subset determines relative probabilities of all possible states of the mind (at a chosen $\psi_0$) and therefore it determines the thinking because it is ruled by means of these probabilities. However, another person, e.g. a psychologist trying to determine the personality of the examinée principally is really able to determine something else:

**Definition**: *The personality of a person* a *from the point of view of another person* B, i.e. the personality of A in a certain representation of B, *is a subset of* B's *metric space of states* (at a certain concentration of B's mind corresponding to the chosen representation) *representing all possible states of* b's *mind created by the information provided by measurements performed by* B *on* A. The results of these measurements are input to B's mind and processed by him. Thoughts of B arising as a result of these operations create certain states of B's mind. It is clear that the thinking and behavior of A are determined more completely by his self-dicovered personality (see the first definition above), than by his personality discovered by the person B (see the second definition above), because the second one contains much less information, *e.g.*, B cannot measure A's thinking processes. Our definitions allow us to study mathematically this difference in the following way: to map A's personality found by B into that determined by A himself and to find what part of the set (A's self-discovered personality) is not covered by this map and what information on A's thinking is contained in this part, In other words, what information is lost at this mapping. The mathematical solution of this problem is very complicated and difficult, but when it will be solved, the proposed way should become a solid basis for the elaboration of adequate psychological methods of the human thinking and behavior study. Introducing a basis of the metric space (Kolmogorov & Fomin, 1963) of states, each open subset of this space can be represented as a sum of a number of basic subsets. The personality is evidently an open subset and therefore it can be represented as a sum of a number of basic subsets, which can be called *basic personalities*. Each of them is also a subset of all possible states of the mind under certain constraints, other than those used above to define the personality of an individual. Notice that it is necessary to suppose the existence of constraints because in the opposite case the subset of all possible states of the mind may coincide with the whole metric space of states. This quantum idea that the personality of an individual can be represented as a superposition of some personalities was suggested first by Pascual Jordan (1960). Pascual Jordan's idea was based on the analogy with the superposition of wave functions in quantum mechanics. Our approach is not connected with this analogy, but based on general properties of metric spaces. According to formula (5.9) observed effects are non-linear functions of $\psi$, so there is the interaction of effects arising on the grounds of different personalities of the same individual. Consider the representation when an individual is concentrated on thinking about his everyday life problems. Usually in this representation the most important effects produced by only one dominating basic personality have the largest relative probabilities. In other words, *in everyday life his psychology is determined practically by only one dominating basic personality* (*cf.* below and in our work (1982): in the case when there are two or more dominating personalities). Relative contributions of observable effects produced on the grounds of different basic personalities are determined by relative probabilities and therefore depend on the choice of $\psi_0$. Thus, one can state that to the same personality, generally speaking, corresponds a manifold of types of the thinking and behavior determined by the choice of $\psi_0$. However, it would be natural to suppose the existence of some invariance principles, as in the physics. Such a principle would establish that for the choice of $\psi_0$ within a certain distinguished sub-set $D$ of the metric space of states of the mind, sub-sets of this space exist possessing the property that $w(\psi_0,\psi)$ does not depend on $\psi$ being within one of these subsets. Thus, the existence of an invariance principle means that the personality possesses a kind of symmetry. The influence of the symmetry on the thinking was demonstrated above by the use of an example when only two equivalent points existed. This means the symmetry of the personality is an important psychological characteristic of the individual determining to a certain degree the type of his thinking and behavior, as well as other manifestations of the personality. The fact that it is defined here as a mathematical concept allows the study of it using mathematical methods. The symmetry of a human personality arises as a result of the heredity, as well as of the creation of some principles of thinking by the intellectual activity of the individual, of the religion, ideology, professional education and experience etc., which may create a distinguished subset $D$ of states of the mind. If such a subset was not created, the thinking, its logic (if logical thinking occurs) and therefore the behavior of the individual are very uncertain because $\psi_0$ can be chosen arbitrarily, no preferable choice exists. However, it must be remembered that a preferable choice of $\psi_0$ does not prohibit absolutely another choice of $\psi_0$, but only makes it not typical for the individual. For example, he may get rid of the ideology that created the set $D$, which in our terms means that he has chosen the point $\psi_0 \not\subset D$. If an individual has two or more dominating personalities, the influence of this "split of personality" on his thinking, and therefore on his behavior, depends on representation in what this situation exists. If it is the representation corresponding to his concentration on everyday life problems and tasks, his behavior may seem strange or irrelevant, so his adaptation in the society would be very difficult. He even may be (sometimes erroneously, sometimes correctly) considered mentally ill because the majority (now not all) psychiatrists consider the split of personality as a symptom of mental diseases. But if this effect exists only in a representation corresponding to the concentration, for example, on abstract mathematical problems, it can be detected only by analysis of his scientific works and his way of the scientific thinking. Perhaps the interaction of different basic personalities of a scientist may help the creation of principally new ideas because to different personalities may correspond different approaches and styles of scientific thinking. If the mind of an individual cannot be brought to a certain representation commonly existing in the human society, or if the information that his mind is able to accept and to process when it is in this representation is very poor, it does not yet mean that his personality in other representations is also damaged and his intellectual level is low. It is probable that he possesses developed personalities in some other representations, i.e. he is different from the majority of human beings, but not mentally handicapped. Individuals suffering from serious limitations of their communications with the outside world seem to be an example of such disturbances. It is known that a part of them have a rich internal world and are able to express it by drawing pictures and by some other ways. However, if to take into account that the information processing (Temkin, 1999; Ch.1) contributes to the development of human brain during the life, it is to be expected that the abovementioned limitations may limit the content and amount ofthe information that the brain of such a person processes during his life, and, therefore, its contribution to the brain development. It is especially harmful during first years of the life when the development of the brain determines the intellectual level of the adult human being. Possibly the percent of babies born with such disturbances, but *potentially able to develop their intellect up to the normal (or close to the normal) level*, is essentially higher than among children of the kindergarten age. Perhaps, education programs (from the zero age, if possible) based on the principle of the intensification as much as possible of the information processing by the brain (in unharmed representations) can prevent the brain underdevelopment of such persons, e.g., autistic.

