VUIRTUAL REALITY AND CREATIVE GAMES: CEREBRAL ASYMMETRY AND FUZZY CATEGORIES

PART II

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2. Formal Interpretation of the VR-Problem for the Creative Games

The realization of the creative games in the VR-problem demands the formal interpretation of the different types of knowledge. Necessary formal interpretation of the different types of data and knowledge needs the different procedures of processing (analytical-calculation, logical-combinatory and Gestalt processing). In the working of the VR-systems the following methodology principles are used: the functionalism, the structuralism, the parallelism, the dualism, the multilayerness, the multiconnectionness, the neurocomputing [1].

The multiconnectionness in neurocognitology problems is characterized by three aspects:

-multiconnectionness of the input pattern's elements (for example, identification of genetic structures [14]). The whole estimation of the multiconnectionness is the function of the RH;

-multiconnectionness of the intercommunications of cerebral hemispheres (these intercommunications ensure the dual procedures of "P-U-F");

-multiconnectionness of cerebral structures determines the effectiveness of cerebral mechanisms (speed of increase of dendrite trees [15]) and specifics of interpretation or formation of knowledge (model of heterogeneous tissue "Chorus" [16]; non-standart topologies of neural field [17]).

The multiconnectionness and dualism are determined by the mechanisms of cerebral asymmetry [1].

The "LH-strategy" is realized by means of the qualitative scales, production rules and the logico-combinatory and the probability-calculation procedures.

The "RH-strategy" of formalization is based on the plurality of interconnections of the multisignificant images (e. g. the specifics of interconnections of the characteristic elements of an input pattern) [1, 9]. The "RH-strategy" is realized by "the whole scope of a multisignificant image" [1]. The formation of the "RH-strategy" of the Gestalt understanding may be realized in "the Space of estimation of multiconnectionness" (SEM), indicated by Z, by means of the global estimation of the image and the graph of estimations (GE) [9].

Let D is the estimation characteristics of the element (knots), L is the interconnections of the elements (arcs). Then the structure of estimations and complexity of the input pattern by graph G=[D(q), L(q)] is determined. The same parametrs of the image (the "invariants") in SEM (complexity Zc, asymmetryZa, harmony Zh) are characterized by means of such graph. Zc and Za are determined by means of the functions Z=f(Nd), where Nd is a number of knots. The estimations Zc and Za are realized by means of the qualitative scales {q}: Zc$\longrightarrow$Yc and Za$\longrightarrow$Ya. Zh is defined by the following features: the interconnections between the characteristic elements ("golden section") Z_1h, the position in the space Z_2h, the connection between the object and background Z_3h, the connection between the indications of the elements ("the colour of the eye and the colour of the hair") Z_4h. These features have the qualitative estimations $\{C_\psi\}: Z_\psi h \longrightarrow Y_\psi h$, ($\psi = 1, \ldots, 4$) and can be formalized [9].

The whole harmony Zh is determined by means of the special ("harmonical") connections of the estimated values of these features $Yh=(Y_1h, Y_2h, Y_3h, Y_4h)$, where Y is the value of the estimate of the feature on the qualitative scale, and Yh is the value which provides harmony. Such connections are individual for each problem and each subject.

The estimation of the parametrs Zc, Za, Zh on the qualitative scales is realized by parallel calculations. Such scales form the SEM. The estimation of the correspondence is realized by the membership surface
Yg, M(Yg)=Π(Yc, Ya, Yh).

The system of the multielementness scales {Ca, Cc, Ch, Cп} is realized by means of the multilayeral neural networks. On the first neural layer the features of characteristical parametrs (for example, Zh) are estimated. On the second neural layer the characteristical parametrs (the complexity, asymmetry, harmony) are estimated. On the third neural layer the global estimation of the concrete image is realized. This approach is used for interpretation of the Gestalts (understanding of the pictures, music play, speech) and comparative estimations of the different images.

The problem of the emergent behavior are characterized by three aspects [17]: the emergent symbolic reasoning; the rules of learning; the global dynamical properties. The emergent symbolic reasonings are

presented by means of the hierarchy multilayer structures in which every layer is determined by the concrete type of strategy. For example, [18]:

the first layer (l=1) - "IF Object - Is - Moving THEN Object - Is - Food";

the second layer (l=2) - "IF Object - Is - Alive THEN Object - Is - Food";

the third layer (l=3) - "IF Object - Is - On - Plate AND Object - Is - Leaf THEN Object - Is - Food". On every layer the new indications and features and the structures of rules are used.

