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ПРОБЛЕМЫ ОБЩЕНИЯ И ВОСПРИЯТИЯ

PROBLEMS OF COMMUNICATION AND PERCEPTION

Труды по психологии VII

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ON THE ORIGINS OF THEORETIC SYLLOGISTIC REASONING IN CULTURE AND IN THE CHILD

Peeter Tulviste

Abstract. It was hypothesized that theoretic syllogistic reasoning (as described in an earlier paper) first appears in the previously traditional cultures and in the child in the sphere of scientific or school knowledge, where it is functionally necessary in problem solving, and that only later on it may be applied also in the everyday sphere, where such functional necessity does not seem to exist. Results of an experimental study are presented, where syllogistic tasks with school and with everyday content were given to Nganassan children (Taimir). The results indicate that the "transitional" group of children (Ss who explained theoretically some of their conclusions, but not all) gave significantly more theoretic explanations for conclusions from "school" premises than for those from "everyday" premises. It is argued that theoretic syllogistic reasoning seems to be absent among traditional subjects. The data provided by other investigators that are contrary to this point of view can possibly be explained, firstly, through an outside-school impact of modern scientific knowledge on the supposedly traditional subjects; secondly , through the fact that the method used to differentiate empiric and theoretic explanations seems to be unsufficient in some specific cases. Some problems concerning the cross-cultural differences in syllogistic reasoning are briefly discussed within the general framework presented in detail in the author's previous papers.

1. Introduction and problem

In cross-cultural studies of verbal syllogistic reasoning, considerable differences have been revealed between the experimental results of traditional and advanced (i.e. , schooled and/or occupied in modern economic activities) subjects (Luria,1976, 100-116; Cole et al., 1971,184-195; Cole, Scribner, 1974,160-168; Scribner,1975; Scribner,1976; Cole et

al.,1976; Sharp et al., in press). Traditional subjects solve the problems correctly at a chance solution rate only; they refuse to make inferences from premises of an unfamiliar content; they usually explain or justify their conclusions by what Scribner calls "empiric" statements, i.e., instead of relating the conclusion to the problem premises, as the educated subjects generally do, they relate it to what they know or believe to be true according to their personal knowledge and convictions, and sometimes they ask the experimenter for more information about the factual content of the problem. This is well documented in the following protocol from a Kpelle tribal leader in Liberia (Cole, Scribner , 1974, 162):

Experimenter: At one time spider went to a feast.He was told to answer this question before he could eat any of the food. The question is: Spider and black deer always eat together. Spider is eating. Is black deer eating?

Subject: Were they in the bush?

Experimenter: Yes.

Subject: Were they eating together?

Experimenter: Spider and black deer always eat together. Spider is eating. Is black deer eating?

Subject: But I was not there. How can I answer such a question?

Experimenter: Can't you answer it? Even if you were not there, you can answer it. (Repeats the question).

Subject: Oh,oh, black deer is eating.

Experimenter: What is your reason for saying that black deer was eating?

Subject: The reason is that black deer always walks about all day eating leaves in the bush.Then he rests for a while and gets up again to eat.

This kind of reasoning is typical for all traditional groups where research with verbal syllogistic tasks has been conducted."Certain qualitative aspects of performance are so similar that it is often difficult to distinguish the translated interview protocol of a Uzbekistanian from that of a Vai - cultural and geographical distance notwithstanding "

(Scribner,1976). Two or three years of schooling produce a radical change in experimental results everywhere. Schooled subjects usually draw inferences from premises of any content, familiar or unfamiliar, and give "theoretic" explanations, i.e., they relate their conclusion to the problem premises, not to their common knowledge or beliefs.Scribner stresses that theoretic explanations practically always coexist with correct answers. (Empiric explanations can coexist with both right and wrong answers.)

How are these differences to be explained? Why and how does schooling influence syllogistic reasoning? Why do schooled subjects draw inferences from any premises, and why do they usually give theoretic explanations? Does schooling only improve syllogistic reasoning, or does it change qualitatively the process of drawing inferences? An examination of the explanations offered by various authors shows that no clear answers to these questions exist.

Luria (1976) connects the differences between the results of traditional and advanced subjects with the transition from practical to theoretical activities and from practical to theoretical thinking in the course of social and cultural change. But we must admit that there are theoretical activities in traditional cultures,too. So may-be we should explain the differences in experimental results through differences between traditional and modern theoretical activities and try to find out the functions of syllogistic reasoning in both of them. The experimental data indicate that the traditional kinds of theoretical activities seem to make people relate their conclusions to what they know or believe to be true, and they seem not to demand making inferences from unfamiliar premises. Why and how do modern kinds of theoretical activities make people relate their conclusions to the task premises, instead, and what may be the function of drawing inferences from unfamiliar premises?

Cole and Scribner (1974,168) don't answer the question of why the describer switchover occurs. Scribner (1976) finds in the classroom some kinds of problems - e.g.,verbal arithmetic problems, - where an empiric approach will not earn a

passing grade."Fields that use technical notational systems may be considered to present "arbitrary problems" in the sense that the problems derive from a system outside the learner's own personal experience and must be taken in their own terms." She also stresses that in future research it should be discovered, what activities outside of school,and especially what activities in traditional cultures might give rise to the "logical genre", as she puts it.

It should be stressed that none of the investigators holds the view that schooling only improves quantitatively a skill of syllogistic reasoning previously present in the subjects (although the contrary position - that qualitative changes in syllogistic resoning occur - is neither explicitly presented by the authors listed). If we would turn our attention only to the conclusions drawn by the subjects across all the tasks used in these studies, such a conclusion would seem reasonable. Indeed, schooled subjects give correct answers just more frequently than the traditional ones, and this difference can be regarded a purely quantitative one. There seem to be two findings that do not permit to consider this explanation sufficient. Firstly,Luria's traditional villagers in Central Asia did not draw inferences from the premises of an unfamiliar content (e.g., " In the Far North, where there is snow, all bears are white.Novaya Zemlya is in the Far North. What color are bears there?") . Schooled subjects draw inferences from any premises. This is a qualitative (all-or-none) difference. Another qualitative fact in this field was obtained by Scribner (1976) : theoretic explanations, generally given by schooled subjects, practically always co-exist with correct conclusions.

It is obvious that a connection between these two facts should exist. We can propose that theoretic explanations indicate the existence in the subject of some specific quality of reasoning that permits him to draw correct conclusions from any premises - familiar as well as unfamiliar.But we must keep in mind that from familiar premises, correct conclusions can be drawn without this proposed quality, too, since correct answers often co-exist with empiric explanations.It must not be forgotten either that, as Scribner

points out, correct answers and theoretic explanations are given not only by schooled subjects, but also by traditional ones. So the proposed quality of reasoning cannot be strictly related to a certain group of subjects, although it seems to exist far more frequently in schooled than in traditional subjects.(Below I shall try to argue that there still is a one-to-one relation between schooling (or,more exactly, modern scientific knowledge) and this quality of thinking.)

In another paper (Tulviste, in press) it was hypothesized that two different modes of syllogistic reasoning exist, which can be labelled "empiric" and "theoretic", in line with Scribner's classification of the explanations given by subjects to their conclusions in experiments with classical syllogisms. This hypothesis can be applied to explaining the differences in the experimental results of traditional vs. advanced subjects as well as younger vs. older children. In empiric syllogistic reasoning, the subject proves his conclusion by relating it (and sometimes also the premises) to his knowledge of reality or to his beliefs.This kind of reasoning is used in the common sense. In theoretic syllogistic reasoning, the subject turns his attention to the logical validity of his conclusion rather than to its factual correctness or to its agreement with his convictions, and he proves it against the premises, not his common knowledge and beliefs. This kind of reasoning is used, first of all, in scientific thinking, where it is often impossible to prove the intermediate or final conclusions by relating them to reality or common knowledge, and one can prove his conclusions only against the premises (see Leontiev, 1964,relating to Leibniz, on this peculiarity of scientific thinking). So we could propose that schooling as a factor transferring scientific knowledge, first of all, necessarily demands (and possibly produces) theoretic syllogistic reasoning as characterized by the possibility of proving the logical validity of the conclusions, and of giving theoretic justifications, respectively.As the child first acquires common sense and only later on scientific thinking, this hypothesis means proposing that a qualitative shift occurs in the ontogenesis from empiric to theoretic syllogistic reasoning. (It should

be noted here that the differences between the experimental results of younger and older children have not been sufficiently explained thus far, as far as the factors that engender the development of syllogistic thinking are concerned. A new kind of syllogistic reasoning seems to appear, characterized by reflectivity, i.e. ,by the possibility to think not only about outer objects and the relations between those, but also about concepts and the relations between the concepts. This hypothesis is based on Vygotsky's idea that at school, the child acquires thinking in "scientific concepts", that means first of all reflective and systematized concepts (Vygotsky,1956). (It must be stressed here that Vygotsky regarded the specifical nature of scientific knowledge the main factor developing the child's reasoning at school.) In this paper, the experimental part of which was carried out before formulating the above hypothesis, it is applied to interpreting data on the origins of a theoretic approach to syllogistic tasks in children grown up in a traditional culture.

For the experimental study, the concrete proposition was stated that the theoretic approach to syllogistic tasks as belonging to scientific thinking first appears in the sphere of school knowledge, whereas later on it can be applied in the sphere of everyday knowledge , too. This hypothesis cannot be proved purely enough on children grown up in a modern environment, where it is difficult, if not impossible, to differentiate clearly school knowledge from everyday knowledge,considering the influence of mass media, children's books, educated parents, etc. In Nganassan children, these two spheres can be sharply enough differentiated. Nganassans, a nomadic people and the most northern people of the Eurasia, live in the North of the Taimir peninsula. The unschooled parents prepare their children for their traditional kinds of economic activities - hunting and reindeer-breeding, both remaining their main activities today - and teach the children their traditional knowledge, beliefs, and folklore. Going to school at the age of 7, the child enters a world almost unknown to him. In particular, the school knowledge is practically totally new for him. So here we seem to have better

possibilities to prove our hypothesis than elsewhere .

But to investigate the origins of theoretic syllogistic reasoning in the child was not our only purpose. In earlier papers, I have argumented that in traditional cultures, where there is no contemporary science (differing from traditional systems of thought in many respects, among which the presence of reflectivity in modern science and its absence in traditional thought must be mentioned here - see Horton,1967), there seems to be - according a certain interpretation of the results of recent cross-cultural studies - no thinking in "scientific concepts" in the Vygotskian sense, either (Tulviste,1975a;1977a). It was proposed that thinking in "scientific concepts" first appears in these cultures only as a result of the distribution of modern scientific knowledge, mostly via the introduction of formal schooling . We can propose that this kind of thinking first appears in every changing culture in the sphere of school knowledge , where it is undoubtedly functionally necessary in problem solving. In the sphere of traditional thought, there seems to be no such functional necessity . Experimentation with syllogistic tasks may be considered one possible way of exploring the presence or absence of thinking in "scientific concepts" in a certain culture and its origins, because in theoretic syllogistic thought, the subject must necessarily operate within a system of concepts, basing his reasoning on connections that exist only between concepts and not referring to the connections between the related outer objects. In other words, theoretic syllogistic reasoning clearly demands reflectivity, the main attribute of "scientific concepts" (cf. Vygotsky, 1956, 308 on syllogistic reasoning).

I tend to propose that it was exactly for finding out the particular sphere of culture where thinking in "scientific concepts" first appears that Luria and Vygotsky included two kinds of syllogistic tasks (with familiar and unfamiliar, or everyday and school content) into the program of their pioneer study in Central Asia *. But all the 5 advanced

*In Shif's (1935) study, directed by Vygotsky, three different methods (but no syllogisms) were used to find out in which sphere - that of school concepts or that of everyday

subjects in that study** draw correct conclusions from all pairs of premises, and the dynamics of the development of syllogistic reasoning in the course of rapid social and cultural change remained unexplored. It seems that it has not been investigated by other authors, either.

The results of adult Nganassans in experiments with syllogisms carried out by V.I.Shestakov (personal communication) were very much like those obtained by Luria in the remote villages in Uzbekistan.Below I shall argue that there is only empiric syllogistic reasoning in traditional subjects. So we proposed to investigate the origins of theoretic syllogistic reasoning not only in the child, but also in a traditional culture, where the introduction of formal schooling has brought to the distribution of modern scientific knowledge and of a related mode of thinking.

2. Subjects

The experiments were carried out in April,1977,with 35 schoolchildren (aged 8 to 15 ; grade 2 to 7) at the Volotshanka school in Taimir.

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concepts - arbitrarity as another distinguishing feature of thinking in "scientific concepts", according to Vygotsky, first appears in the development of the child's thinking at school.It was explored that arbitrarity first appears in the sphere of school knowledge, where the shift from "complexes" to"scientific concepts" occurs first, and that schooling as scientific knowledge teaching leads the development of conceptual thought in the child in general . Vygotsky (1956,190) proposed that in traditional cultures thinking occurs in "complexes", not in "scientific concepts". It was natural to use this general scheme of investigation in the Uzbekistan study, undertaken to find out the impact of social and cultural change (including the introduction of literacy training and elementary schooling) on the development of cognitive processes of adults from a traditional background.

** not 15 as on page 116 in Luria, 1976. Cf.page 103, ibid. But this is not important. Luria notes (p.103) that the data obtained from the group of advanced subjects "were so uniform that enlarging it any further seemed pointless".

3. Method

The subjects were orally presented 10 syllogisms of the first figure. After each syllogism of everyday content (e. g., "Saiba and Nakupté always drink tea together. Saiba drinks tea at 3 p.m. Does Nakupté drink tea at 3 p.m. or not?"), a syllogism of school content followed (e.g., "All precious metals are rustfree. Molybdenum is a precious metal. Does molybdenum rust or not?"). After each answer, the subject was asked "Why do you think so?" When no explanation followed, the syllogism was repeated once more, and after answering the subject was asked for an explanation again. The experiments were carried out in Russian. At school, only Russian is spoken, and as there is no Nganassan literacy, the children could not speak about school matters in their native language. In Russian, they spoke about everyday affairs as well as about school matters. There were no remarkable language difficulties.

4. Results

Among 35 Ss, 9 gave theoretic explanations for all conclusions, and 4 - for none. It is the results of the remaining 22 Ss that are crucial for our hypotheses. These Ss gave theoretic explanations for some conclusions, but not for all.

This "transitional" group made correct conclusions from school premises in 90 cases out of 110, and gave theoretic explanations for these conclusions in 59 cases. (In the remaining cases, empiric or no explanations were given.) Correct conclusions from everyday premises were made in 81 cases, and 26 theoretic explanations were given. Theoretic explanations always co-existed with correct answers. As we are interested just in these cases, let us take a look at their distribution (i.e., the distribution of the cases where theoretic syllogistic reasoning was supposedly used in relation to both kinds of syllogisms).

TABLE 1. Results of the subjects in the Nganassan study

Number of theoretic explanations for conclusions from school premises	Number of subjects	Mean number of theoretic explanations for conclusions from everyday premises in the same subjects
5	2	2
4	5	1
3	5	1,6
2	5	0,6
1	4	1,25
0	1	1
	22	

Number of theoretic explanations for conclusions from everyday premises	Number of subjects	Mean number of theoretic explanations for conclusions from school premises in the same subjects
5	0	-
4	1	5
3	2	2
2	4	3,5
1	8	1,9
0	7	3
	22	

The results presented in Table 1 indicate that Ss from the "transitional" group gave definitely more theoretic explanations for conclusions drawn from school premises than for those from everyday premises. Among 22 Ss, 2 gave more theoretic explanations for conclusions from everyday premises than for conclusions from school premises, and 3 Ss gave an equal number of theoretic explanations for conclusions from both kinds of premises. The remaining 17 Ss gave more theoretic explanations for conclusions from school premises than for those from everyday premises.

5. Conclusions and discussion

The experimental results of the subjects labelled "transitional" (i.e., the subjects who gave both theoretic and empiric explanations for their conclusions) confirm the proposition that theoretic syllogistic reasoning, charac-

terized by theoretic explanation of the conclusions (but see the discussion of this characteristic below),first appears in the sphere of school knowledge and only after that is also applied in the sphere of everyday knowledge. The results presented reveal that theoretic syllogistic reasoning is not a skill previously present in the subjects, which under the impact of formal education can be applied to new kinds of problems. Rather, it is a qualitatively new skill engendered by schooling, which later on may be also applied to everyday matters.

But is it correct to label these subjects "transitional?" The data provided by the authors listed confirm the view that the impact of education on syllogistic reasoning ends in a practically hundred-per-cent solving and theoretic explanation of syllogistic tasks like those used in the present study. But is theoretic syllogistic reasoning really a fully new skill first acquired at school? Can it be stated that no traditional subject never reveals a theoretic approach to syllogistic tasks? The data gathered by Scribner (1976) make her stress that unschooled subjects, too, give theoretic explanations, although definitely more seldom than their schooled counterparts. Some traditional subjects even justified theoretically all conclusions they made. At the same time, Scribner notes that "at the extreme of rural isolation (as among Luria's Muslim women) empiric approaches may be all-or-none"*. How is this "extreme of rural isolation" to be understood? It seems reasonable to interprete this condition as an isolation of all factors of social and cultural change, a traditionality par excellence . So it seems correct to state that there may be no theoretic syllogistic reasoning in the cultures that are strictly traditional. But what about the less traditional people, who have had no schooling and are illiterate, but do give theoretic explanations for their conclusions? There seem to be two points that

*Cf also Sharp et al.(1978,in press): "The Mayan adults from Ticul respond significantly better than a comparable population from the smaller, more traditional town of Ramonal".

make us believe that there still may be no theoretic syllogistic reasoning without any acquaintance with modern scientific knowledge.

Firstly, scientific knowledge and thinking in "scientific concepts" can undoubtedly be acquired outside school . This is best illustrated by the fact that in modern societies, children at the age of 5-6, not attending school solve syllogistic tasks of an unfamiliar content and give theoretic explanations for their conclusions (Tamm,1977).We may propose that in some cases, the theoretic explanations given by traditional subjects should be explained through school knowledge and skills, acquired outside the school.In other words, the presence of theoretic explanations should be explained through the "untraditionality" of the traditional subjects giving them.