## 7. Symmetry of physicist's personality and symmetry in physical theories

The connection between the human mind and laws of physics was discussed in the book of Penrose (1989). We shall discuss here an aspect of it based on symmetry properties of the human personality. As it was explained above, the symmetry of a person's personality directly influences the structure of the quantum logic and therefore his reasoning ways. Therefore, it would be very natural to expect that the symmetry of a physicist's personality influences the structure of physical theories elaborated by him. It would be very interesting to explore whether a connection exists between symmetry properties of elementary particles appearing in physical theories, and the symmetry of the common professional personality of modern theoretical physicists, i.e. to check whether homomorphisms exist between symmetry groups (or semi-groups) of this common personality and those of the theory of elementary particles. It would be interesting to clarify whether symmetry properties of this common professional personality exist *only* in the representation corresponding to the scientist's concentration on his research or also in other representations and these properties are not lost completely in transformations from one representation to another. In other words: the scientist's profession does or does not influence, for example, his thinking and behavior in everyday life? To study this problem and other ones connected with transformations of the mind from one representation to another, it would be desirable to develop projection operator formalism in the framework of our theory. This is a task of future researches. However, at the present time a psychological study of this problem would be interesting and useful. Symmetry properties of the observer's personality may be important for the study of observer reactions upon the observed considered by Schmidt (1982) and Costa de Beauregard (1980). For example, it can be expected that the interaction of the mind with the wave function of a particle depends on the symmetry properties of this wave function and those of the observer's personality. Thus, it can be expected that the psychokinetic effect as produced, according to Schmidt (1982), by the observation provoking the collapse of the particle wave function, should depend on symmetry properties of the observer's personality and particle wave function. On the other hand, there is no reason to expect its dependence on the symmetry properties of the particle wave function, if no connection exists between them and symmetry properties of the observer's personality. Therefore, the existence of this connection can be checked experimentally, if we study this effect for scalar, spinor, vector a.o. particles possessing various types of the symmetry. If the obtained results are different for various types of particles, it would be a serious argument in favor of the existence of a connection between symmetry properties of the particle wave function and those of the observer's personality.