The formation of the emergent symbolic reasonings for every layer is characterized by both problems: the principles of choosing of corresponding indications and features; the principles of formation of production's rules with fuzzy elements [19]:

"IF Object - Is - Fast - Moving AND Object - Is - Alive AND Object - Has - Suitable - Smell THEN Object - Is - Food".

The using of emergent reasonings is special effectivity for the creative games in which the objects and their features are springing and disappearing ("weights" of sensorical channels).

The formation of the types strategy is determined by both: the degree of the gravity of situation and the degree of the gravity of the user's state, it specifics. The gravity of situation is determined by means of the qualitative estimations of states of environment and so-communicants. These states are presented in the input pattern. The user's specifics determines the preferable sensorical channel and the method of knowledge processing. Then on every layer of the hierarchy structure the concrete types of strategy (for example, "the radical" or "the conservatory" of different degree of the regidness [12]) are formed.

The strategy is presented by

$$U_0 (X, Q) \in \{[Ur^{\xi} (X, Q)]_l , [Uc^{\xi} (X, Q)_l \},$$

where: U_0 is the concrete strategy,
X are the set of world's states,
Q are the set of criteries,
Ur is the "radical type" of strategy,
Uc is the "conservatory type" of strategy,
ξ is the degree of regidness (or softness) of strategy,
l is the layer of hierarchy.

The production rule for strategy U_{0l} on the l-layer is presented by

$$\text{IF } \underset{N_l}{\forall} [\text{Object - Is - } Y_i^j] \text{ THEN } [\text{Object - Is - } Y_i]_l ,$$

where: Y_i^j is the set of estimations of object's features,
$j=1, \ldots, m$ is the feature of the i object,
N_l is the number elements in the production rule,

$\forall$ is the operator.

The set of objects, their features, their estimations and structures of rules in the Knowledge Base are keeped. The learning in the Knowledge Base must be realized with using of these specifics. Similar way is used for realized the "Left hemisphere procedures" (LHP) which include the logical-combinatory and probability-analytical procedures.

The "Right hemisphere procedures" (RHP) form the whole estimation of the Gestalt and the RHP are realized by means of the neurocomputing's methods. These methods allow to use the multilayer structures in which on every layer work the concrete computational procedure. One from these procedure is based on the heteregeneous tissue with the multiconnection structure ("Chorus"). The different algorithmical procedures are realized by means of the

$$U = U \{ Y_r, Y_\phi, \Delta_t Y, T \}$$

where: Y_r is the estimated geometrical state,
Y_ϕ is the estimated physical features,
$\Delta_t Y$ is the estimations of structure's features,
T is the global titue of functioning.

The problem of determination of the behavioral strategy in the VR-system on base the polysensorical input pattern and with using the dual procedure and also the emergent reasonings, learning and dynamical properties may be presents by the following way:

$$\text{Let: } E = \{ \underset{v}{\square} [O_i (X_i(t), f(t, X_i(t)))] v \}$$

where: X_i is element of the pattern,
$X_i=(X_i^1, \ldots, X_i^m)$, $i=(1, \ldots, n)$,
$j=(1, \ldots, m)$, m is the dimensionness of the state's space,
$f(\ )$ is the function of structure,
$\square$, O are the operators,
$v=1, \ldots, N_V$ is the number of sensory channel,
$\{U_\alpha\}$ is the set of strategies,
$\alpha=(1, \ldots, N_\alpha)$,
N_α is the number of the degrees of freedom in the realizational space.

Need to determine the strategy $U^* \in \{U\}$ which provide both: the dual (LHP and RHP) and outcome of the emergent principlies for dynamical processing of the pattern

$$U_{ep} = U ([U_{lhp}]^l, [U_{rhp}]^l / \beta_v, E_{inp}, X, Y, \{C\}, Q).$$

Then : the reaction on the input pattern is

$$R (E_{inp}) = \mathcal{F} \{ [Y_{oi} / (Y_i^1, \ldots, Y_i^m)], [Yg, M(Yg)] \},$$

where: $\mathcal{F}$ is the operator of reaction.