Secondly, it seems to be the case that the seemingly theoretic explanations given by traditional subjects for their conclusions from familiar premises only too often coincide with some possible empiric explanations. It seems highly probable that these explanations are really empiric, not theoretic. For example, if we present a Nganassan the syllogism "All men hunt. Kudapté is a man. Does Kudapté hunt or not?" and he says "yes, because he wants to shot polar foxes", we classify his explanation as empiric; when he says "yes, because he is a man", we classify his explanation as theoretic, because he seems to justify his answer through referring to the premises. But it is obvious that the second explanation may as well indicate a reference to a cultural norm (indeed, all Nganassan men hunt). It cannot be concluded from this explanation that the subject indeed proves his conclusion against the task premises - he may be referring to the common knowledge as well. This last possibility is only the more probable, when this subject does not refer to the task premises in those cases when they are unfamiliar to him. In all cross-cultural studies of syllogistic reasoning, including our research in Taimir, tasks can be found that probably are given explanations which cannot be classified as empiric or theoretic with full conviction. Sharp et al. (in press) examined the

content of the syllogisms on which traditional and advanced subjects did not differ markedly in the amount of theoretic explanations, and found those to be "precisely the problems on which a correct answer is completely in tune with the experience of the subjects". It is highly probable that in those problems, the premises were also a commonplace for the traditional subjects, and that their explanations, remaining seemingly inside the task given, could really be empiric in nature. This difficulty can be easily overcome in future studies. The experimenter should not content himself with the first best answer of the subject to the question "why do you think so",instead,when any doubt arises in the empiric vs. theoretic nature of the answer, he should go on putting questions to find out the real nature of the explanation . This method has been proved in experiments with children (Tulviste,in press).

Luria's data on the unsolving of syllogistic tasks of an unfamiliar content by traditional subjects can be interpreted as confirming the idea that they have no theoretic syllogistic reasoning. Indeed, if conclusions can be drawn only from common knowledge, or if a "picture of reality" (whatever it may be) is needed to answer the questions concerning this reality and the conclusions cannot be proved against the premises, so it is understandable enough that Luria's subjects refused to draw conclusions when no such picture was available, and Cole's subjects demanded more information to create such a picture. It would be interesting to find out what information exactly is needed to create such a "picture of reality" and to convict the subjects of its "reality".What the subjects could not do was to make an inference from unfamiliar premises and to prove it against the premises.

As traditional subjects seem to possess no theoretic syllogistic reasoning at all, while highly educated subjects tend to apply it to all kinds of tasks, our 22 subjects can be labelled a transitional group, indeed. They had acquired this kind of reasoning in the sphere of scientific knowledge, but they did not apply it as often in the everyday sphere.

The hypothesis made in this paper must obviously be proved in further studies with children and adults from different culture groups, before it can be said with full conviction that in both cases theoretic syllogistic reasoning really first appears in the sphere of scientific thinking. The amount of skill needed and its exact nature must be revealed.

6. General discussion

The hypothesis advanced in this paper includes theoretic syllogistic reasoning into a general mode of verbal thinking (thinking in "scientific concepts"), which in its turn is functionally related to a certain sphere of knowledge and of theoretic activity, present in some cultures, absent in others, and currently appearing in still others under the impact of social and cultural change. The ideas underlying this general approach to the problems of cross-cultural differences in thinking are presented in earlier papers (Tulviste, 1975a; 1977a;1977b). The general thesis consists in the following: there is no "natural" human thinking and no one direction, in which it should inevitably develop in the course of its ontogenesis and cultural historical development. Rather, different kinds of theoretic activity produce different modes of verbal thinking that are necessary in creating (or generating), acquiring and using of the respective modes of culture texts.It is obvious that observing the behaviour of people engaged in different kinds of theoretic activities will not help us make hypotheses about the respective modes of verbal thinking. Instead, we need descriptions (semiotic, linguistic etc.) of different modes of culture texts, to make any hypothesis for experimental studies. This is exactly what Scribner did when she focused her attention on the nature of the problems that are solved at school, looking for the reason why educated subjects give theoretic explanations in syllogistic reasoning experiments. In the present paper, it was the description of a certain property of scientific thinking, given by Leibniz and cited by Leontiev (1964), that permitted us to propose that theoretic syllogistic reasoning might be necessary to solve scientific or school problems, first of all.Analyses of

different kinds of culture texts in traditional and modern societies are needed to do the same for various other modes of verbal thinking.It seems reasonable to propose that theoretic syllogistic reasoning (and thinking in "scientific concepts" in general) should appear in children and in adults in a certain culture only when certain modes of texts function there that demand those modes of thinking and, respectively, produce them (at school or outside school). (In the papers listed above, I have argued that the descriptions of traditional thought given by several authors, and first of all by Horton (1967), reveal no necessity for thinking in "scientific concepts"). Indeed , when it is sufficient to prove the conclusions against the common knowledge, why should the skill to prove them against the premises appear and develop? It seems reasonable to propose that this skill appears only when problems appear that exclude the possibility to prove the conclusions against the common knowledge.

It is in line with the above approach to think that if the texts of different cultures are markedly different, verbal thinking must be different, too.The exciting idea expressed by Lucien Lévy-Bruhl many years ago that thinking is qualitatively different in different cultures, has found no clear experimental support nor denial in the recent cross-cultural studies. If a real qualitative difference has been obtained in the present study, it consists in the fact that a certain operation of thought has become reflective or conscious in the course of the cultural historical development of thought.This is in line with one of Vygotsky's main ideas concerning the development of verbal thinking in the child and in culture. It is possible that no qualitative differences have been revealed in the cross-cultural studies so far because they have been commonly thought of as situated in the logical, not in the psychological properties of thinking. Cole and Scribner (1974, 163) demonstrate convincingly that even when the traditional subjects substituted new premises for those presented by the experimenter, their reasoning in the attempts to solve the task can be easily presented in a syllogistic

form. There is no evidence that the operations carried out by traditional subjects were more simple than those carried out by educated subjects (in a logical sense).The empiric explanations given by traditional subjects are certainly not simpler than the theoretic ones offered by their schooled counterparts. Why should they be, indeed? But even if there is no logical difference at all, this does not mean that there is no psychological difference,either. May-be we shall be able to explain the real differences in the experimental results if we turn to the possible and predictable psychological differences rather than to the logical properties of the thinking in different groups of subjects.

But it does not follow from the ideas expressed here that all thinking would be different in modern and traditional cultures, nor that culture change would change all the verbal thinking of man. There are universal kinds of theoretic activities and universal modes of culture texts, and the respective modes of verbal thinking should be uniform across different cultures. In terms of syllogistic reasoning, this means the following. In modern cultures,relating the conclusions to the premises is certainly not the only way of proving them. Scientific thinking must not and cannot substitute for the common sense. In the experimental situation, the educated subjects do tend to apply theoretic syllogistic reasoning to all kinds of syllogistic tasks.But it would be sufficient to change the instruction, and the subjects would relate the premises and the conclusions to their common knowledge and personal convictions. Moreover, this occurs often enough even in the usual experimental situation, when the subjects are told to draw and justify conclusions from the given premises, or even when they are explicitly told to judge the logical validity of the given conclusions. Indeed, several authors have noted and specially investigated the impact of the subjects' personal convictions on their performance in the experiments with syllogistic tasks. Morgan and Morton (1944, cited in Henle, 1962) came to the following conclusion: "Our evidence will indicate that the only circumstance under which we can be relatively sure that the inferences of a person will be logical

is when they lead to a conclusion which he has already accepted". In a somewhat less categorical form, the idea of the impact of the subject's convictions on the inference is stated by Janis and Frick (1943) and by Henle (1962). All of them worked with educated subjects.So it is not that educated subjects have only theoretic syllogistic reasoning at their disposal, and are therefore totally different from the traditional subjects who seem to reason empirically. Rather a new mode of reasoning appears in the educated subjects, that functions parallel to the empiric syllogistic reasoning and serves - first of all - to solve problems that cannot be dealt with by the means of the latter. In other words, a new mode of thinking does not substitute for those previously present, obviously because those remain functionally necessary in various kind of activity. This process is responsible for what can be labelled the historical heterogeneity or multiciplity of thinking (considered at some length in Tulviste, 1975b). Sharp et al. (in press) tend to reject the idea suggested by some of the results of the recent cross-cultural studies in thinking that schooling might cause a qualitative change in thinking processes, because schooling does not seem to change all thinking. Indeed, why should it ? But the possible qualitative changes must not consist in a total shift in all thinking. Rather, they consist in the appearance of qualitatively new modes of thinking, which function parallel to those that were present previously.

The Vygotskian term "thinking in scientific concepts" has been used in this paper, and some related ideas of Vygotsky have been applied. The very term shows that the respective mode of thinking has been defined through its units . Those were described by Vygotsky in detail, as different from various kinds of "complexes".But it is reasonable to propose that a functional relatedness between a certain kind of the units of thinking and certain kinds on thinking operations should exist. This aspect was not elaborated by Vygotsky, and there is no experimental evidence so far. Still we can speculate that it would be rather inconceivable why higher order units of thinking should ap-

pear at all, if all operations were realiable in lower order units as well. Theoretic syllogistic reasoning seems to be an operation that demands "scientific concepts", and that cannot be realized in various "complexes". Indeed,it demands necessarily relying on connections that exist only between concepts, and not between the respective outer objects. Scientific concepts are defined through other concepts, and often cannot be defined or explained otherwise, while various kinds of complexes are "defined" through the respective outher objects (as investigated in the Vygotsky-Sakharov classification studies), or through perceptual and/or emotional experiences of the subject, and possibly need not be defined through other "complexes".The "complexes" therefore seem to be inadequate for a thinking operation where any turning towards reality and emotions has a disturbing effect, and connections between concepts must prevail. Of course, theoretic syllogistic reasoning is but one operation among others that demand "scientific concepts" to be realized.

Last but not least, if theoretic syllogistic reasoning has its origins, strictly speaking, not in the child himself, and not in the traditional cultures where we are investigating its distribution under the impact of social and cultural change, where are its real origins, then? It seems that we should look for those in the social and cultural situation of Ancient Greece, where the scientific thinking (differing from traditional systems of thought) first arose. From there, it has come into different cultures and changed the thinking of men.But this is another problem.

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COULD MARGARET MEAD'S METHODS REVEAL ANIMISM IN MANUS CHILDREN? A PARTIAL REPLICATION STUDY IN A EUROPEAN CULTURE

Peeter Tulviste Anne Lapp

Abstract. Mead's data on the absence of animistic thinking in Manus children have been regarded as unreliable by some authors who claim that the methods she used possibly could not reveal animism in the subjects. In a replication study, three methods used by Mead were applied to 75 Estonian children (age 3 to 7). The methods revealed animism in 65 and 66 subjects, respectively, and the proportion of animistic responses was found to decline with the increase of age. The children's drawings revealed no animistic thinking. It is suggested that Mead's data and her ideas on the cultural determination of child animism should be taken more seriously, and that further research in traditional cultures is needed to decide the universal or culture-bound nature of child animism.

1. Problem

Among numerous authors who have investigated child animism, only Margaret Mead has consequently pursued the view that this peculiarity of cildren's thinking, first described in detail by Piaget, is of cultural origin. She argued that animism may be absent in children in a culture where adults do not communicate folklore to children, where children must necessarily make correct physical adjustments, and where the language contains no or few metaphors (Mead,1932; 1954). She describes the Manus culture in New Guinea (in 1928-1929) as differing from ours in just these aspects.She also adds that "the habits of personalizing inanimate things, of kicking the door, blaming the knife, apostrophizing the chair, accusing the moon of eavesdropping,etc.,are lacking in Manus" (1954,101) . Mead used several different methods to reveal whether there is animistic thinking in Manus children,and failed to find any. On the contrary, she notes that Manus children even "... show what may perhaps legitimately be termed a negativism towards explanations couched in animistic rather

than practical cause and effect terms" (1932,186). Mead came to the conclusion that "personalizing the universe is not inherent in child thought, but is a tendency bequethed to him by his society. The young baby's inability to differentiate or at least to respond differentially to persons and things, is not in itself a creative tendency which makes an older child think of the moon, the sun, boats, etc., as possessed of will and emotion. These more elaborate tendencies are not spontaneous, but are assisted by the language, the folklore, the songs, the adult attitude towards children. And these were the work of poetic adult minds, not the faulty thinking of young children" (1954,103).

Most investigators regard child animism as a universal feature of children's thought, quite independent of the particular culture where a child lives. To prove this hypothesis of universality, several cross-cultural studies have been undertaken. Jahoda (1958a) points out in his review article that all the cross-cultural investigations he surveyes report some degree of animism, Mead's being the single exception. Dennis (1943) had noted earlier that Mead had not followed Piaget's methods, and he had claimed that the methods she had used had been inappropriate for the study of animism. Jahoda comments that "there is no doubt a good deal of weight in this objection, but in view of the fact that Mead did employ a variety of approaches one would nevertheless have expected some animism to emerge" (ibid.).On his turn,Jahoda argues that Mead's negative findings cannot be regarded as conclusive evidence against the assumption of universality of child animism, because her very conception of animism was quite different of Piaget's. In the paper cited by Jahoda,Mead regards as animism that "... a child spontaneously attributed personality to natural phenomena, animals or inanimate objects, or created imaginative non-existent personal beings" (Mead,1932,181). Characterizing Piaget's conception of animism, Jahoda notes that it "... requires merely the attribution of certain characteristics of living beings to inert objects" (1958a,207).

Jahoda's comment is correct, but we tend to think that the various methods used by Mead go far beyond the definition of

animism she gives. An examination of those (some of which will be described below) reveals that some of them could possibly be appropriate for the study of animism in both Piagetian and Meadian sense.

Looft and Bartz (1969,4) in their review article,return to the method criticism of Mead's work given by Dennis (1943), and conclude that "... there is no reason to believe that the methods of either Piaget or Russell and Dennis would not reveal the presence of animism among the Manus children".

As it were, those methods have not been used among the Manus,yet. And, what is more important, it seems that not a single study of child animism has been conducted among isolated traditional subjects, with the exception of Mead's . (It must be mentioned that Mead's subjects were only relatively isolated,too). Dennis and Russell (1940) and Dennis (1943) worked with bilingual American Indian children, Zuni and Hopi, respectively. Dennis' subjects were schoolboys. Jahoda's (1958b) West African subjects were schoolboys,too. It seems doubtful that traditionality in its full sense can be found among the American Indians,with whom Havighurst and Neugarten (1955,cited in Jahoda 1958a) worked.Given the well-documented unifying impact of social and cultural change, especially that of formal schooling on cognitive processes (e.g.,Cole,Scribner,1974),it seems that isolated traditional cultures are more appropriate to test the hypothesis of universality of child animism, than those in contact with Western culture. Thus it seems that Mead had not only exceptional methods and exceptional results, but also exceptional subjects. And this makes her study exceptionally important. It should be added that the Manus culture seems to be somewhat inordinary among traditional cultures , in its turn. It is perhaps not usual that folklore texts are not communicated to children.

It seems that Mead had no control group of American or European children. If her methods do reveal animism in groups where animism is undoubtedly present, and if the age tendencies found by other methods can be revealed by her methods as well, it seems reasonable to think that these

methods possibly should have discovered animism in Manus children, too, if the children had any. We have undertaken a partial replication of Mead's study with Estonian children who are highly animistic, as one of us has found out in an earlier study using the Russell and Dennis questionnaire (Niit,1977).

2. Subjects

75 urban children of the ages 3, 4, 5, 6 and 7 years participated in the experiments, 15 Ss from every age group.60 children (age 3 to 6) were kindergarten children, the 15 seven-year-olds attended the first grade of school.

3. Method

Of the several methods used by Mead, three were selected that seemed to us especially appropriate to make animistic responses emerge.

The first method (1) is described by Mead as follows : "The attribution of malicious intent to a pencil. When a child had made a drawing which he considered bad and had shown his displeasure by remarking on it "This is bad" or "I just draw, that's all," i.e. without definite intent to produce any result (this was a most frequent alibi),I would then seize the opportunity to say "The pencil is bad, isn't it? The pencil does not do good work" (1932,179). The children's responses were registered.

There was a slight difference between Mead's method and ours. Our subjects were not drawing for the first time,as the Manus children were, and most of them made good pictures and were convinced enough of the good quality of their work themselves.So we did not wait for bad pictures and self-criticism. In some cases, we followed Mead, but in all cases the experimenter showed the child a really bad picture drawn by herself, and said:"One child has drawn this picture and brought it to me. The pencil was bad, wasn't it? The pencil did not do good work." The picture was the same for all subjects.The difference of Mead's method does not seem essential to us. Indeed, it seems that Mead's subjects had much more reason to accuse the bad pencil, than ours.

(2) Mead used Chinese glass chimes which were made so that when the wind agitated the paper, it caused the glass pieces to tinkle against each other. Mead told the children that this was her ramus (a property-getting charm like those of Manus), crying for native property, and asked them:"What do you think it is crying for now?"

(3) Mead also presented the children with a dancing doll made of paper that could be manipulated by slight jerks of a string, and registered the children's comments.

We tried to combine these two methods in one. We used a toy: kittens sitting in a basket and mewing, when pushed.The experimenter pushed the toy on the table in front of the subject and asked: "Why do the kittens mew? Do they want something?" This method, too, seems to be rather similar in its essential features to the two used by Mead.

We also investigated the pictures the children had made, as Mead had done, and registered the explanations they gave to their drawings, to look for possible marks of animism or personification in both.

4. Results

The results are presented in Table 1.The responses were classified animistic when the Ss agreed that the pencil was fault of bad drawing, and when they agreed that the kittens were mewing because they wanted something. Other answers were classified non-animistic.