## 8. Conclusions

This article is dedicated, first of all, to the clarification how our thinking is governed. Without knowledge of this all possible theories of the human thinking hangs posed in mid air. Unexpectedly the consideration of mind self-measurings has led us to the answer to this question. The development of the approach of our work (Temkin, 1982) in combination with results of (Temkin, 1999; Chs.1-4) allowed us to conclude that the mind is a system described by an algebra of non-commuting operators acting upon its states representing by points $\psi$ of the metric space of states. Then the incompatibility of self-measurements corresponding to concentration of the thinking on different subjects (its microscopic mechanism was found in Chs. 3-4 means the existence of uncertainty principles that leads to the conclusion that the mind behavior should be described by an algebra of non-commuting operators acting on points of a metric space representing states of the mind. In this space the notion of the probability of a state relative to another one was defined. Thinking, as information processing occurs on the level of mind, i.e., on the level of the set $A^{(N)}_{M^{(N)}}$. However, it is not governed directly on the same level, but only indirectly on the level of the metric space of states of this mind by means of relative probabilities. It leads, in particular, to a kind of quantum logic as the logic inherent in the human reasoning, when logical thinking is considered. Notice once again that *the proposed theory considers all kinds of thinking*, no matter whether it is logical or not, meaningful or not *etc*. The formalism developed in this work allowed us to define the concept of the personality as a certain subset of the metric space of states of the mind. It opens the way to study the personality by mathematical methods, e.g., by the study of its symmetry properties influencing essentially the logic of the thinking, as it was demonstrated in Sec. 4. The conclusion concerning the possible connection between the structure of the physicist's personality and the structure of physical theory possibly indicates the way how the observer can be included explicitly to future physical theories.

Some conclusions made in the present work on the grounds of the proposed formalism hint of possible applications of this theory to the psychology, medicine and creative, e.g., scientific, thinking. On the other hand, the general character of the proposed formalism may lead to its applications to objects other than the human mind, which also are able to perform self-measurements. For example, according to Mensky (1991), Halliwell (1989) and Zeh (1986; 1988) the Universe is able to measure itself, if it is considered as a quantum system (see, for example, Hartle & Hawking, 1983; Fukuda, 1989; 1991). It is possible that because of this some mathematical definitions, considerations and conclusions made in (Temkin, 1999; Chs.1-5) are also valid for the quantum Universe. If it is correct, it would be interesting to check about the possible existence of the thinking on the same grounds on the Universe scale and the possible existence of communication between the Universe and the human mind on the grounds of different level thinkings' interaction (Temkin, 1999; Chs.3-4). *Maybe the Mach's principle, but more sophisticated than in mechanics, exists also for the human thinking*? (Temkin, 2003). The following mechanisms of this communication are possible:

1) the information processing by ACRs, if it indeed occurs in the quantum Universe, may influence the human thinking by the telepathy because the consideration of telepathy between two minds made in our work (Temkin, 1982) remains valid for the Universe - mind system,

2) modulation of gravitation and electromagnetic fields by stars' motion, explosions cosmic processes may create thoughts in the Universe, which influence cells of brain initiating new thoughts creation in the brain as follows from our interpretation (Temkin, 1999; Sec.4.4) of Libet effect (Libet *et al*., 1979; Libet, 1985). Of course, this hypothesis needs to be checked theoretically and maybe experimentally. It seems the astrology at least hints that such influence exists. Then the very rich collection of facts accumulated during thousands of years of astrology existence can help to check this hypothesis. The author is not specialist in astrology, and can say only that without the considered connection astrology would be nonsense because the information processing by the Universe and its connection with human thinking on the Earth are necessary to make possible the influence of the occurring in the Universe on Earth's events. Thus, if the proposed hypothesis be confirmed, it may, in particular, serve as the starting point of a scientific approach to the astrology. On the other hand, it could extend the synergetic character of thinking to the Universe's scale that opens the way for information transfer from micro-world to the Universe and *vice versa* as described in (Temkin, 1999; Ch.4) for subcellular level information transfer to the brain and *vice versa*.

Possibly in the proposed theory of the mind, principles of extremum exist on the level of the metric space of states of the mind (like in quantum mechanics on the level of the Hilbert space). If it is discovered that they really exist, it would be interesting to clarify whether *emotions* represent simply the expression in psychological terms of the mathematical events that are deviations from an extremum. In particular, a deviation from an extremum may correspond to such a state of the mind that we customarily call feelings of anxiety, dissatisfaction etc., while the achievement of an extremum brings the mind to a state of contentment and calmness. This is an interesting matter for future researches. It would be interesting to check whether the process of the achievement of a certain aim is guided by a principle of extremum. The experimental checking is possible, for example, by study of corresponding processes in vision.

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