The concrete strategy is formed on base of the estimation of situation's degree of gravity and the specifics of human's "interior vision" of the situation (which are contained in the Knowledge Base).

Examples of the Local Procedures

Example-1. Dynamic Performance "Elephant-Cupboard"

The input pattern is presented by

$$Einp = \{ \underset{i}{O} [Xi (t), f (Xi (t))] \},$$

where: Xi is the element of input pattern (i=1, . . . , n);
f( ) is the function of structure;
O is the operator;
t is the time.

The estimation of elements Yi are realized by means of the multielemental qualitative scales Ci: Xi--->Yi. X_1 is the countur; X_2, X_3 are the foods; X_4, X_5 are the ears; X_6, X_7 are the eyes; X_8 is the trank; X_9 is the tail.

The estimations of element's states are realized on base of the feature's scales {Cij}: Xij⇒Yij; (j=1, . . . , m); where $Cij=(Ti_1, \ldots, Tid)$ - is the linguistical term-set. The elements of the term-set are classified by the two types: the memorable words (beautiful [eyea], sharp [corner], complexity [fracery], red [spot]) which in the RH are formed; the certain words which verify signs as the modificatirs (very, not very), quantificators (often, many). The state of (i) - element on the (k) stage (k=1, . . . , 8) is

$$[Y_i(k)]_e = \{ [Y_{i1}(k)]_e, \ldots, [Y_{ij}(k)]_e, \ldots, [Y_{im}(k)]_e \}.$$

The dynamics of changing of the element's estimations Y(k) for performance the "Elephant-Cupboard" on Fig-1 is presented. Such approach is used for performance the "Cupboard-Elephant". X_1 is the countur; X_2, X_3 are the foods; X_4, X_5 are the doors; X_6, X_7 are the ornament; X_8 is the central partition. Then

$$[Y_i(k)]_c = \{ [Y_{i1}(k)]_c, \ldots, [Y_{ij}(k)]_c, \ldots, [Y_{im}(k)]_c \}$$

(see Fig-1). The certain estimation of the image on the stage (k) [Y(k)]e/c is determined by the production rules:

$$\text{If } [Y1(k)], \ldots, [Yn(k)] \text{ Then } [Y_0(k)]_{e/c}.$$

This is the logical-combinatory procedure of the qualitative estimation (the LHP).

The RHP is realized by means of the whole estimation of the Gestalt on every (k) stage (or moment of time "t"). The estimated states of the elements on the moment of time (t) $\{Y_1(t), \ldots, Yn(t)\}=Yg(t)$ is determined on the base of the parallel estimation of the invariants and the corresponding membership surface $\Pi\ \{Y_1, \ldots, Yr\}=Yg$, M(Yg); where M() is the membership function. The invariants for the Gestalt's estimation are: Z_1 - the degree of complexity, Z_2 - the degree of asymmetry, Z_3 - the degree of harmony. The states of the invariants are estimated by means of the set of the qualitative scales {Cr}: Zr⟶Yr; (r=c, a, h). The estimation of the Gestalt's state is Yg(t)={Yc, Ya, Yh}, (ESG).

But the global estimation of the image (GEI) in the "living systems" is realized by means of the unconscious activity (the RHP), which form the estimations of the image on base of the "Interior etalons" (presentations of the imagery memory and associations, learning and genetic experience). The differentiation between ESG and GEI is determined by means of the operator Yg(k) <> Ye/c(k), where <> are signs: the full similar, partial similar, likeness.

The concrete sign of operator characterized (/) the cognitive specifics of the Human, its cerebral mechanism's specifics (dominant hemisphere) and the complexity of environment (for example, uncomplete of data, availability of disturbances-textures, etc). These experiences are suitable for the formation of the LH and RH computer procedures and are basis for the development of the personal creative activity.

Example-2. Interpretation of the Face's Expression [1].