Both methods - the pencil question and the kittens question - revealed the same amount of animism in the Ss' responses: 65 and 66 of 75, respectively. Both methods revealed also a decline of animistic answers in the seven-year-olds.

The drawings made by children did not reveal animism or personification, with one exception.One girl of 5 years draw the sun with eyes. Nor were the explanations animistic or personifying.

Table 1. Animistic and nonanimistic responses in children (N = 75)

Age	The pencil question		The kittens question	
	Animistic responses	Non-animistic responses	Animistic responses	Non-animistic responses
3	14	1	15	-
4	14	1	13	2
5	13	2	14	1
6	15	-	14	1
7	9	6	10	5
Total	65	10	66	9

5. Conclusions and discussion

The results we obtained among Estonian children differ radically from those obtained by Mead among Manus children. Mead gives the following summary of her subjects' responses to her suggestion that the pencil was at fault of bad drawing: "Younger child's response: "I drew it." "I made it." "I made it badly." Older child's type response: "No, I didn't make it right," this of one's own work. Bystander comment : "No, she did it wrong." "No, she is stupid. She doesn't know how to draw right" (1932,186). 65 of our 75 subjects agreed that the pencil was faulty, although it was not their own drawing they were commenting. Manus children commented the Chinese glass chimes "The wind winds the paper. It shales the strings. Then the glasses hit and it sounds", and the doll: "She (the experimenter) pulls the string. It's dancing." 66 of our subjects agreed that the kittens were mewing because they wanted something.

Dennis (1943,35) commented these methods of Mead as more appropriate for the investigation of notions of causality than for the study of animism. It seems to be correct that notions of causality may be investigated by these methods , too, and consequently there seem to exist great differences in those in Manus and Estonian children. Nevertheless, the

methods successfully revealed animism in our subjects, whereas Mead's subjects gave no animistic answers at all.

Dennis (1943,34) seems to be correct when criticizing the drawing method as inappropriate for the study of animism. Indeed, "the child has no way of expressing in a drawing the fact that the object pictured is alive". Our animistic children did not reveal their animism while drawing and explaining pictures.

We don't want to claim that there is only animistic thinking in our children concerning the objects that were used in this study. Rather, we tend to think that changed experimental situations and instructions would reveal non-animistic responses in the same subjects. But we do think that the results of the present study give some support to Mead's claim that there seems to be no animistic thinking in Manus children. Respectively, we also think that Mead's hypothesis of the cultural origin of child animism deserves more serious attention that it has received so far.

For the reasons described above, we think that the cross-cultural data that exist cannot be considered a strong evidence in favor of the universality hypothesis. The strongest case against the idea of the cultural origin of child animism remains Dennis' careful one-child-study (1942). It is natural that the child was not cut off completely from culture. Dennis stresses that she had contact with childhood literature, and suggests that "it would be valuable to examine a young child who had been brought up without contact with children's literature" (1942,318). In some sense, this seems to be what Mead did. We think that further studies of child animism in various traditional cultures would be of great value for the explanation of why animistic thinking arises and develops in children.

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COGNITIVE CONTOURS : OVERVIEW AND A PRELIMINARY THEORY

Talis Bachmann

Abstract . The present article reviews main research on the problem of subjective contour formation. Two groups of theories - the cognitive-organizational theories and peripheralist theories are reviewed. On the basis of the research data and speculations it is concluded that the subjective contour could not be explained as a result of any single causal factor. Instead, a multifactor theory seems to be more adequate. Some hypothetical possibilities of cooperative interaction of different factors in subjective contour formation are proposed.

1. Introduction

Recent years are marked with easily observable increase in the number of studies devoted to the problem of cognitive contours. This phenomenon should be defined as perception of apparent contours without spatially corresponding local luminance differences (gradients) on the perceived surface . Sometimes these seeming gradients could be perceived in a three-dimensional space also (Ware, Kennedy,1977; Kennedy termed this as "mind line"*). The real, physically existing patterns and contours which are giving rise to the cognitive contours should be defined as the inducer elements or inducers.

According to the predominant view such contours had been first described by Schumann in 1904 (after Kaufman, 1974) . Figure 1 demonstrates only some of the many possible variants of cognitive contours. As a rule such contours are made to form certain geometric figures (forms), although they need not always follow such a goal. In the relevant literature the terms "subjective contours", "illusory contours", "virtual contours", "apparent contours", "anomalous contours" , "contours without gradient", "nonsensory margins (edges)" , "quasi-perceptive margins", and "subjective gradients" are also widely used.

*personal communication.

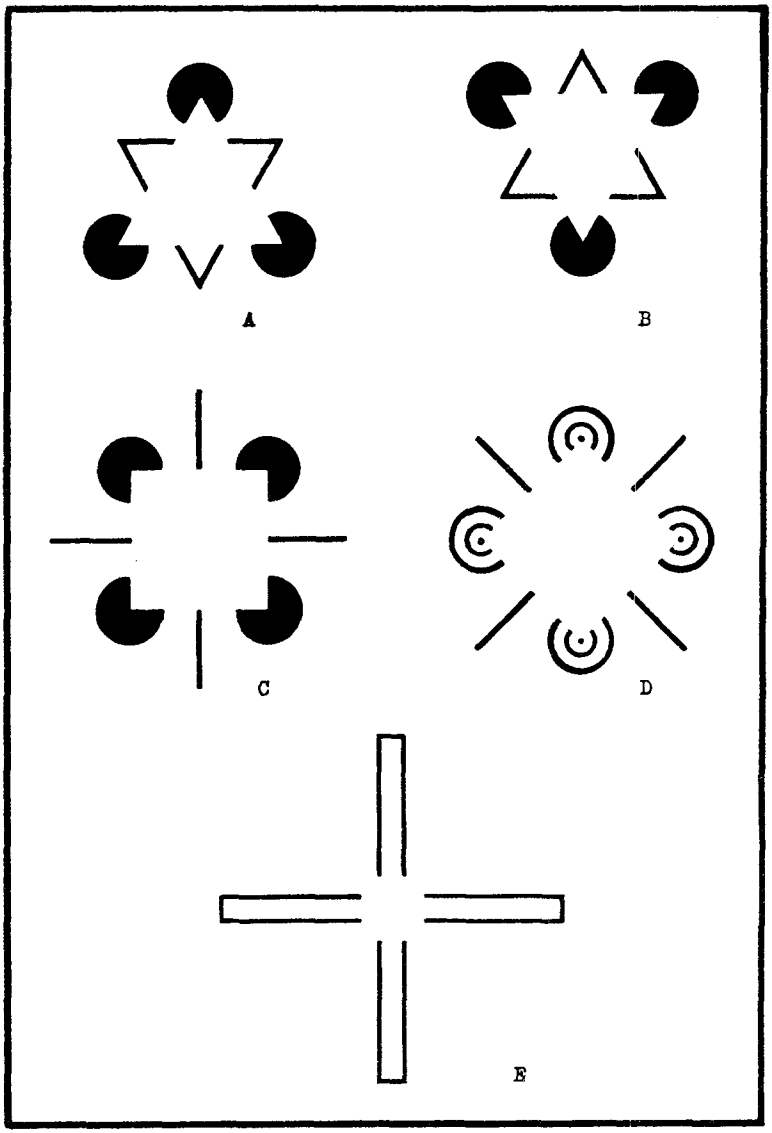

Figure 1. Examples of the stimulus patterns used to form the subjective contour: A - "triangle", B - "inverted triangle", C - "square", D - "rhombus", E - the cross with subjective "square" or "disc" at centre.

The increased popularity of the phenomenon depends probably on the current boom of cognitive psychology on the one hand and on the other hand it depends on the fact that the situation where perceivable images are built up without corresponding (in one-to-one fashion) physical luminance gradients, would give us a nice opportunity for the experimental investigation of the formation of "ordinary" images.

The theories explaining the origin of cognitive contours may be divided into the following five groups: (1) cognitive theories (Gregory, Kennedy et al.), (2) gestalt theories (Kanisza, Pastore, Bradley et al.) , (3) depth perception theories (Coren, Kaufman), (4) simultaneous contrast -lateral inhibition/facilitation theories (Frisby,Clatworthy , Brigner, Jung et al.), (5) spatial frequency analysis theory (Ginsburg). These five in turn can be divided into two general groups: The organizational-cognitive group (1-3) and the sensory-factors group (4-5); or respectively the "centralist view" and the "peripheralist view" (with no anatomical consideration of the term "peripheral"). Further we shall present a short survey of these groups of theories.

2. Organizational-cognitive theories of subjective contour

The term "cognitive contours" has been most thoroughly used by Gregory (1972a,b; 1975). According to his theory, cognitive contours are formed as a result of selection of one of certain cognitive hypotheses activated by the existing sensory data. This final percept, however, is richer than the sensory information. In our figure 1a the "postulation" of illusory masking object (triangle) is needed in order to account for the blank sectors of presupposed dark discs and the breaks in the presupposed line-made triangle. Gregory showed that the phenomenon occured also for stabilized images and for the presentation of different parts of the figure to different eyes by the means of a stereoscope . In other words - cognitive contours are not necessarily connected with eye movements or retinal processes.The figures , formed by illusory contours, appear as having a brighter surface ("whiter than white") as compared with homogeneous

background and as standing in front of the rest of the figures. The characteristic of uniformity in large regions of cognitive figures is often taken as an argument against lateral inhibition explanations.

Harris and Gregory (1973) demonstrated that when presenting each eye with different disparate cognitive contour figures it is possible to obtain their fusion and perception of three-dimensional illusory surface. When masking cues were incompatible with stereo depth, rivalry was observed. It was argued that before the stereopsis each eye had formed the object representation which then, according to the cues, would be the basis for fusion or yield rivalry between two objects.

The work of Kennedy (Kennedy,1976a,b; Kennedy,Chattaway, 1975; Kennedy, Lee, 1976) represents the line of theoritizing close to the Gregory's. "Pictorial attention" is the mechanism responsible for the subjective contour phenomenon, this statement being put forward by Kennedy (1976a). Using uncomplicated examples such as afterimages, inducers presented binocularly to rise two-dimensional cognitive contour after the fusion of monocular patterns without a subjective contour, presentation of the inducer elements demanding gestalt completion but lacking a subjective contour, he showed that the factors like eye movements, retinal processes,depth perception , and the principle of gestalt closure could not be the sole causes of subjective contour. The starting point for Kennedy's attention-theory departs from his demonstrations of importance of instructions in the formation and dynamics of subjective contours. One example would be our figure 1e, enabling optional perception of the subjective circle(disc) or the subjective square at the centre of the lines. Another argument by Kennedy for attention theory is based on the fact that factors which themselves do not create subjective contours play a major role in modifying them (behaving like catalysts). Kennedy introduced a new characteristic of subjective contour - the hysteresis-effect: when decreasing gradually the distance between observer and the figure, at a certain point the illusory contour disappears. However, doing vice versa the distance point where contour re-

appeared was closer to the observer than the initial disappearance-point. Moreover, the subjects were able to speed up and slow down the subjective contour appearance at will. The author explained these data with the concept of set. He has drawn the reader's attention to the fact that when one is forced to be analytic, this kind of set (to determine what is truly on the display) weakens the effect of subjective contours or even suppresses it. It is especially so with careful steady fixation on the contour. Thus the nonanalytic productive kind of attention to whole scene is the prerequisite of illusory contours.

The important point in this theory is that the subjective contours of nonoptional kind are readily perceived if the changes in reflectance of a line or path of "pigment" or changes in the direction (and continuity - T.B.) of a line or border are close together. When these are far appart (then) the influences of productive optional attention become dominant, generating "subjectively subjective" pictorial space.

Kennedy's (and Gregory's)ideas are partially confirmed by the experimental investigations (Berman, Leibowitz, 1965 ; Parrish, Smith, 1967; Coren, Komoda, 1973, et al.), which have been carried out to demonstrate the attentional and set-specific influences upon simultaneous brightness contrast and brightness judgments of invariant physical displays. All those experiments reject the simple, retinal as well as other relatively peripheral explanations of apparent lightness (saturation) and permit the acceptance of subjective organization of sensorium.

To mention the Ramachandran's (1975) popular demonstration of the texture-like pattern where the subjective "ghost lines" can be seen with image blur and beyond fovea (unless invisible) one may find the analogies with our illusory contour patterns and the Kennedy's theory. With analytic (focused, foveal, or field-prone) mode of perception the high-frequency information might indeed dominate our attention , but with general pictorial attention the subjective lines become visible. Although it is surprising that no one has assessed the importance of such factors as accomodation

in subjective contour generation.

The above described psychophysical studies seem to point to the complex and inseparable nature of both peripheral and central factors, their relationships warranting the subjective phenomena. Some of the recent articles by Kennedy (Kennedy,Lee, 1976; Kennedy, 1976b) also indicate that he turns his theory so as to consider also the local brightness effects.

Kennedy and Lee (1976) developed a new, a somewhat speculative preliminary theory - BCI. This means that the abrubt ends of lines and changes of direction of contours form the regions of brightness contrast and instability. If the eye succeeded in grouping several BCI regions then the enclosed area had to possess enchanced brightness in relation to surrounding. Due to the directional property of BCI the region is polar in darkness to the region which remains on the other side of the inducing lines or contours. Unlike the contrast models, this model accepts the possibility of darkening the region between dark inducers, which was observed in several Kennedy's figures, and permits to incorporate the phenomena of brightness reversal. One important principle of the BCI model, which also differentiates the latter from the peripheral brightness models (see further on), is that the grouping principle, modifyable by instructions, has primary status with regard to the illusory brightness effects.

Having reviewed the main cognitive theories let us briefly touch upon the gestalt theories of illusory contour formation. Here the leader seems to be the Italian psychologist Kanisza (1955, 1974,1976) who has considerable merit in revival of interest in our present problem. His theory, following Schumann's line, states that the subjective contours are formed due to the existence of incomplete, unfinished, unstable elements in the visual field. The need for completion will be satisfied by the use of anomalous contours which perform the organizing functions so as to achieve the formation of an image, elements of which become arranged into the more simple, regular, and stable entities (patterns),e.g. sectors become discs, angles become triangles etc.

In parallel with Gregory,Kanisza demonstrated how anomalous contours, being used instead of real ones, could give rise to the well-known optical illusions (cf.Smith,Over, 1977; Day, Dickinson,Jory,1977).

Generally, a subjective contour, as it is described by Kanisza, appears at the "empty place" almost as deus ex machina: "And since the triangle must have a border, the necessary contours are supplied by the visual system." (Kanisza, 1976,p.52). In other words - the surface is the primary entity and contours the secondary ones. The logic of subjective figure microgenesis should be: (i) elements, (ii) tendency for completion,(iii) formation of surface, (iv) creation of the previously lacking contour. The argument was defended again graphically.If Kanisza completed or closed the open or unstable inducer-elements so that the regions of subjective contours remained intact, then nevertheless, the subjective contour disappeared.

Nearly the same gestalt ideas helped Pastore (1971)to briefly describe the phenomena of subjective contours, however with additional reference to gestalt-type cortical processes.

In the modern gestalt tradition the problem is approached by Bradley and Dumais (1975;1976; Dumais,Bradley, 1976). They devised configurations which gave rise to the ambiguous cognitive contours (see Bradley,Dumais,1975,1976). At any moment one variant of organization (grouping) could be perceived.The apparent brightness enchancement corresponded to that configuration variant which was actually perceived as a figure, i.e. figure reversals paralleled the brightness reversals. As such a dynamics is clearly illusory (phenomenal variants based on physical invariant), the authors conclude that subjective contour phenomena are not totally stimulus-bound. Consequently, the stimulus-bound physiological theories appear inadequate for the authors . Yet the pure cognitive hypothesis theory was rejected on the ground of its failure to explain the brightness differences. The authors themselves explain this relying on Rubin's demonstrations of subjective figure-ground brightness differences.

The above theory is contradicted by Cavonius (1976).He pointed out that it is difficult to maintain the perception of only one variant of an ambiguous cognitive figure. This, as Cavonius thought, apparently contradicts the cognitive (gestalt) hypothesis. Moreover, brightness differences are also best accounted for by physiological model, as Cavonius claimed. He used the observations by Campbell, Blakemore et al. - rivalry of the two differently oriented sine-wave gratings - as the basis for explanation. Consequently the responsible mechanism in Bradley's demonstrations should be the selective adaptation of narrowly tuned sensory structures.

In their reply, Bradley, et al. (1976) stress that Cavonius' theory explains only involuntary alternation. On the contrary, they demonstrated a figure (subjective Necker cube), alternations of which were subject to the vigorous observer's control. To expand Bradley's et al. criticism,we wish to add that the account of Cavonius explained only the fact of alternation, but not the genesis of cognitive contours and thus it might not be regarded as appropriate theory for our discussion.

The paper by Dumais and Bradley (1976) assessed the apparent strength of subjective contours as dependent on the illumination level, figure size, and viewing distance.Using the real contour standard modulus method it was found that particularly the small retinal size of figure (1.2^{o} - 4.8^{o}) as well as dim illumination (0.1 log lx) were most optimal for the strong contour impression. The data on inverse relationship between illumination level and subjective contour strength clearly conflicted with the lateral-inhibitory and simultaneous brightness contrast explanations of the problem.

Dumais and Bradley elaborated Gregory's object hypothesis theory and claimed that the reduction of illumination (i.e. legibility of information about the real stimulus array) might increase the role of cognitive interpretive mechanisms . The lack of interaction between "same retinal size - different distance" pairs was interpreted as a fact

stressing the retinal size per se being the critical factor in subjective contour.

The third group of cognitive theories of illusory contour was labeled a depth-cues theories. In Coren's (1972) already classical work the support for this theory came from the following observations:(1)Subjective reports about phenomenal characteristic of illusory figure as standing in front of the other elements (interposition cue). (2) The next depth cue - the shading - evident in several of the patterns producing illusory contour. (3) The fact that binocular disparity (being the depth cue) can generate anomalous contours after fusion (Julesz,1964; Shipley,1965; Lawson,Gulick,1967) is also taken as evidence for the depth theory of the subjective contour.The halves of certain dot stereogram, each lacking any continuous contour, would result in the binocularly fused image containing a clear contour. Lawson and Gulick (1967) demonstrated an anomalous contour even without retinal disparity of different stereograms.