The expression of face is characterized by the twenty six elements [20], but for our task is sufficiently the following: X_1, X_2 are the ears; X_3, X_4 are the eyes; X_5 is the nose; X_6 is the mouth; X_7, X_8 are the wrinkles; X_9 is the hair (i=1, . . . , 9). The state of each of these elements is determined by the regulated aggregate of the their qualitative characteristics ("the term-set") - the qualitative scale $\{C_i\}=(C_i, \ldots, C_\lambda)$. The concrete expression of face is determined by means of the set signs on these scales Ci: Xi⟶Yi and their combinations. This is the Gestalt which correspond with the concrete mood of the Human. The simplest aggregate of the psychology state and moonds is presented by Duvale [21] (Fig-2a). The graph of estimations G=[D, L] is formed on the base of the estimated features of the face. The state of the Gestalt is determined by the estimations of the invariants (Z_1 is the degree of complexity, Z_2 is the degree of asymmetry, Z_3 is the degree of harmony) Cr: Zr⟶Yr in the space of the estimated multiconnectionness (SEM). The degree of membership of the concrete human's state to the "Expression of Image" is determined by means of the membership surface Yei, $M(Yei)=\Pi\{Yc, Ya, Yh\}$ (on the estimated characteristics of elements) (see Fig-2b). Similar conformity allow to determine the human's state (for

example, by children's) and form the base of knowledge for the development the creative activity.

Example-3. Applications of the Emergent Strategy

The dynamical process "The Dog catch of the three Hares" [12]. The dog Fo and hares Fi (i=1, 2, 3) may be to move only on the strip by the "left-right" (see Fig-3). The simple strategy is determined by the initial conditions

$$U = U [X_0(t_0), Xi(t_i)],$$

but in the dynamical processes are used the another strategies

$$U = U [(X_0(t_0), Xi(t_0)), (X_0(t_k), (Xi(t_k))] \text{ and}$$
$$U = U [(X_0(t_0), Xi(t_0)), (X_0(t_k), (Xi(t_k)), Wi],$$

where: X(t) is the speed of the object,
Wi is the effectiveness of the object
(for example, the degree of "richness of hare", the qualitative of flesh, "the qualitative of wool" etc).

The parametrs Xi, Xi and Wi are estimated by means of the qualitative scales Ci_1: $(X_0 - Xi) \Longrightarrow Yi$; Ci_2: $(X_0 - Xi) \Longrightarrow Yi$; Ci_3: $Wi \Longrightarrow Yi$ (i=1, . . . , 3; j=1, . . . , m).

The 6 types of local strategies are used:

u_I is "to catch of the first hare, second hare, third hare";

u_{II} is "to catch of the first hare, third hare, second hare";

. . . . . .

u_{VI} is "to catch of the third hare, second hare, first hare".

The rules of production are formed correspondely

[IF (Y AND Y) Y THEN $u_I = R_I$,

[IF (Y AND Y) Y THEN $u_{II} = R_{II}$,

. . . . . .

[IF (Y AND Y) Y THEN $u_{VI} = R_{VI}$.

The local strategies and rules of production are be complexed, if are be complexed the conditions of the environment or states of objects: big variation of parametrs (speed of object 2), the new feature (object 3 is very well), new information on environment (weather). Every layer of structure is characterized by concrete type of production rules. Then the new types of emergent strategies and the new rules production are formed:

u is "to catch "stop" the objects first and three and to catch the object second",

[IF (Y AND Y AND Y AND Y) THEN u = R].

The estimation scales, principles of formation of the production's rules and the new types of strategies and presentation of the new types of input information in the knowledge base are contained.

Different approaches to the same task by each student present their personal attitude to the objects and events and various ways of understanding and interpretation of the situations basing on their life

experience, traditional background and amotional characteristics, that makes it possible to identify the personal statute of everyone.

Method of the virtual reality and the very process of creative are an appropriate for curing the stress states, relaxation, immersion into "another reality".

The transformational tasks develop the creative abilities of an individual finding for himself a comfortable environment, and let us to expose personal characterics of perception, understanding and producing of multisignificant imagery knowledge, reaction speed and the logic of thinking.

The examples mentioned were drawn or painted by the students using the traditional art materials, but now the software is being processed, so these tasks could be done on the screen.

The computer realization of the tasks mentioned above, based on the methodology of the virtual reality, makes it possible to increase the cognitive and creative abilities of the students/users.

Conclusion

The paper contains the methodology problems and the formal presentations of the formation of the creative games which are based on the specifics of the mechanisms of the cerebral asymmetry, the dual procedures of neurocomputing, the wide abilities of the fuzzy categories for these tasks and the emergent strategy's principles. This approach allows (with consideration of the necessery technical meanses) essential widen the creative possibilities of the User.