Coren used an additional demonstration showing that circles of equal diametre and identical configuration, if placed one on the apparently closer cognitive contoured figure and the other on the background, can be seen as different in size. Because the one situated on the figure appeared smaller, then resting on the constancy scaling assumption , the perception of depth was implied. (Consider analogy on the Emmert law. - T.B.). Further on Coren showed the difference of texture density as depth cue being potentially important in subjective contour generation. In general the pure presence of depth cues would be - according to Coren - insufficient in order to evoke subjective contours. The prerequisite should be that presupposed three-dimensional depth could help to organize the image elements according to the simpler principle than the two-dimensional image. Kaufman (1974), when discussing the present problem, found similarities between the above statement and Hochberg's figure-ground organization theory.

Coren and Theodor (1975) argued against the simultaneous brightness contrast model of the subjective contour by

graphic demonstrations obtaining maximum contrast at regions which should be equally bright with other enclosed white regions if the contrast theory had worked.

3. Sensory-factors theories of the subjective contour

The first group here contains viewpoints, based on the hypothesis that the process of simultaneous brightness contrast between inducers and background field generates a phenomenally brighter zone which in turn gives rise to the subjective contour. The physiological basis for such a process should be lateral inhibition. So Brigner and Gallagher(1974) argued that the inducers' configuration predicts the direction of contrast between incomplete figures and the rest of the field. By juxtaposing the zones of equal apparent brightness, as Brigner and Gallagher argued, the appearance of the subjective contour should be granted.One of their important demonstrations was that strong subjective margins were generated if the brightness differences between inducers and background were pronounced contrary to the formation of weak contours when the heterochromatic (Munsell stimuli) background and inducers both of equal luminosity were used. An analoguous design was used by Gregory (1977) who also presented cognitive contour patterns as two-colour pictures with controlled brightness contrast at isoluminance (zero brightness contrast). He noticed the reduction in illusory contours and brightness differences , but nevertheless, contours did not disappear entirely.

The widely accepted fact of more pronounced generation of the subjective contour with small visual angle of the figure is again taken as evidence for the brightness contrast theory by Brigner and Gallagher. Namely, when the image is embraced by the foveal zone it is elaborated by the neural structures which are giving rise to the strongest contrast.

Rather close to the theory of the above authors are the views of Frisby and Clatworthy (1975). A special emphasis of these investigators is made on the process of lateral inhibition. Frisby and Clatworthy refer to the data (Cornsweet illusion) which substantiated the possibility of brightness

spread (assimilation) beyond the area covered by standard lateral inhibition thus explaining the nature of enchanced brightness over the full area embedded between subjective contours. A further important point was the postulate (hypothetical explanation together with graphical demonstrations) of greater brightness contrast at line ends than at line sides, originating probably from the retinal ganglion cells level.This enables to explain the formation of cognitive contours even without large dark areas (cf. Gregory, 1972 a; see also our figure 2). Frisby and Clatworthy agree that we should not rule out the possibility of cognitive "shaping" of brightness assimilation effects into illusory figure.

Brussell,Stober, and Bodinger (1977) investigated the same problem of whether the brightness contrast could be the principal factor in generating the subjective contours.They hypothesised that if the model works then the enchanced brightness contrast should accordingly yield the enchanced magnitude of the illusory contour (enchanced clarity). Results of experiment were not unequivocal.Apparently the inducing luminance had different effects on the clarity of subjective-contoured pattern and the magnitude of brightness contrast. Authors concluded that the contrast and the subjective contour are interdependent but not deterministically related phenomena.

The second group of sensory theories includes work on the significance of contour (line) detectors in the emergence of the subjective contour. Thus Stadler and Dieker (1969,1972) think of the partial activation of contour detectors as the critical mechanism. Jung and Spillman (1970) point to the interactive processes between the receptive fields of orientation-specific detectors at the cortical level which cause the subjective contour to appear.

The final theory,perhaps the most modern one, is based on the view that all contours are real and are based on the spatial-frequency analysing mechanisms (Ginsburg,1975).In his demonstration Ginsburg filtered the black Kanisza triangle, removing the high frequencies proportionally to the spatial modulation transfer function of the human visual system by

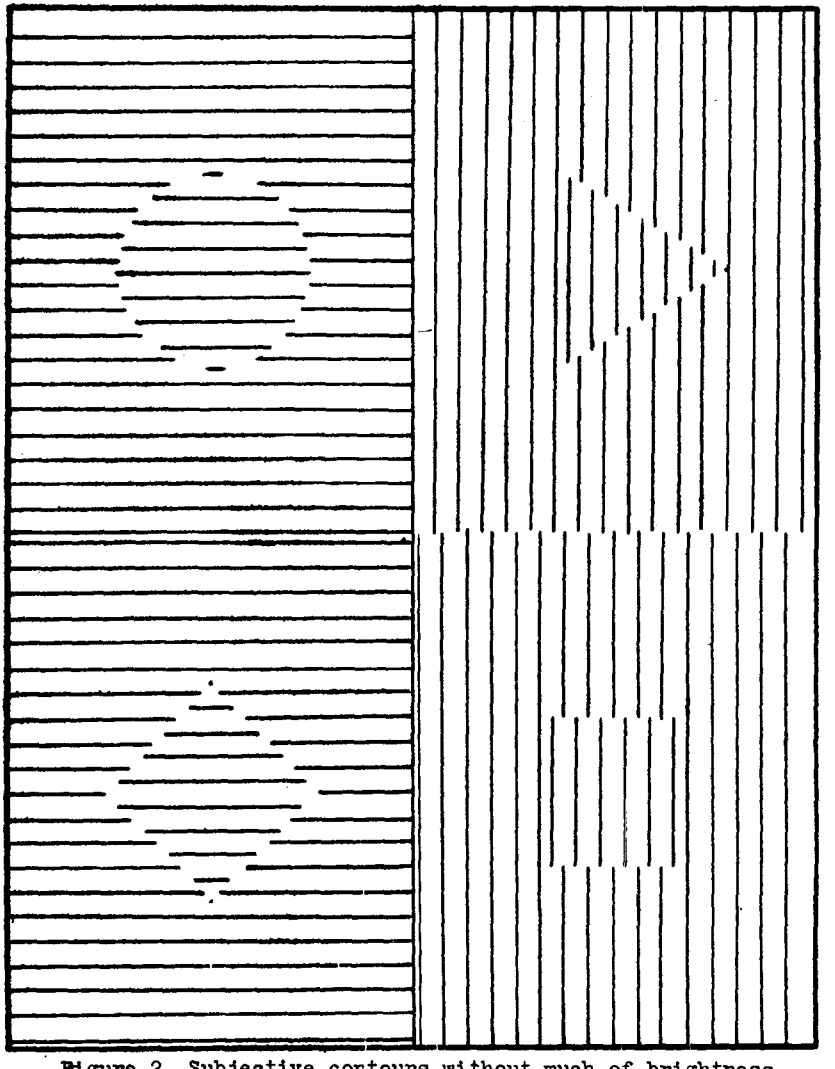

Figure 2. Subjective contours without much of brightness contrast. (Note the higher relative brightness of the field containing vertical lines as compared to horizontal-lined field. To control this subjective impression turn the page for 90 deg)

the use of the Fourier transform.The next step provided an inverse Fourier transform in order to reconstruct the attenuated data. As a result practically the same illusory triangle was generated having lower contrast in the lines however. In the next procedure Ginsburg filtered out even the most of high-frequency information and showed the resultant triangle with strong contours.If correlated with the actual triangle (of its low frequencies),then the subjective triangle appeared to be also "actual", whereas this correlation was true. Ginsburg concludes that, without adding cognitive clues, the filtering helped to isolate the illusory triangle information that was implicit in the overall spatial relations of the original features of Kanisza figure. Hence already the figure itself physically contained a triangle.

Ginsburg's discovery was disputed by Tyler (1977). His criticism is based on several observations and conclusions . Firstly, Ginsburg's original figure must have more resemblance with the actual triangle than the filtered one had, because the former contained no illuminated blobs in the triangular region contrary to the filtered one. Secondly , Ginsburg's discussion seemed to be based upon his subjective analysis of the filtered pattern, whereas the filtering operation was performed not by the brain of the observer,which, then, turns to be deprived of information probably important in reconstructing the unfiltered image. Thirdly, the line, evident in the filtered pattern in the place of the triangle's side, may be an artifact, because of the special characteristic of Fourier space step function's distribution, namely - repetition in the filtering variant used by Ginsburg. Fourthly, if the high-cutoff filtering was done in the smooth manner (optical filtering), the illusory triangle disappeared according to Tyler's own impression.In general, to show that the subjective contour can be perceived on the basis of a limited band of spatial frequencies is not the critical fact to conclude that this phenomenon is "physically" immanent in the stimulus.

In addition to the different theories the investigations have shown rather manifold manifestations of the subjective

contour: Tilt aftereffects (Smith,Over,1975), orientation masking and the tilt illusion (Smith,Over,1977), contour masking (Weisstein,Berbaum, and Matthews - after Dumais and Bradley, 1976), visual illusions (Goldstein, Weintraub, 1972; Day, Dickinson, Jorý, 1977; Gregory, 1972; et al.) , binocular rivalry (Harris, Gregory, 1973), angularity of contour, (Sambin, 1974,1977), figural aftereffects etc. All these phenomena in the subjective contour behave analoguously to the respective real-contour stimuli.

4. Discussion and the theory

It is not difficult to conclude that there are more controversies or complementary relationships than agreement between different theories of cognitive contours. None of the previously described approaches separately can explain all the data. In the recent studies, however, the consensus seems somewhat changed. The tendency to integrate different factors and theories is apparent as to show their principal nonexclusiveness and complementarity.So, Coren and Theodor (1977), after demonstrations of difference in the magnitude of increment thresholds inside the subjective-contoured pattern and control pattern lacking the subjective contour (with greater threshold for the former), argued that the subjective contour would be accompanied by lateral inhibitory or neural interactive effects, supporting brightness difference. But as this difference was rather small and confined to the area near the contour then the authors described the facts showing that the higher-level cognitive processing interacts with the properties of brightness contrast. As Coren and Theodor argued, the cognitive effects should have the gating function, either allowing the differential neural response originating from lateral interactions to manifest itself in consciousness, or, as an alternative, selecting an averaging (assimilative) mode of processing .(Analoguous integrative tendencies might be noticed also in Kennedy,Lee,1976).

The type of selectivity just described might be labelled as a "to-be-or-not-to-be" type of selection. But there exists another way by which the cognitive levels' selective

influence can manifest itself: If we observe the figure 1e , we can readily control the alternative phenomenal appearance of small subjective figures - "whiter than white" square or analoguous disc (ring).This seems like a "how-to-be" type of selection.This phenomenon of optional control over the choice of subjective contours proved the one departure point for our experiment (Bachmann,1977): If subjects could change the spontaneous tendency of appearance of the subjective figure in the fashion biased by preliminary categorical instructional set with controlled sensory parameters then this should be a strong confirmation for the cognitive theory.The second line of experimentation came from the opinion of Dumais and Bradley (1976) who predicted that the less the brightness of the display, the easier it would be for Gregory's cognitive object hypotheses to take an effect because of higher physical ambiguity of the stimulus.Actually,their data favored this idea.Let us hypothesise now,however, that we are lowering the brightness even more,up to the values of the recognition threshold. What then should disappear first - the subjective contour or the contour of inducers or both at once? To be systematic in using the Dumais's and Bradley's data and views, one should expect that the relative distinctness of the subjective contour increases. Intuitively it seemed to us improbable that this process could continue indefinitely.Moreover - one data point (the smallest figures), considered as an artifact by Dumais and Bradley, showed an increase in the subjective contour with systematic brightness enchancement. We decided to explore the microgenesis of cognitive contours by systematically increasing the contrast (brightness) of the stimulus field.

In the first series the relative contrast thresholds for inducer-pattern recognition and cognitive contour recognition were measured for six subjects (Bachmann, 1977). The total set of stimuli are shown in figure 1. The data revealed significantly lower thresholds for inducers than for the subjective contour for all forms exposed and for all subjects .(It should be pointed out that the naive subjects , believing the reality of "whiter than white" objects on slides, were employed). As for the figure 1e we found that

the small "square" was perceived 57.5% of trials, and the "disc" - in 42.5%. That ambiguous inducer was termed as the "cross" in the series of inducer threshold determination .

In the second series the instructional set, by varying the "probability" of appearance of the variants of figure 1e, was developed. This changed the previous per cents of two selection variants to the 96.7% for the "square" and 75.0% for the "disc", this change being statistically significant ($t = 5.87, p < 0.001$ for square; $t = 2.43, p < 0.05$ for disc). The response bias explanation of this outcome was ruled out by the fact that the differential thresholds of seeing "disc" or "square" remained unchanged at the statistically significant level ($t = 3.958, p < 0.001$). This means that the subjects' reports of each form were based indeed on their respective visual impressions.

The above facts as taken together indicate that we should accept the bifactor theory of subjective contour generation. On the one hand - the instructions and category expectations influence the phenomenal appearance of the subjective contour. The observer may control the variant of an image to be perceived and the rate of alternation (Kennedy, 1976; Bachmann, 1977). On the other hand, we can not ignore the sensory factors. The previously discussed data and our own data indicated that some degree of brightness contrast should be necessary for the formation of subjective contours. If we consider Gregory's theory, it has predicted the equality of the contrast levels for inducers and for cognitive contours, because as soon as the inducers' pattern is recognized, the object hypotheses must generate the subjective contour. In the light of our investigation this turns out to be in conflict with facts (Bachmann, 1977). Thus the mechanism of "cognitive inference" should work in ensemble with certain sensory mechanisms. In Krueger's terms interpretation might well work back to alter the extraction (Krueger, 1975). This coordinated operation of different levels of perceptual data processing showing the influence of higher cognitive levels to the lower sensory levels require us to forward the hypothesis about the

existence of feedback processes in the course of perception. In the information processing terms the encoding operations of category level should give feedback to the preattentive (Neisser,1967; Broadbent,1977) processes of icon formation.

Whereas - according to the previously described data - we should accept the existence of multiple determinants of cognitive contour formation such as simultaneous contrast (lateral inhibition),depth cues implicit in the display, line-detector activity,gestalt grouping principles, direction of attention, cognitive-category hypotheses etc.,there nevertheless seems to be one general integral property, on the basis of which we are able to characterize the coordinated activity of different levels in every concrete instance of subjective contour. This property is the object-quality of perception (see Leont'yev, 1975; Stolin, 1973; Logvinenko, 1976).All cognitive contours form some objects or they may be regarded as informative features of the object-related world. There have been several descriptions of lack of object-quality when perceiving through the pseudoscope or with inverted vision (Stolin, 1973; Logvinenko , 1976; Puzyrey, 1976). The authors argue that in those cases the object-quality of percept would be artificially separated from the "sense-related weft" of consciousness (cf. "visual world" vs the "visual field") and neglected from the percept. Analoguously, in case of cognitive contours the pure seeing of "sense-weft" would be obtained with analytical set. As a rule in such conditions the subjective contour tends to disappear, thus pointing to the immanent object-relatedness of the subjective contour. On the contrary, the relatively greater weight of object-quality as compared to peripheral processes might be the case when Gregory (1977) described the impression of quasi-detectable subjective contours with an isoluminant display containing inducers of different chroma: Again, with only one level involved (object hypothesis) the phenomenon is not full-blooded.

So our explanation is somewhat similar to Gregory's object hypotheses, yet the difference is marked. We propose that the object hypotheses have to work in ensemble (by

feedback and concurrent maintanance of activity) with sensory processes in order to evoke the impression of a contour. The mechanism servicing the object-quality of percept should be the kind of integral attention in the sense that the sensory data and cognitive-categorical data are simultaneously represented (integrated) in the awareness so as to give rise to the cognitive contour. The hypotheses, generated on the basis of inducers, enchanced brightness zones, depth cues and the like could not solely (as a final stage of percept-genesis) be responsible for the subjective contour but become the controlling and classifying element in the integral percept. To use once again the example with the analytical set we believe that in this situation the integral nature of attention is disturbed, attention is turned mainly onto the certain sensory zones selectively amplifying the information intake from that display areas and consequently the nonexisting contour disappears.

One possibility of description of the nature of real perception process with feedback requires us to examine the principles of percept microgenesis (Flavell, Draguns , 1957; Smith,1957). As we know, the process of perception consists of gradual development of image qualities, having specific phases and being too rapid for introspection as to reflect it adequately. The perceptuogenetic process takes no less that 100-150 msec. Lomov (1966) outlines the next phases: (1) The coarse differentiation of stimulus localization and overall proportions. (2) "Twinkling" of form. At this phase of instable perception of an actually invariant stimulus, the observer may perceive, for example, at times the square,at times the ring, or occasionally the other alternatives (cf. also Andrews, 1967). (3) The phase of coarse discrimination of main details and abrupt changes of contrast. (4) The phase of globally-adequate perception without reflecting fine details. (5) Optimal perception with appearance of differentiated and stable image.

In the course of percept-genesis the meaning (category , object-quality) is aquired at the final stages (Lange,1893 ; Nikitin, 1905; Zhirmunskaya, Bein, 1974).

Our previously described experiment (Bachmann,1977) revealed that the cognitive contour should not be formed at the first stages of microgenesis; not earlier than the final phase of inducer-elements analysis. If we parallel the "twinkling" phase (Lomov, 1966; Andrews, 1967) of percept growth with the alternating of Gregory's cognitive hypotheses it appears clear that the subjective contours do not emerge as based solely on this stage. Certain minimum level of intensity of sensory stimulation is also necessary. In other words - the hypotheses about object-quality of stimulation seem to be able to generate the relatively stable invariants of sensory image (icon) only if the sufficiently full sensory material should be provided. This guarantees the general backround of activity of the detectors of actually present sensory features which in turn activate the detectors, receptive fields of which are tuned so (orientation, length, localization) that the detector become triggered should the features be analoguous to cognitive contours being hypothesised. Whereas such kind of activation causing the subjective contour depends not on the intense actual afferent information but on the indirect lateral influence from the neighbouring detectors and the (due to the) feedback from object-quality categories, the subjective contours should be perceived as scarcely sensed supralevel signals.

We may suppose that this activity of individual detectors and the products of lateral inhibitory activity should be integrated at some next intermediate level, which is connected with a visual impression (image). In information-processing terms the sensory register activity, being afterwards integrated and fed on to form the iconic image, might constitute the preattentive process, being under the control of feedback from the encoded levels. This feedback represents the mechanism by which the gestalt groupings are formed and variants of ambiguous cognitive contours selected.

In addition to the above described considerations the integral nature of image formation is supported by Pribram (1971). The advantages of his holographic model of sensory coding appear to be first, the possibility of reconstruction (though less distinct) of the whole signal if only part

of it (of the hologram) had been presented, and, secondly, the possibility to perform the cross-correlations between stored and input patterns. The above first point seems analoguous with our situation with cognitive contours: Having only part of the data at input (e.g. sectors as corners of bright triangle on figure 1a) the whole image of triangle should be generated. With regard to the cross-correlation it should be noticed that in case of identity of the standard (e.g. using visual code; Phillips, 1974; Velichkovsky, 1977) with actual sensory input data we probably may speak of an autocorrelation process. On the basis of autocorrelation such phenomena as repetition-clarity effect, fading of stabilized images as well as form (pattern)perception (recognition)in general have been explained (Dodwell , 1971; Uttal,1975). The stabilized image fading is thougt tc be the result of auto-correlation disturbance due to the lack of <u>different</u> samples of information (cf.Dodwell,1971). This again is close to the disappearance of the illusory contour when carefully fixating on it and, on the contrary, to the ease of seeing illusory patterns when one moves his eyes over the pattern. All this forces us to hypothesise the subjective contours as being the result of autocorrelation of different (temporally and spatially) information pickups, executed on the objects situated in the visual field, with the information in the holographic encoded category system, the attention being the catalyst of selection of a class-representative for the autocorrelation.

The microgenetic "twinkling" phase, by the way reported by some of our subjects (Bachmann,1977), might reflect the stage where the autocorrelation process could not yet finish the invariant cycle in order to "retouch" the actual information. The conscious, invariant percept of some "whiter than white" object could be the result of pre-conscious competition of different hypotheses, interpretations, and crosscorrelation variants.Thus the function of consciousness would be the <u>conflict-resolving-power</u> when different hypotheses and inquiries (cf. Navon,1975, after Broadbent , 1977) had been applied back to sensory data (to "suggestion", after Navon). And if the sensory evidence (sugges-

tion) is ambiguous, weak, noisy, too brief, too numerous,or peripheral, the invariant sensory features, characteristic of the presupposed objects, should be entered to the icon not only as afferents, but also from the lateral and/or higher levels without their actual presence in the visual field. Whith regard to the above the cognitive contour inducers may be viewed as ambiguous patterns.

Our hypothetical theory requires that the data have to be processed at the same time at different levels. The preliminary pre-conscious processing at the beginning of microgenetic process already reach the higher levels without completion of the lower level processes. As a result the feedback from the encoded functional blocks becomes possible and sensible, this operations being well done also before the final formation of conscious percept. The process of "taking into account" (Epstein,1973) could be the mechanism by which the depth cues, lateral brightness enchancement, closure, the experience of statistics of data-distribution and common arrangement principles in the visual field,etc. should help to organize the growth of a percept. In case of our object (figure 1e) the visual system may encode it as the cross, made from dark parallel lines with some bright object on the centre. Since the gap in the black contours of that form as it is seen could be caused equally well by overlaying a white square or a white disc (then) the currently dominant interpretation gives a feedback e.g. to the sensory registers of straight edges with receptive fields corresponding to the location of the gap; or alternatively the analyzers of curved edges (lines) with respective receptive fields may be activated. At the iconic level this results in the integration of sensory features to the concrete object, corresponding to the higher-level interpretation (hypothesis) - the square or the disc. We wish to stress again that such relatively optional mode of percept growth with "up-to-bottom" route of information being decisive proves atypical, its manifestations found mainly in the above-described difficult or ambiguous visual conditions. Pachella (1975) had ingenious demonstrations and

discussion of how set can influence the perception at the subjective level.

Clearly, the cases of cognitive contours are examples of productive operation of the perceptual system (cf. Zinchenko, 1973). They are examples of some kind of interpolated events. The contours are interpolated at "empty place". The inducer elements are interacting in the creative mode. This might be termed the static creative interaction. But the analoguous phenomena could be dynamic as well. We feel that the stroboscopic motion, the kind of dynamic creative interaction also represents a situation where a subjective (albeit moving) contour had been generated, interpolated at "empty place". Moreover, analoguously to the possible ambiguity of subjective contours and the optional cognitive control of their variants the ambiguous apparent movement patterns have been described (Kolers, 1972; Attneave, Block, 1974), also enabling attentive influences on the movement organization with invariant display parameters.

Before summing up let us briefly remind some main prerequisites of our proposed resonance-by-feedback theory of subjective contour formation.

1. The consciousness and subjective experience (impression, awareness) should be regarded as having multidimensional integrative power (compare Zinchenko, 1973; Dzhafarov , 1976). The cognitive objects' categories, physical representation of external object in iconic memory, phenomenal evidence of sensory features and gradients - all these (as a minimum) constitute the integral percept.
2. This percept is formed microgenetically with respective preconscious processing at all levels preceding the growth of subjective, phenomenal representation. Thus preconscious hypotheses might be developed before completion of icon formation.
3. The process of attention, although having the capacity of integrating information from several different levels , requires time for this. Else the interference-causing interaction would be observed. (cf. the situation where too rapid succession of stimuli yield processing interruption resp. the switch of attention from the previous element

encoding onto the next element's sensory-perceptual analysis with backward masking as a result; Bachmann,Allik, 1976).The subjective contour as a phenomenon of creative interaction requires just integrative kind of attention (i). Otherwise this contour tends to disappear as in the case of concentrated (analytic) attention to "visual field" which parallels to the inhibition of cognitive processing. So attention might be switched (ii) between levels as well as within one level (e.g. Zinchenko, Vergiles, 1972).

4. To warrant the influence and control-possibility of higher (encoded, object-quality) levels in the present system of simultaneous activity of different levels (though genetically developed activity), the feedback channels for "up-to-down" regulation and data transmission should be postulated. This principle together with the above ones could explain the cognitive contour formation in the phenomenal representation, the context effects in perception (cf. Smith, Spoehr, 1974; Biederman , 1972), the facts of class recognition before item recognition (Brand, 1971). It also helps to resolve the paradoxes of subliminal perception (e.g. the homunculus paradox; see Dixon, 1971; Erdelyi,1974).

By the use of this multilevel information processing system featuring feedback paths it can be possible to obtain the resonance between different levels and different cues or features represented by each one level in order to generate the invariant percept of some object. Sometimes this percept may contain subjective results of creative interactions.

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VISUAL SEARCH AND SELECTIVE ADAPTATION

Talis Bachmann

Abstract .Subjects searched for the presence of a target stimulus in the displays of disc-formed stimulus patterns,"cut out" from square-wave gratings of four differeferent orientations. Targets were specified and displays exposed immediately after the subjects had been selectively adapted to one of the four differently oriented gratings. Orientation-specific adaptation lowered the probability of correct detection and localization of both the targets and the nontarget stimuli, but the threshold elevation for targets was smaller than for nontargets. Statistical analysis showed, that this interaction between adaptation-specificity factor and stimulus factor (target - nontarget) was significant only for one out of four subjects. Some possible explanations of the results,showing also permanent significant superiority of target detection over nontarget detection are given. The above-mentioned explanations are connected with locus-of-selectivity problem.

1. Introduction

Among the most widely discussed problems in the field of perceptual activity investigation there is the problem about whether selectivity, caused by set or attentive pretuning (priming) by foreknowledge operates at the input stage of the incoming data analysis (perceptual or sensory selection) or at the output stage (selection within short-term memory or some response bias). Beginning with the classical work by Külpe (1904), one group of investigators prefers the perceptual explanation (Ickoyama, after Boring, 1924 ; Chapman,1932; Neisser,1963; Bower,1965; Egeth and Smith,1967; Treisman,1969; Aderman,Smith,1971 ; Gummerman,1971; Estes,1972). Others (Wilcocks, 1925; Lawrence,Coles,1954; Lawrence,LaBerge,1956; Brown,1960; Deutsch,Deutsch,1963; Harris,Haber,1963; Gummerman,1970 ; Gardner,1973; Shiffrin,Geisler,1973; Shiffrin,1975) favour the output-explanation of selectivity, while the rest of

the researchers hold that, depending on the task and stimulation parameters both the input and output theories of selectivity can be accepted (Long, Reid,Henneman, 1960;Haber, 1966; Erdelyi,1974; Garner,1974; Krueger,1975; Asmolov, Kovalchuk,Yaglom, 1975; Bachmann,Allik,1976; Ornstein,Winnick, 1968; Winnick,Daniel,1970; Tolkmitt,Christ,1970; Skanes,Donderi,1973; Kahneman,1973; Herzog,1976; Carr,Bacharach,1976; Dodwell,1970;Underwood,1976; Keren,1976; Bachmann,1977a,b).

The two important experimental methods,most frequently employed for resolving the above dilemma, are the "before - after" design and the method, used by R.M.Shiffrin and his collaborators (Shiffrin,Geisler,1973; Shiffrin, 1975).Regardless of the indisputable productivity of these approaches the problem of localizing selectivity is still in the order of the day. The possible reasons for such a situation are pointed out elsewhere (see Egeth,Bevan,1973; Carr,Bacharach, 1976; Keren,1976; Erdelyi,1974; Underwood,1976; Bachmann , 1977a,b). In the light of persisting actuality of the discussion we feel that it would not be superfluous to introduce an additional method which could give us some data about the questions under interest.

After analysing the literature on the locus-of-selectivity problem we reached the conclusion that the experimental design would have to meet next requirements: (1) only one before-instruction should be used (in order to overcome the possibility of artifacts due to the image decay factor and to the ignoring of the microgenetic principle of percept growth). (2) Only one critical (relevant,target-) stimulus or feature should be pointed out before the exposition of actual display so as to obtain the true narrow pretuning effect (unlike the forced choice techniques employed in many of the "before-after" type of investigations and Shiffrin's experiments). (3) The data about processing effectiveness of target stimulus and nontarget (background,noise-,irrelevant) stimuli and for emphasizing both alternative hypotheses should be collected on the basis of the same set of trials (as Lawrence ,LaBerge,1956,in Emphasized condition). (4) An additional technique (converging operation) which could help us to point out the sensory or perceptual level should be used.

2. Experiment

The task of visual target search from brief simultaneous tachistoscopic displays of stimulus matrices was chosen. In each trial subjects had to find out and localize the target stimulus among the background items (analoguously to the task, used by Solman 1976). Additionally, the subject was required to localize correctly the background stimuli, for which he was not preset, as much as he could. The trivial hypothesis predicts that due to the operating of some selective process there should be a difference between the correct target localization level and the mean correct nontarget localization level in favour of the first. But this selectivity may result from input as well as from the output processes. The converging operation we chose for controlling the sensory-perceptual level of processing was the selective adaptation technique. On the basis of specific adaptation of sensory channels to a certain sensory feature, included in targets and nontargets, we obtained the possibility of elevation of perceptual thresholds for stimuli used. In our experiment, every trial employed the orientation-specific adaptation in such a way, that the adaptation stimulus orientation coincided with the orientation of only one of the stimuli. The underlying variable of interest was the relative threshold elevation for targets and for background items.

2.1. Method

Four students (three female, one male) possessing normal vision were the subjects. Four discs, made ("cut out") of differently oriented square-wave gratings (8 cycl/deg) served as the stimuli (see figure 1). The different orientations used were: vertical, horizontal, 45° (right oblique), 315° (left oblique). The stimuli were presented in random combinations of three items in a 2 x 2 matrix so that each stimulus appeared equally often at each position. Thus one stimulus from the total set of four was always missing

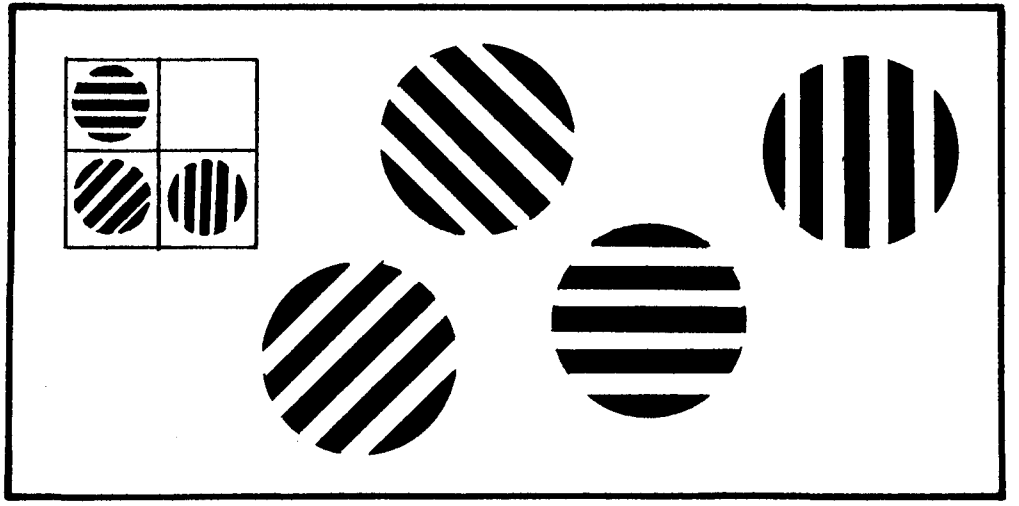


Figure 1. Examples of the stimulus discs, "cut out" of the four differently oriented square-wave gratings identical to the adaptation gratings, and an example of stimulus matrix with stimulus discs.

from the displayed matrix. The side of the square-formed matrix subtended 1.2 deg of the visual angle and the stroke width of the matrix's sides and its inner elements was 0.06 deg. Each stimulus subtended 0.5 deg of the visual angle. The matrices were presented by means of a three-channel mirror tachistoscope in the centre of a rectangular illuminated stimulus field which subtended 5 deg vertically and 6 deg horizontally. The fixation field matched the stimulus field exactly in size and position and had a fixation cross (0.15 deg) in the centre. The subjects saw the displays binocularly. There were four different adaptation stimuli, matching in size exactly the stimulus field and the field with the fixation cross. The adaptation stimuli were square-wave gratings with the same spatial frequency and the same four orientations as in the stimulus discs, but covering all the field (5^{o} x 6^{o}). In the centre of the adaptation gratings there was a ring, subtending 0.3 deg of the visual angle.

2.2. Procedure

Four series were used in the experiment, specified according to the single adaptation grating employed within each. The sequence of events in each trial was as follows. An adaptation grating appeared for 40 seconds with a luminance of 3 cd/m^2. Then it was followed by the fixation field for 1000 ms (1 cd/m^2). At the termination of the fixation field the stimulus field with a stimulus matrix with three stimuli appeared for 25 ms with a luminance of 8 cd/m^2, followed again by the the fixation field for 1.5 seconds. The subject was instructed to view (with no steady fixation but with controlling the acuity of image) the adaptation grating, avoiding the excess of the central ring area. He was informed that at the termination of the grating the orientation of the target (vertical, horizontal, "right"/45^{o}/, or "left" /315^{o}/ would be told him while he would be fixing his gaze at the fixation cross, his main task being to search the target in the following matrix and detect the target localization. The additional task he knew before exposition was to locate all the other stimuli which he could see in their

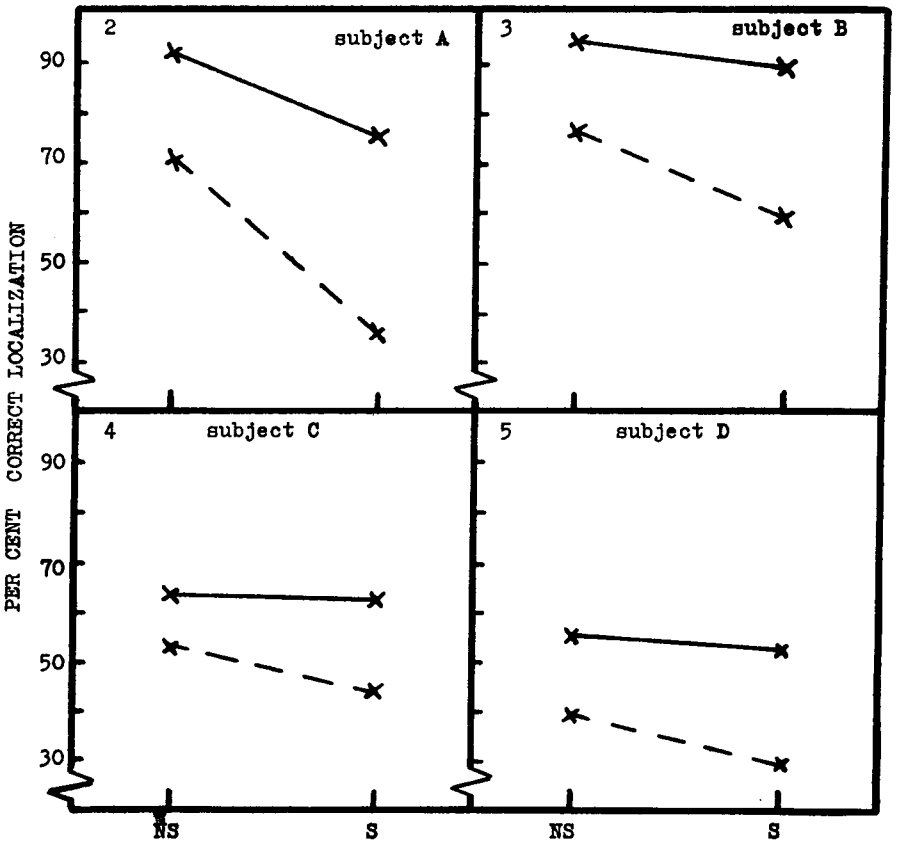
correct locations. The subjects knew that at times there was no target item on display. To fill the response sheets the subjects used the following code: They filled the cells of matrices by putting down single lines on the analogy of the stimulus orientation in an appropriate location. It was stressed that it was desirable to recognize a maximum amount of the stimuli within any single trial, however, without forgetting to pay attention to searching out the target. In each of the four selective adaptation conditions 216 expositions were given per subject. 120 trials contained a target disc in the display, in 96 trials the target was missing. Each cell of matrix equally often contained the target and each stimulus was equally often specified as a target. A single adaptation grating of one orientation was used for each of the four series, therefore the interval for recovery from adaptation between trials could be ignored; and orientation-specific (selective) adaptation was developed in alternation for the target stimuli, the nontargets, and the missing stimulus in random order. The targets and missing stimuli were also determined in random order. In each adaptation condition the target item's orientation corresponded to the adaptation-grating orientation in 40 cases, and in 80 cases the adaptation was nonspecific to the target orientation. 120 times nontarget orientations differed from the adapted orientation within each of the series, and in 40 cases these orientations coincided. Expositions of the matrices containing only nontargets (if the name of the target and the missing stimulus were the same) employed a selective adaptation to the nontarget orientation in 32 cases and a nonspecific adaptation in 64 cases.