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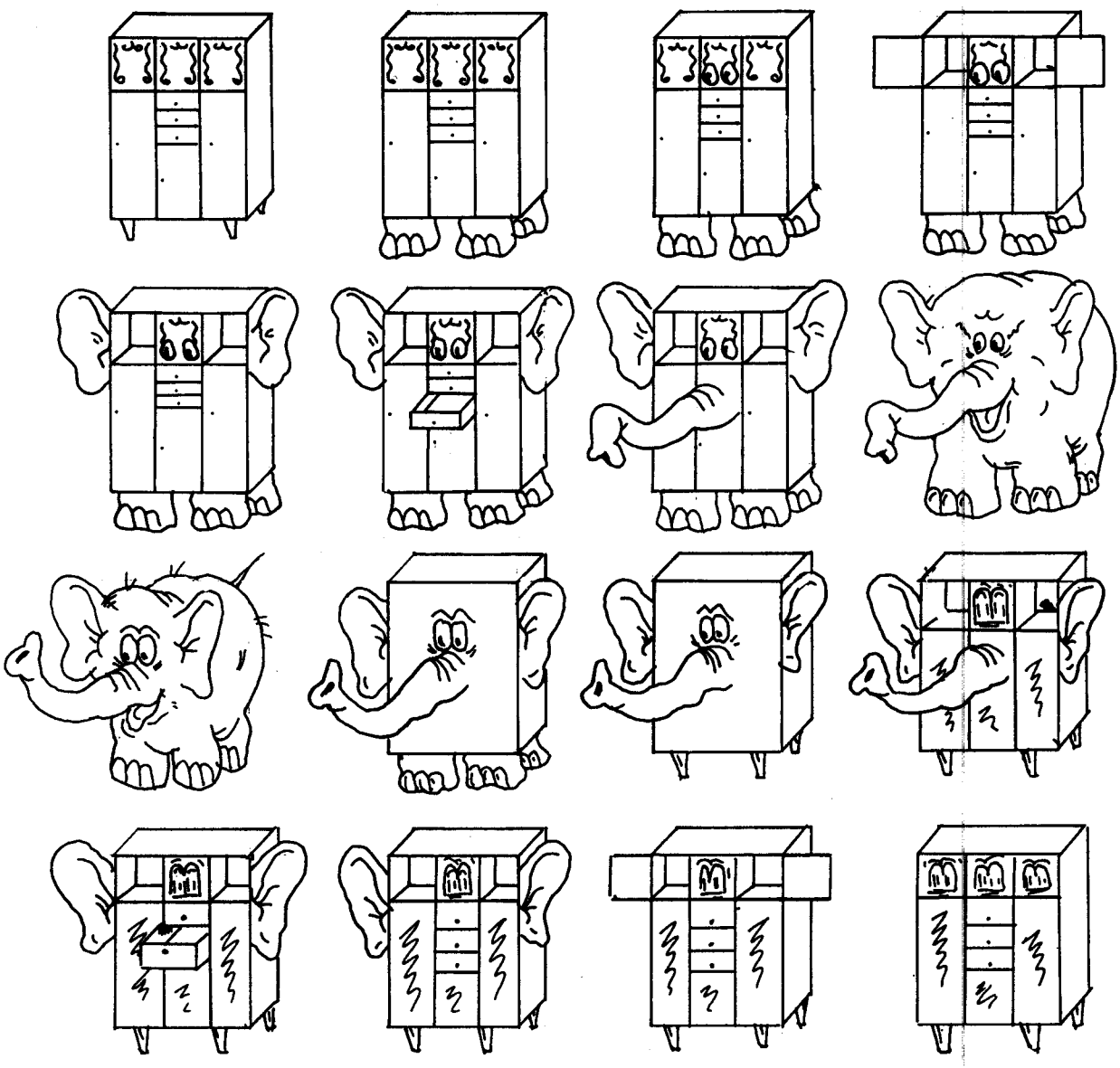