2.3. Results and discussion

The scoring of results was done on the basis of per cent correct localization of target discs and the mean per cent correct localization of background stimuli. A two-way ANOVA was used for the treatment of the data of each subject, the two factors being the stimulus type (target, background

stimulus), and the adaptation condition (orientation-specific selective adaptation, nonspecific adaptation). The results of each subject are displayed graphically in figures 2 - 5. As it can be seen, the targets have always been detected with greater efficiency than background stimuli, and this result confirmes our assumption about the existence of certain selective process by which the critical information is analysed. This trend is significant for all subjects (for A: df=1,476; F=39.213; $p < 0.01$; for B: df=1,476; F=30.935; $p < 0.01$; for C: df=1,476; F=7.588; $p < 0.01$; and for D: df=1,476; F=13.293; $p < 0.01$). The figures also show that the selective adaptation to grating orientation, which coincided with the stimulus orientation, resulted in the lowering of correct perception level for both targets and the background discs. But this threshold elevation is relatively smaller for targets as compared with nontargets in all subjects. Statistical analysis, however, showed that this interaction between the two factors was significant only for one out of four subjects (subject A: df=1.476; F=4.119; $p < 0.05$). For the others this "interaction" appears only visually (see figures 3-5). It is interesting to point out that for the subjects A and B whose performance indicated the significance of the interaction between factors (subject A) or tendency to the significance (subject B : df=1,476; F=1.647; $p < 0.25$; see also figure 3), the adaptation specificity factor also was significant, showing the effectiveness of adaptation in threshold elevation (for A: df=1,476; F=29.141; $p < 0.01$; for B: df=1,476; F=7.342; $p < 0.01$). For the subjects C and D the weaker adaptation effect paralleled also with the total lack of statistical interaction.

What, then, could be the way by which we are able to explain the empirical results? The explanation of selectivity on the basis of selective overt eye movements should be excluded because of too brief exposition of test matrix (25 ms) and because of positional uncertainity of stimuli. The response bias effect also seems unapplicable since the special type of response (localization) was



Figures 2 - 5. Per cent correct localization of targets (continuous line) and nontarget stimuli (fragmentary line) as dependent on the adaptation conditions for subjects A,B,C, and D. NS - nonspecific adaptation; S - orientation-specific adaptation.

given in all trials without modification of instruction and probabilistic parameters. At present we tend to favour the two possibilities of interpretation.

The first general explanation of our present preliminary data is based on the consideration of scanning process of the contents of iconic memory. Here it is assumed that the fact of greater efficiency of target processing and the tendency of differential threshold elevation for targets and background items with relatively greater sensitivity to targets would be the result of scanning order : While the target is scanned out first, the nontargets, in their iconic form, loose legibility ("attensity") and subsequent further scan appears less effective. Moreover, recent investigations have demonstrated that orientation-specific adaptation shortens the duration of corresponding visual short-term storages (Meyer, Lawson, and Cohen,1975). So the iconic image of the background item had to fade more quickly when its orientation coincide with the adaptation grating's orientation and, consequently, its scanning should not be as effective as in the case of nonspecific adaptation.

The second main possibility assumes the direct interaction of preliminary selective tuning process with sensory-perceptual analysis of stimulus,which results in a clearer ("retouched", "standing out", contrasted, amplified) perceptual image or icon in the locus of target signal. This possibility equals the pure input-selectivity hypothesis. Elsewhere we proposed the model of microgenetic feedback-controlled image formation process, which could explain how critical information can obtain the greater relative "attensity" in comparison with nontarget stimulation (Bachmann, 1977a) . The basic feature of the model requires the visual information processing to take place <u>simultaneously at different levels</u>. The part of signals is fed on and encoded on to higher levels, up to semantic analysis before the processing at more sensory levels is completed. This enables , after successful comparison and matching of first bits of actual target-related stimulus information with the preliminarily activated selective standard at higher levels,to give positive

feedback to the lower-level feature analysing and/or icon-building systems at the "locus" of target information. This very fast cyclic process of perceptuogenesis (in the domain of dozens of ms) probably results in a "retouched" target stimulus representation in the iconic image. If the previous scanning hypothesis taked for granted the successive processing of signals from icon and hence the all-or-none type of selectivity, the present mode of selection is not juxtaposed to parallel processing of stimuli.

On the physiological level the feedback operations might be carried out with the aid of superior colliculus complex (see Goldberg and Wurtz,1972) or under the control of the inferotemporal cortex (Pribram, 1971). Recently several papers forwarded the view that the selectivity of information processing might be based on the activity of two visual systems - the transient channels system and the sustained channels system (Breitmeyer and Ganz, 1976; Bachmann, 1977a,b) . Hypothetically, transient system "finds out" the presupposed target locus in the set of sensory channels and directs then the more slow and detailed analysis, performed by sustained system onto that locus.

The principle of internal feedback from higher recognition units to the lower-level sensory processing receives support from some recent investigations on attentive information processing (Mackworth, 1971; Gordeyeva, Nazarov, Romanyuta,Yarovinskij,1972; Kahneman, 1973, p. 83-84; Hoffman, 1975; Navon, 1977) and also it could help to describe the psychological nature of autocorrelation process, proposed by recent pattern recognition models (Dodwell, 1971; Uttal , 1976), in the time-sampling aspect of pattern information pickups. Due to the preactivated selective standard the autocorrelation process should be selectively amplified on the locus of target information analoguously to the repetition-clarity effect. Due to the sensory-perceptual "retouching" of target the selective adaptation should influence its detection less than the detection of not "retouched" nontarget stimuli. This was the apparent tendency in our experiment.

Some possible means for choice between the above described two selective mechanisms could be : (1) modification of the variable of adaptation duration, (2) modification of the spatial frequency of stimuli, (3) variation of the number of stimuli, (4) variation of the number of needed-to-reproduce background stimuli. These modifications are currently used in our laboratory.

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SPONTANEOUS MOVEMENT PERCEPTION: PRECISION OF THE TEMPORAL DISCRIMINATION DEPENDS ON SPATIAL SEPARATION

Jüri Allik Milvi Tepp

Abstract. The present paper examined the displacement thresholds as a potential method for the investigation of the spontaneous movement perception. The displacement thresholds were measured as a minimal temporal asynchrony detection between the onsets of two spatially separated flashes by the subjects. The precision of the temporal asynchrony discrimination was found to be approximately inversely proportional to the square root of the spatial separation between retinal points of stimulation. A theoretical consideration allows one regard to the discrimination function as a measure of spatial "weights" by which the nonlinear interaction between any two input elements contributes to the total movement detection.

1. Introduction

At least two trends within the stroboscopical motion paradigm can be distinguished. The first trend, called conventional stroboscopic motion paradigm, started with the research by Wertheimer (1912) and Korte (1915).At the present time there is no doubt that the investigations under this trend reflect the high-level function of the human visual system. A typical conventional procedure utilizes relatively simple figures that are sequentially presented in two (or more) different spatial and temporal positions.The subjects' reports are based on the perceptual quality or subjective goodness of the apparent movement. Under the described conditions the perceived movement may be based on a logical inference from successive appearance and disappearance of spatially separated objects in the visual field.The most plausible explanation for the conventional paradigm is that the subject's perception results from a process analogous to intelligent problem solving.Thus it is the result

of a perceptual inference about object in space (Sigman , Rock,1974).

Another line in the history of psychology originates from the studies of Exner (1875) and Basler (1906). It was shown that the distance by which a spot of light of constant intensity must be displaced to be seen as different from a stationary one is several times shorter than the distance by which two flashing luminous spots must be separated to be distinguished as different from one spot. This observation suggests a relatively simple and primary status of motion perception which most likely guarantees low displacement thresholds. As a rule the visual task of displacement discrimination is achieved by any subject without remarkable effort and deliberation. Thus it is the case of pure or spontaneous perception which depends very little or not at all upon someone's will.

The most powerful technique for the investigation of spontaneous motion perception is to ask the subject to discriminate the direction of motion within a complex random-dot patterns (Anstis, 1970; Julesz,1971; Bell,Lappin, 1973; Braddick,1974; Lappin,Bell,1976). But other methods are also available. Thorson et al. (1969) renewed interest in Exner's paradigm showing its suitability for an objective measurement of spontaneous movement perception. The most critical property of this paradigm is as follows: the subject is required to determine the direction of perceived movement without notions about the subjective "goodness" or "quality" of the movement. Using this method we were able to show that the displacement thresholds have some properties (directional specificity,linear superposition) very similar to the thresholds of moving sinusoidal gratings (Allik et al., 1977). This similarity allows us to assume that the determination of displacement thresholds is a potent method for the investigation of spontaneous movement perception.

The experiments reported in the present paper examined the displacement thresholds in the human visual system. The basic question of the study concerns the functional interaction between spatial and temporal constraints of the displacement discrimination. More frequently the displacement thresh-

olds were measured as a minimal distance of a constant intensity spot by which it must be displaced to be seen as a shifting one, differently from a stationary spot. The displacement threshold estimated by the above mentioned method is about 1' or even less in the central part of visual field (Basler, 1906; Scobey,Horowitz,1976) and highly dependent upon the dynamical range of stimulus presentation (Tyler , Torres, 1972; King-Smith et al.,1976; Butler et al., 1976). The procedure used in the present investigation differs from the above mentioned studies by a logical inversion of spatial and temporal conditions.The displacement thresholds were measured as a minimal detected temporal asynchrony between onsets of two spatially separated spots. Thus the temporal constraints of the displacement discrimination were determined as a function of spatial separation between two luminous spots.

2. Methods

2.1. Apparatus and stimulation

Stimulus configuration consisted of two yellow-green light emitter diodes having the emission maximum at about 570 nm.Their luminance was estimated to about 10 nt. Each stimulus has an approximately rectangular form subtending 3 and 9 min of visual angle at a viewing distance of 114 cm. The average illuminance in the experimental room was held constant at a level of 0.5 lx measured at the site of the subject. The stimuli were presented on a black background with a red fixation point 1° below the main stimuli.The spatial separation between the stimuli was varied from experimental series to series in the range of 6' - 120'.The form of the stimulus in the time domain was controlled by a two-channel pulse generator with outputs an approximately triangular wave-form with a sufficiently rapid rising time. The duration of the pulse was held constant at 10 ms. The temporal asynchrony between the onsets of the two pulses was varied and the actual value was monitored by a frequency metre (Ф5080). Throughout the present paper we define the temporal asynchrony as $t = t_1 - t_2$ where t_1 is the onset time of the righthand stimulus and t_2 is the onset time of the lefthand stimulus. Thus,the negative value of t corresponds to the leftward displacement.

2.2. Procedure

The subject was dark-adapted for at least 5 minutes prior to each experimental session. She/he was sitting with the head fixed in front of the stimulus display and vieving the fixation point binocularly. The method of constant stimuli was used. Within a set of 11 different values of Δt any value of Δt was chosen in a random order. In each series there were 18 trials at every value of Δt.

The subject was required to decide in what direction the perceived movement occurred. Only two possible answers were permitted: "movement to the left" and "movement to the right".

2.3. Subjects

Two persons of normal vision served as subjects: one female (V.R., 20 years old) and one male (H.O., 23 years old). The subjects were well trained and highly experienced in the participation in the psychophysical experiments, however they were naive as to the expected results of the present experiments. It is important to notice that the visual task of the present study could be performed without any special training and effort by the subjects.

3.0. Results

The results of the present experiment are presented on Fig. 1 (the subject H.O.) and on Fig. 2 (the subject V.R.). The results are plotted as a percentage of the subject's reports "movement to the left" against the temporal asynchrony between the onset of two flashes. The left-right discrimination versus temporal asynchrony was determined at nine different spatial separations from 6' up to 120' which correspond to the alphabetic order of the figures 1A,1B,..., 1I (respectively 2A,2B,...,21). Each point present on these figures represents a per cent of the answers "to the left" at the given value of the temporal asynchrony from the total number (n=18) of trials. One can notice a simple rule which governs all results irrespectively of the spatial separation and the subject. This rule could be formulated as follows: at extreme values of the temporal asynchrony ,

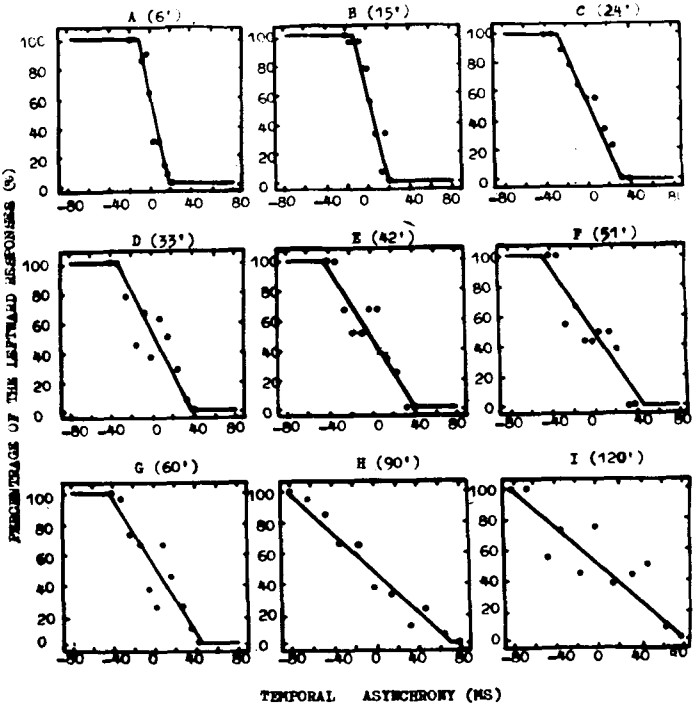

FIGURE 1. Percentages of the leftward movement discriminations as a function of the temporal asynchrony Δ t (in ms) between the onset of two flashes. The increase of spatial separation (6', 15',24' 33',42', 51',60',90' and 120') corresponds to the alphabetic order of figures. The results of the subject H.O.

the subject was able to discriminate the rightward and leftward movement in accordance with the highest level of probability. On Fig. 1 and 2 this case corresponds to 100% and 0% reports of the "movement to the left". There is an intermediate range of temporal asynchronies around zero (this, of course, corresponds to the simultaneous presentation of two flashes) where the determination of the movement direc-

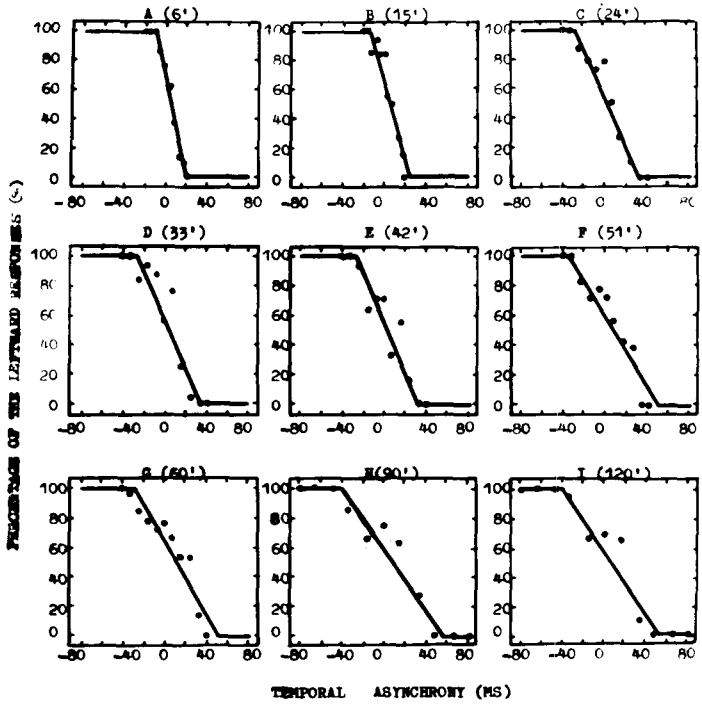

FIGURE 2. The same as Fig. 1.The subject V.R.

tion.changes indefinitely i.e. responses "to the left" alternated with the subject's responses "to the right". The width of the range of indefinition characterizes the temporal precision of the displacement discrimination.As one can notice there are regular and continous changes in the subject's answers from one category to the other.For this reason we applied a linear approximation for the description of the subject's answer transitions. The continous sloping lines on Fig. 1 and 2 are the best approximations for the number of empirical points expressed graphically. The results of the linear approximation are presented in the numerical form in Table 1. The coefficients of correlation are highly significant. (In each case $p < 0.0005$ at least) . Here two points should be beared in mind. Firstly, the linear regression is computed

on the basis of the number of the subject's answers "movement to the left" instead of the percentage of answers (100% equivalent to 18). The approximation was applied to the region of temporal asynchronies which elicits the subject's indefinite responses except the first values where the answers reach the level of absolute confidence. Secondly, to prevent some possible misunderstandings we should like to emphasize the purely technical nature of the linear approximation without any obligation to the sophisticated neural quantum theory.