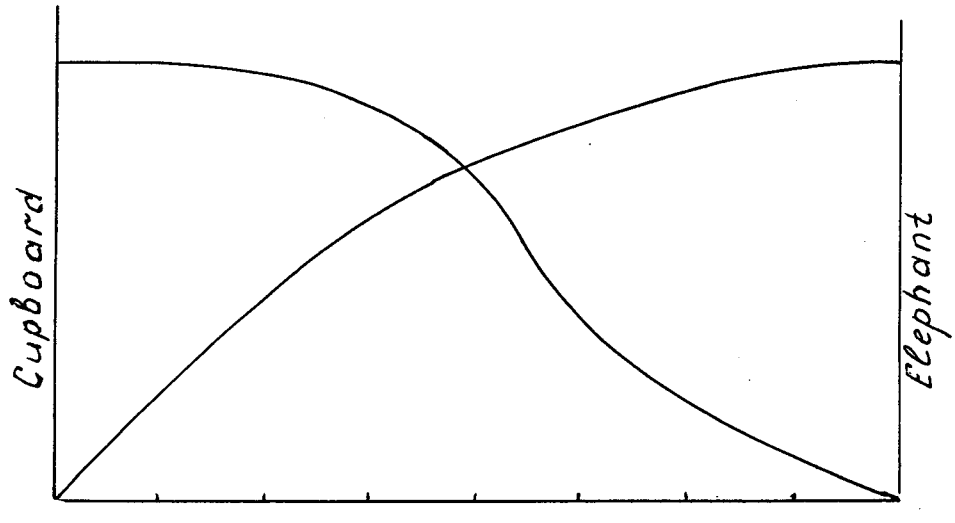

Fig-1. a) Transformations Elephant-Cupboard and Cupboard-Elechant
b) Functions of membership.

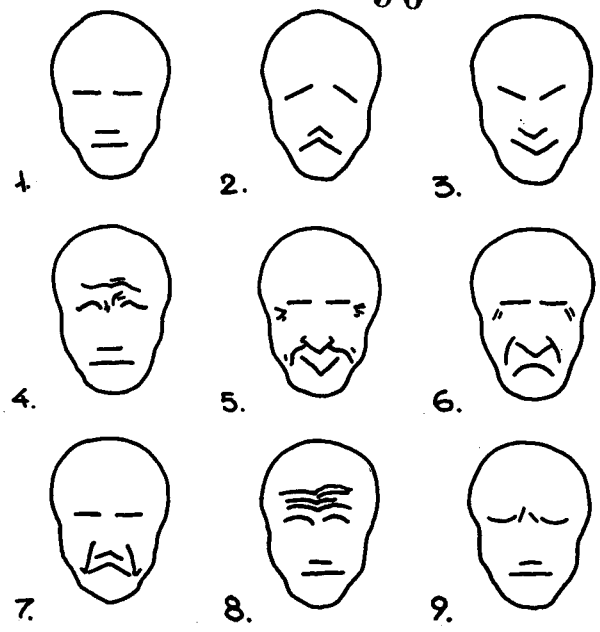

Fig-2a. Structures of "the face's muscles - different states of Human" (on M. Duvale]: 1 - serenity, 2 - sadness, 3 - joy, 4 - pain, 5 - laughter, 6 - weeping, 7 - contempt, 8 - attention, 9 - meditation.