TABLE 1. The results of the approximation by the linear regression y = ax+b. The linear regressions show changes in the left-right discrimination (the real number of answers "to the left" was used) in a definite range of temporal asynchronies. The table presents values a, b, and coefficient of correlation r at different values of spatial separation. Subjects: H.O. and V.R.

Spatial separation (min)	Subject					
	H.O.			V.R.		
	a	b	r	a	b	r
6	-.622	10.63	-.973	-.516	10.40	-.977
15	-.502	10.89	-.942	-.498	11.70	-.957
24	-.267	10.00	-.986	-.293	10.23	-.973
33	-.192	9.34	-.892	-.333	10.44	-.932
42	-.199	9.12	-.864	-.263	10.11	-.922
51	-.180	9.03	-.833	-.200	10.90	-.944
60	-.200	9.00	-.900	-.192	11.38	-.887
90	-.144	7.91	-.972	-.189	10.64	-.944
120	-.095	9.52	-.855	-.202	10.11	-.937

The slope of the linear regression characterizes the subjects' performance to discriminate the temporal asynchrony between the onset of two adjacent flashes. As it becomes evident from the present results the growth of the spatial separation is accompanied by a decay of the linear regression slope. The value of the coefficient a decreases

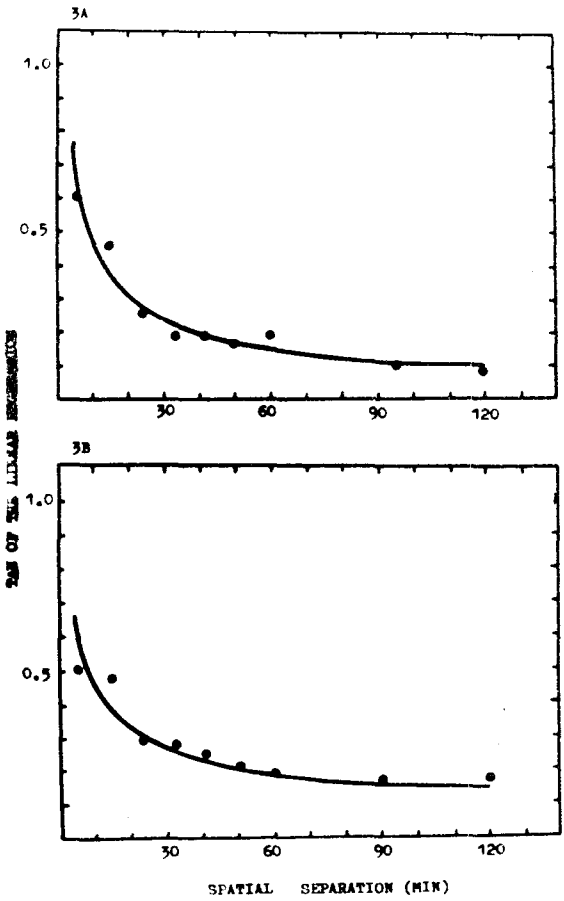

FIGURE 3. The slope of the linear approximation (in absolute values of the multiplier a) as a function of the spatial separation (in min). The results of the subject H.O. (Fig. 3A) and V.K. (Fig. 3B).

from about .5 - .6 to about .1 - .2 with the corresponding change in the spatial separation from 6' to 120' of the visual angle. Using 75% as a criterion of the discrimination thresholds it is easy to compute the precision of the temporal discrimination at the mentioned values of the

coefficient of regressions. The subject is able to discrinate satisfactoryly the asynchronies of ± 7 or 8 ms in case of minimal spatial separation. This ability deteriorates to about $\pm$ 20 or 40 ms in case of the largest spatial separations. On Fig. 3 the coefficients of the linear regression a are plotted as a function of the spatial separation for the subject H.O. (Fig. 3A) and for the subject V.R. (Fig. 3B). The relationship between the discrimination precision, and the spatial separation is obviously nonlinear. The best available least square approximation is achieved by a power function $y=ax^b$. The approximation gives the following results: for the subject H.O.: a=2.190, b=-.644 and the coefficient of correlation r=-.973, for the subject V.R.: a=1.434, b=-.478 and r=-.913. The values of r suggest that the obtained relationship between temporal discrimination (the slope of the linear regression) and spatial separation is well described by the approximations applied. Thus the precision of the temporal discrimination vary as a power function of the spatial separation between two flashing spots. The power of function is about -.5 or -.6 i.e. the temporal discrimination precision is inversely proportional to the square root of the spatial separation. We must notice that the approximation with the power function is not valid for small spatial separations near to the displacement threshold.

4. Discussion and conclusions

4.1. The main results

The finding that the accuracy of the displacement direction discrimination is a rapidly decreasing function of the spatial separation between stimuli indicates that the analysing routine which discriminates the directions operates over a short-range retinal distance only. The discrimination performance dropped to about 50% of the maximum within the distance of 30 minutes. Consequently the spontaneous movement analysing routines that support the discrimination of the displacement direction depend on the influences that are laterally transmitted over near-by distances in visual space. The power of the in-

fluences rapidly diminishes with the distance of the lateral spread from the point of excitation. For the discrimination of the displacement direction the comparision between the stimulation of two retinal points is needed. Thus the comparator must be a detector of an asynchroneous change in the luminance of the two neighbouring points on the retina. The main result of the present paper consists in following: the comparator of the asynchroneous changes in the luminance as a basic element of the spontaneous movement analysing system is able to carry out comparison in pairs of the nearby points that separation does not exceed 30' or the like. As we showed the discrimination performance is about inversely proportional to a square root of the spatial separation of the two flashing spots.

4.2. The relations to other studies

The reported findings are similar to the studies of the movement discrimination in the complex random-dot patterns. Braddick (1974) came to the conclusion that the accuracy of the direction discrimination in successively presented random-dot patterns is a monotonically decreasing function of the absolute magnitude of the retinal displacement. The highest limit of the displacement that one can detect is about 15 minutes of the retinal angle. Bell, Lappin (1973) and Lappin, Bell (1976) confirmed these conclusions except for a proposition that the relative number of elements in a random-dot pattern determines the discrimination performance rather than absolute retinal displacement. In spite of this discord the principle remains the same: spontaneous movement discrimination operates over short spatial separations. This conclusion is entirely different from that proposed by the classical stroboscopic motion paradigm originally invented by Wertheimer (1912). The question about the relationship between spontaneous movement perception ("element movement sensation" in the terminology of Pantle and Picciano, 1976) and inferred movement perception ("group movement") arises. We have no ready answer for this question however we willingly favour a hierarchical arrangement of feature extractors regarding the

spontaneous movement perception as a perception of texture dynamics (see Julesz et al., 1973).Another question concerns the uniqueness of the movement analysing system. Bonnet (1977,1978) distinguishes Displacement Analysing System from Movingness Analysing System.These two systems differed from each other in their responses to discrete and continuous components of motion. However we are oblidged to admit that there are no specifications how these two before mentioned systems actually extract the information from the time-varied luminance contour on the retina in Bonnat's papers.That is the reason why we can say nothing about the uniqueness of the movement analysing system.

The spatial properties of the displacement differentation system are similar to the spatial properties of another visual phenomena like simultaneous brightness induction (Heinemann, 1972,p. 158 ff.), metacontrast (Weisstein,1972) and others. The major changes in the phenomena referred to occur over a short spatial distance in the range from 0'to about 30'. The coincidence might have occured occasionally but the existence of the common mechanism should not be excluded from the considerations.

4.3. Neurophysiological correlates

Barlow and Levick (1965) in their study of the directionally selective rabbit retinal ganglion cells reported that the ability of the retinal ganglion cells to discriminate the sequence of excitation by a pair of disparate stimuli is potent at small separations and fades out for separations greater that about 30'.On investigating the properties and mechanism of the direction selectivity of the cat's simple striate cells Goodwin et al. (1975) found that the direction selectivity is due to inhibition that spreads laterally over about 25' of the spatial distance. These results were confirmed by Emerson and Gerstein (1977) who showed that both the directional asymmetry and the directional selectivity of the simple striate neurones depend upon the spread of the lateral inhibition via sequence-detecting subunits.The spatial properties of the movement detecting units are determined by a short-

lived and short-ranged influences that are laterally transmitted between .125 and .5° in visual space. Scobey and Horowitz (1976) advanced a tempter model for the movement discrimination by unspecific retinal ganglion cells.It was assumed that the detection of a displacement requires change of intensity or by moving a spot to nearby location in the receptive field that differs in sensitivity. Thus the effective displacement discrimination can be performed within a radius of the receptive field of the retinal ganglion cells. Half of the value of the receptive field diameter belongs to the range of values refered to above.

4.4. Considerations on possible models

Obviously, the stimulation of two disparate points on the human retina as it was done in the present study is the minimum configuration for the movement detection.What kind of interaction between stimulated points is necessary to perform a directionally specific movement detection? By the theoretical analyse the directionally specific movement detection requires nonlinear (for example a multiplicationlike) and asymmetrical interaction between stimulated retinal areas (Buchner,1976; see Appendix A).As far as the subject performs the rightward movement detection equivalently well to the leftward movement detection the existence of a pair oppositely tuned nonlinear and asymmetrical channels one would propose to be exist in the human visual system. It is also easy to accept that the movement detecting system has significant nonlinearities only up to the second order and that the infinite or sufficiently large time average of the output is taken. In case of the acceptance of these two proposals it was demonstrated that the correlation model is the most general expression of every two-input system. (Poggio, Reichard, 1973). Thus the nonlinear operation of correlation between two stimulated points of the retina is performed for the detection of the movement. Some recent studies explicitly proposed that the movement perception in the human visual system is based upon correlational analyse of the

visual image (Foster,1971; Lappin,Bell,1976).Further,it is known that if nonlinearities of order higher than the second are negligible in an n-input system,the system can be decomposed into a set of 2-input subsystems,added linearly. The implication to our study of this last statement is readily understandable;the total reaction to a moving object can be predicted as a sum of any two points' interaction along the moving path. It is possible to regard the curves on Fig.3 as spatial "weights" by which the interaction of two spatially separated points contributes to the total reaction.As we saw the relative "weight" rapidly lessen with the increase of the spatial separation of the interacting points.Finally we must admit that the results are in agreement with a model that was advanced by van Doorn,Koenderink (1976). The model which incorporates the class of correlational model is based on the lateral spread of excitation the best described by the diffusion equation.In the model the wave of excitation rapidly dies down with the increase of the distance from the point of excitation.

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PERCEIVED VISUAL DIRECTION OF THE BRIEF TEST-FLASHES ON THE HORIZONTAL SCALE

M.Rauk A.Luuk

Abstract . An experiment consisting of three series was carried out to study the processes participating in the perception of the visual direction of objects. The angular length of the horizontal illuminated scale with test-flashes, the stimulus duration, the position of fixation point and the head turning position of the Subjects were varied in this study, with binocular viewing condition of the fixated gaze. The results reveal a systematic pattern of the estimation error. The tendency to mislocate the stimuli in the direction of the foveal fixation point was maintained in all conditions varied,while the exact decisions were always obtained in the fixation point. It was concluded that the directional values of the test-flashes in the visual field were accepted by the Subjects on the basis of the afferent visual information.

1. Introduction

In the last decade a number of experimental studies have been concerned with the problem of visual direction perception of the brief duration test-stimuli in the visual field (Bischof,Kramer,1968; Hill,1972; Findlay,1974; Leushina,1965; 1974; MacKay,1970; 1973; Mateeff,1973a; 1973b;Matin, Kibler,1966; Matin,Matin,1972; Matin,Matin,Pola,1970;Zyssin, 1967;1970). The main aims of the investigations in this area are the search for 1) the accuracy of localization of the test-stimuli by perceptual system, 2) the functional principles operating in this system, and 3) the contribution of different possible sources of directional information to the complete information about the perceived visual direction. The notion of the objects' visual direction in these investigations has been defined in the following way (Matin, Pearce et al., 1965) : When a foveally fixated point is perceived as lying in what may be called the principal visual direction (straight-ahead),an object whose image strikes any other retinal point is then perceived at a distance to the

left, right, above or below this principal direction in accordance with the retinal signal,i.e. the direction and the distance values of the stimulated retinal point relative to the fovea. Hill (1972) has noted that the perception of direction is complicated by the fact that the Subject may use different reference points which are located on his body as origin, and therefore, the reference point in action for the Subject must be determined. In most cases the head is used as the reference point, and as the eyes can move, the apparent radial direction from a Subject's stationary head position to a fixed visible object is a function of both the position of the eyes within the orbit and the space values of the region of retina stimulated by the image of the object (the retinal local sign by Hering, 1879). An object's direction is perceived as a constant when the eyes and the retinal image move equal amounts (in the same direction) and when neither moves (disregarding tremor movements). If either the extent of the retinal image or eye position information is misinterpreted, the judged direction is affected (Hill,1972).

The experimental data obtained reveal a constant error in the direction estimation processes (Leushina,1965; 1974; Mateeff,1973a; 1973b; Matin,Matin,1972; Matin,Kibler,1966 ; Matin,Matin,Pola, 1970; Zyssin,1967; 1970). It can be supposed that these errors of localization are caused by the displacement of the objects' retinal images during the eye movements since the phenomenon of mislocalization was found in most cases in the studies where direction estimation was carried out in temporal proximity to voluntary saccadic eye movements (Bischof,Kramer, 1968; Leushina,1965; 1974;Mateeff, 1973a; 1973b; Matin,Matin,Pola, 1970). It can be seen that the greatest errors of localization coincided with saccades.

A common opinion exists that in addition to retinal visual information an extraretinal signal is necessary for completing the localization process when voluntary saccades occur. Efferent commands (von Holst,Mittelstaedt,1950) from the eye movement control centre in the CNS are considered to be the most probable sources of the extraretinal information.If this is the case, the visual information must be transmitted

to the perceptual system with minimal distortions in the absence of voluntary eye movements. The purpose of present study was to determine the accuracy of the localization processes during fixation.The problems of interest for us were : (1) How great is the accuracy of location judgements in the course of fixation when the distance between adjacent test-stimuli and of each test-stimulus from the fovea are varied? (2)Does there exist any influences of the proprioceptive information from eye and neck muscles involved in direction estimation when the head is turned to a certain amount and the Subject perform a lateral fixation? (3) Is it possible to reveal any subjective scale for the Subjects applied in direction estimation process and whether the objects' locations are transformed to this internal scale? (4) What is the contribution of different reference points and a straight-ahead line of sight to the accuracy of the perception of visual direction?

2. Method

Apparatus and stimulation. A visible horizontal scale with 11 or 12 divisions in different series and a fixation point were continuously exposed on the black screen.The red light-emitting diodes with the luminance 40 nt were used as the scale-points and the fixation point. Test-flashes were presented at 1 cm above the illuminated scale according to the locations of the scale-points. Green light-emitting diodes were used as the test-stimuli. The fixation point was placed 0,5 cm lower in the centre of the scale-line. In each trial a single test-flash was exposed. The position of the test-flash varied randomly from trial to trial. The room was dark during the experiment.The experiment was carried out in 3 series of binocular viewing conditions.

In the first series the scale with 12 divisions was used. The horizontal distance between two adjacent targets (the scale-points or test-flashes) was 2 cm. The angular length of the scale varied with different viewing distances. The subject (S) was seated at the distances of 43 cm, 57 cm , 114 cm or 228 cm from the screen. The angular dimensions of

the scale (or the width of the whole possible test-flashes area) according to these viewing distances were 28,5°,22° , 11° or 5,5°. Accordingly the mean distances between the adjacent targets were 2,6°, 2°, 1° or 0,5° in these conditions. The duration of the test-flash was also varied (5 ms or 0,5 ms). The subject was seated in front of the screen , his head fixed in a stationary position in a straight-ahead line with respect to the screen. The central fixation point was continuously illuminated.

In the second series 11 divisions of the scale with separating distance of 1 cm were used. The test-stimulus duration was 0,5 ms. The viewing distance was 57 cm and 114 cm. The angular dimensions of the whole scale were 10° or 5° for different viewing distances, angular distance between the adjacent targets 1° or 0,5° respectively. The S 's head was fixed in a stationary position turned off from the straight-ahead line to the left or to the right for 15° in one case and fer 30° in another. The fixation of the gaze to the central fixation point was maintained during the experiment.

In the third series the same scale was used. For the viewing distance of 114 cm the angular length of the whole scale was 5° and the adjacent targets were separated by 0,5° respectively. The test-flash was presented for 0,5 ms. The head of the Subject was directed along a straight-ahead axis perpendicular to the screen plane as in the first series.The difference between the viewing conditions of the first and the third series consisted in changing the positions of the fixation point. The different positions of the fixation point were below the 4.,5.,6.,7 or 8. scale-point as counted from the left to the right.

Procedure. In the beginning of every session the Subject was asked to hold his gaze in the fixation point steadily . The S's head was fixed stationarily with the chin and forehead rest. A single trial occured in every 10-12 sec. The Ss were instructed to identify the number of the scale division from the left to the right above which the test-stimulus had been seen. A number of learning trials were carried out before the experimental sessions. The purpose of this task

was to train the Ss to name a correct scale-value of the viewed position of the test and to try to eliminate accidental errors due to pure guessing.

Subjects. Eight Ss with normal vision were used: 6 female and 2 male students between 18 and 26 years old. All of them were ignorant in respect to the purposes of the experiment.