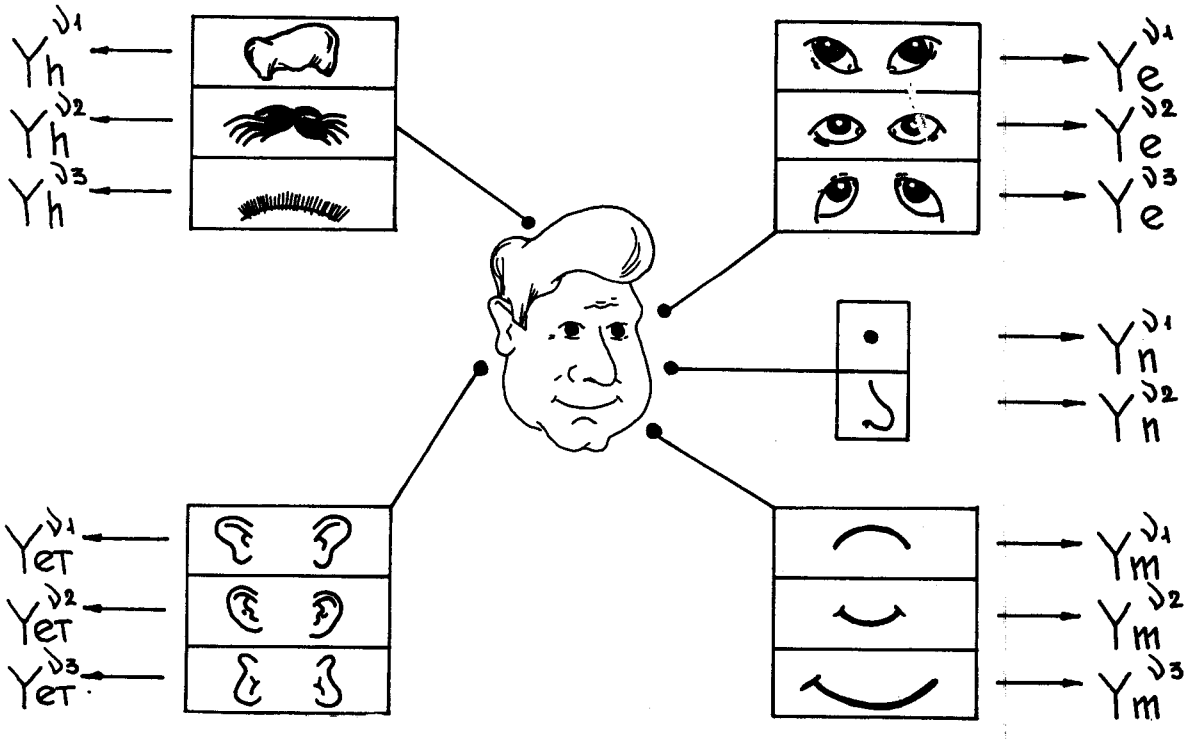

Fig-2b.Example of face's estimation on the qualitative estimation basis.

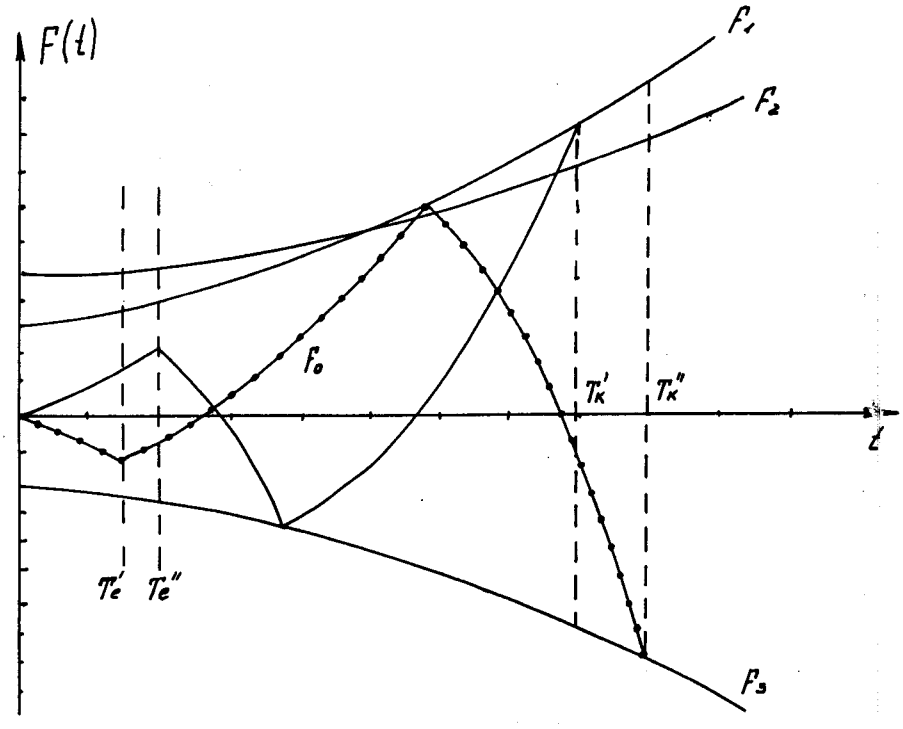

Fig-3. The emergent dynamic process

T_e' , T_e'' - the moments of presentation at the new (emergent) knowledge;

——— - the processes of objects F_1, F_2, F_3;

—•—•— - the processes of object F_0.