3. Results

23136 single trials were carried out in this experiment. The number of trials for each combination of stimulus situations in all series was 16 per Subject. The main results are presented in Figures 1 - 3.

As can be seen in Figure 1, the summary curves of all the Ss' show the systematic pattern of error in the first series. The evaluations given by the subjects about the visual direction of the brief test-flashes relative to the fixation point were not correct for each test-flash position. All Ss estimated the position of central test-flashes (above the fixation point of the gaze) without an error. Moving away from the centre of the scale a systematic perceptual error appeared in the location of the test-flashes presented. This error was minimal for the test-flash positions adjacent to the central position from the left and right, and increased for more distant positions. The error obtained its maximum value in the vicinity of the outer scale-points. The most remarkable is the fact that the errors were always made in direction of the central fixation point, i.e. the tests numbered 1.-5. from left are seen to the right for a certain extent from their real location, but the tests numbered 8.-12. are seen to the left from their real location. The mean values of the error in scale divisions are the greatest for the $5{,}5^{\circ}$ scale and the smallest for the scale of $28{,}5^{\circ}$. However, the difference between these mean values is not significant.

In Figure 2 the results of the second series of the experiment are plotted. The curves, very homogeneous in this case, show essential similarity with the results of the first series. The tendency to mislocate the test-stimuli in the direction of the central fixation point was confirm-

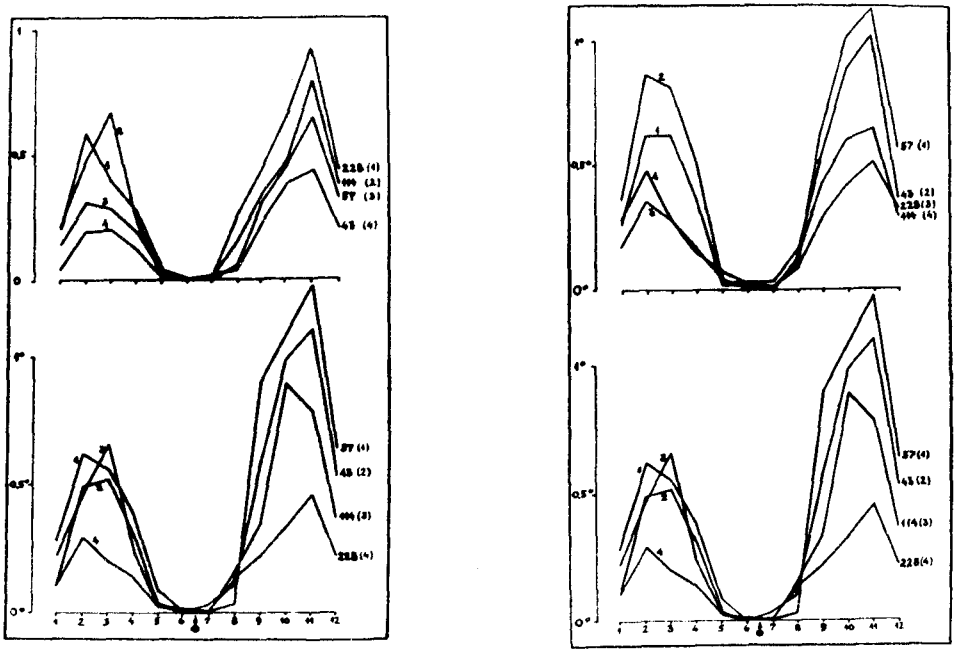

FIGURE 1 . The data of the first series indicate the mean values of the error in the case of different viewing distances. 1a: the upper part indicates the absolute error (a unit of the vertical axis corresponds to the distance between two adjacent scale-points); the lower part indicates the error in angular dimensions; test-stimulus duration is 0,5 ms in both cases. 1b : the upper part indicates the error in degrees at the test-stimulus duration of 5 ms; the lower part indicates the same at the test-stimulus duration of 0,5 ms. The depiction of the curves in the upper side of the horizontal axis shows that the errors were made in direction of the fixation point.

ed. The correct answers were obtained for three middle test-flash positions. It can be seen that the results obtained are not influenced by varying the position of the eyes in the orbit with respect to the S's head.

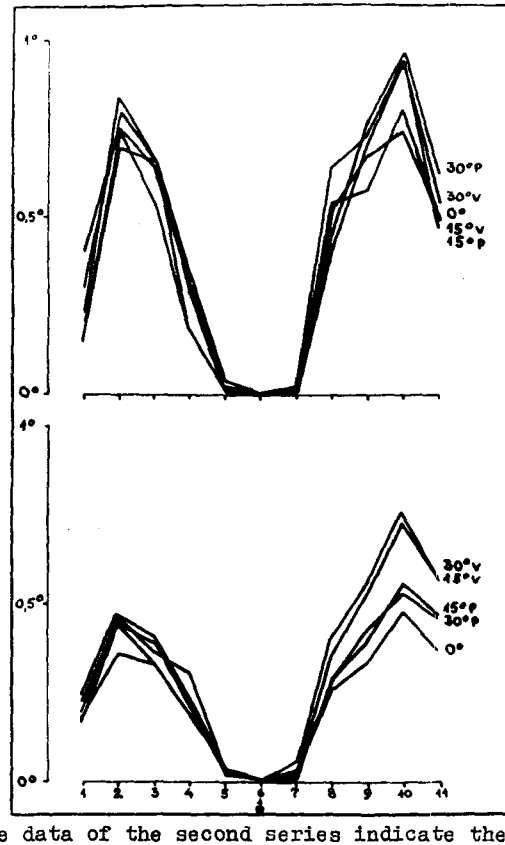

FIGURE 2. The data of the second series indicate the mean values of the error in degrees when the different positions of the eyes within the head were used. Head turning to the right denoted with "P", to the left with "V" at the curves. The upper part indicates the results at the viewing distance of 57 cm; the lower part indicates the results at the distance of 114 cm.

Figure 3 shows the summary results of the Ss' performance in the third series. The results of this series confirm the tendencies of previous series described above. The curves have maintained their configuration despite of various positions of the fixation point of the gaze used in

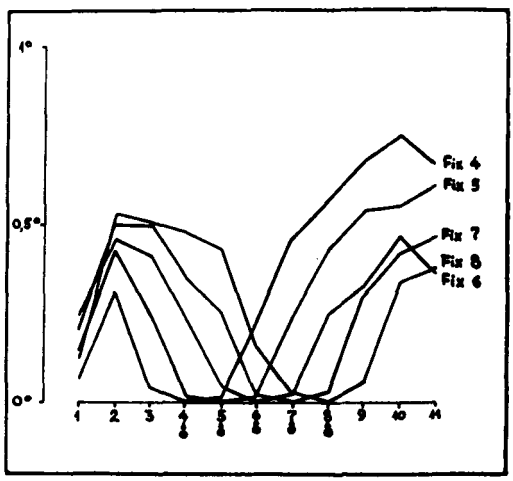

FIGURE 3. The data of the third series indicate the mean values of the error as the function of the fixation position.

this series.They seem to be shifted parallel to one another according to changes in the fixation position. In the last two series no significant differences between the mean values of localization error can be found. Thus, an analogous effect of the misperception of the direction of brief test-flashes in relation to the fixation point has become evident in all series of the experiment.

4. Discussion

The data obtained confirm the point of view that the direction of foveal sight is a very important reference point for the observer to make decisions about the locations of surrounding visible objects. Regardless of the various fixation positions with respect to the scale in the third series (Fig.3) correct answers were received in all the trials where the test-flashes were exposed in the position just above the foveal fixation point. Moving off this position the estimations made had a systematic error in central direction of the fixation point. The results very similar to ours have been presented by Zyssin (1967;1970). If only the angular measures were used by the perceptual system without taking into account the horizontal length of the scale and the locations of the reference points on the scale, the essential variance among the errors in the case of various angular dimensions of the whole scale (in the first and second series; Fig. 1 and 2) would appear. The estimation errors were always in certain units corresponding to the separate points of the scale-line presented to the Subjects. It must be concluded that the subjective scale used by the visual system is not homogeneous within the whole visual field. Real visual field with visible objects in it always serves as the basis of such estimation processes. The central point and the end points of the scale are the most impoftant parts and thus the main reference points of the visual field for the Subjects. As can be seen, the number of other reference points between the three main points is of no great importance in our case (Fig. 3); it may be decreased or increased without changes in the nature of errors made.

Perceiving the visual direction during fixation may be affected by microsaccades, as Findlay (1974) has demonstrated.It means that some kind of sensory-motor compensation may take place in the perceptual system. Perhaps it was not the case in the present study. In our experiment the data from the second series demonstrate that the possibility of taking into account the additional proprioceptive information from the ocular and neck muscles is not used by the Subjects.Pre-

sumably, the decisions about the directional values of the test-flashes in the visual field are made on the basis of afferent visual information, while the exact estimations are always guaranteed by foveal fixation. For each different visual direction in respect to the direction of the gaze the existence of a constant error may be supposed, which must be taken into account for adequate perception of spatial relations in the visual field.

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REGULARITIES OF VISUAL SEARCH IN COMPLEX FIELD

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Abstract. The present study deals with the problem of regularities in the visual search for objects embedded in random visual textures. It was assumed that the statistical similarity between the test configuration and textured background is the determinant of the visual search time. Proposing the validity of the exponential function for the description of the visual search time it was experimentally demonstrated that the parametres of the exponential approximation function depend upon the number of the random background texture areas similar to the test configuration. The visual search time depends upon the angular size of the test object and of the search field. The visual search time rises rapidly with approach of the angular size of the test object to it's size threshold value. The results of the present study show that the scale transformations of the visual search field do not significantly affect the search performance. In conclusion a supposition is advanced that the mean search time can be used as a measure of the visual search task complexity and an appropriate means of grading the visual texture complexity.

1. Introduction

In spite of the large number of studies devoted to the investigation of visual search, the problem of search performance, especially in regard to search of objects embedded in random complex visual textures, maintains its importance.

Considering the search as a random process many authors (Krendel, Wodinsky,1960; McGill,1960; Pinegin,Travnikova, 1971; Bloomfield, 1972; Travnikova,1977) make use of the exponential distribution of search time with one parameter , that is:

$$P(t) = 1 - \exp(-\lambda t), \qquad (1)$$

where t is the search time distributed randomly in interval $(0, \infty)$; λ is the parametre ; $P(t)$ is the probability

of finding object for time $\leq t$.

As distinguished from the expression (1), we shall make use of the exponential distribution with two parametres, namely:

$$P(t) = \begin{cases} 1 - \exp\left[-\gamma\ (t-\tau)\right], & t \geq \tau, \\ 0, & t < \tau, \end{cases} \qquad (2)$$

where and are the parametres and the rest of symbols are similar to the ones in formula (1).

The corresponding probability density function has a view:

$$f(t) = \begin{cases} \gamma \exp\left[-\gamma\ (t-\tau)\right], & t \geq \tau \\ 0, & t < \tau \end{cases} \qquad (3)$$

and the expectation value E (t) of random variable t given by the distribution function (2) is equal to:

$$E(t) = \begin{cases} \frac{1}{\gamma} + \tau, & \tau > 0 \\ \frac{1}{\gamma} \exp \gamma\tau \approx \frac{1}{\gamma} + \tau, & \tau < 0 \end{cases}, \qquad (4)$$

limited with the first members of series expansion of $\exp\gamma\tau$.

The expression (4) gives the mean search time for general population which is distributed according to (2), as shown from (4) the mean search time is unambigously defined by the parametres γ and τ. Obviously, these parametres depend upon a large number of different factors affecting the visual search performance.

The purpose of the present study is the following:

(1) to find out an analytical relationship between E(t) and the statistical characteristics of the test object and background;

(2) to find out the dependence of E(t) on the test object and the search field sizes.

Accoringly, the present study falls into two parts.

2. Part I.

2.1. Method

The stimulus patterns were random-dot textures which are composed of a different size cell array, for example 128 by 128, in which each cell is randomly printed black or white. The frequency that any cell of the texture will have a certain luminance (for example black) is called the mean

density or the first order statistics of the visual texture (Julesz,1975). The test object is a cross composed of the five black dots placed in 5 by 5 cell array (Fig. 1A).

In regard to the visual search binary (only black and white elements) textures two suppositions can be advanced:

(1) It is credible that the detectability of the test object embedded in the random-dot visual texture is determined by the similarity of the test object to the remaining visual texture. Evidently the degree of similarity is determined by the size of cell array occupied by the test object, by the number of elements (black dots) in the array and by the distributition (or configuration) of the elements within the array.

(2) The visual search performance is determined by the mathematical expectation that any background area will have by chance the same number of the black elements and the same distribution (configuration) in the area. In a more convenient terminology,it can be said that the visual search performance is determined by the first order and the second order statistics (Julesz, 1975).

Let us turn to a more precise formulation of the conditions satisfying the similarity between the test object and the random-dot texture.The test area can be compared with any arbitrary area T' of the background having exactly the same size as the test one. The similarity conditions can be written as:

$$\left.\begin{aligned} n' &= n_o \\ p' &= p_o \end{aligned}\right\}, \qquad (5)$$

where n' is the size (number of elements) of the area T', p' is the mean density or the number of black elements per size of area T', n_o is the size of the test area and p_o is the mean density of the test area (the number of black elements m_o per size of the test area: $p_o = m_o / n_o$).

Now the probability of an occasional appearance of the background section T' satisfying the requirements (5) can be readily calculated. The probability of the appearing exactly m_o black elements in n' independent trials (this is the total number of elements) can be calculated by the Bernoully scheme:

$$q = C_{n_o}^{m_o} p^{m_o} (1-p)^{n_o - m_o} .$$

If M is the total number of elements in the visual texture, the possible number of background areas T' would be equal to

$$N = \frac{M}{n_o} .$$

The probability p_k of forming exactly k sections, satisfying the conditions (5), will subject to the binomal distribution, that is:

$$p_k = C_N^k q^k (1-p)^{N-k},$$

where k = 1, 2, ..., N. The mean number of such sections T' on display is equal to their expectation value E (k) and for the binomal distribution it is:

$$E(k) = qN. \qquad (6)$$

In addition to section T', similar with the test object according (5), its possible random appearing of section (or area) T* that is similar to the test configuration can be revealed by the second order statistics. The probability of random forming the element configuration that is identical with the test object is connected with the number of the sections T* on display. The mean number of sections T* equal to their expectation value E(k*) is

$$E(k^*) = N p^{m_o} (1-p)^{n_o - m_o} . \qquad (7)$$

It follows from the formulas presented above (just under $Mp \gg 1$) that when the mean background density is equal to the probability p of appearing the black element approaches to the mean test object density, E(k) and E(k*) increase, and, according to the second supposition, the difficulty of the visual search increases achiving maximum value under $p = p_o$.

The series of such displays with textures having 128 elements on diameter were prepared for seven values of p . The displays with the common value of parameter p differed one from another by the spatial position of the test object in the visual field. The test object can appear with equal

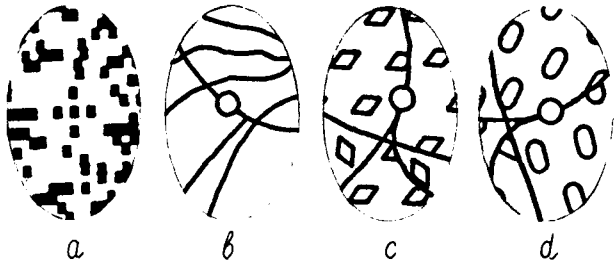

FIGURE 1. Examples of the display sections with the test object used in experiments as a stimuli. See details in the text.

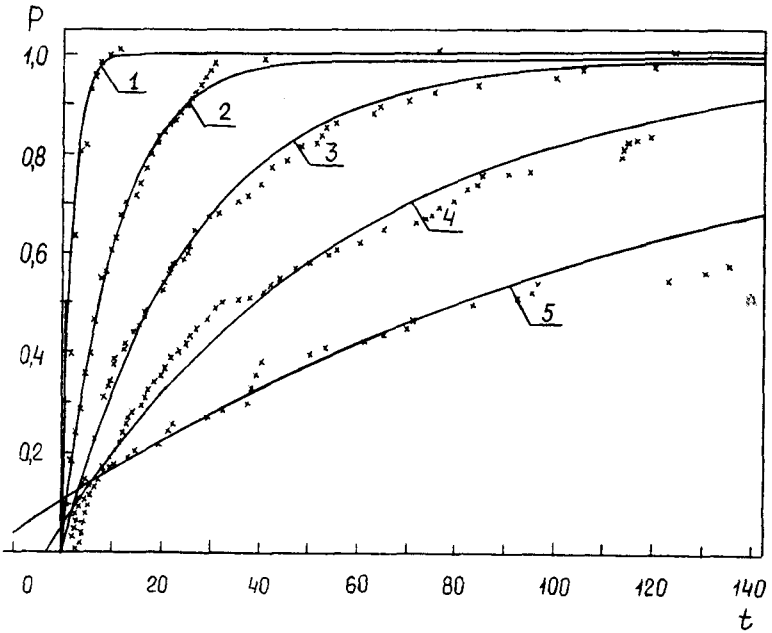

FIGURE 2. The distribution functions of the search time : the experimentally determined empirical functions marked as crosses; the approximation functions are shown by the continous curves.

probability at one of six fixed spatial locations of the circular display which are regularly distributed on display.

The textures were projected on a mat back-projection screen. The plane of the screen has been 500 mm from the subject's eyes. The angular size of the search field was fixed and equal to 40°, the according angular size of the test object was equal to $1^{\circ}34'$.

Twelve subjects from 30 to 35 years old with normal vision took part in experiments. The visual display was viewed binocularly. The sequence from 42 images was presented in a random order to each subject. Any search time exceeding 3 minutes was treated as a refusal.

2.2. Results and discussion

To analyze the data obtained the empirical distribution functions of the visual search time were found for each value of parameter p over subjects. These empirical distributions were approximated with the exponential function (2) and the best fit for the parameters and was found by minimum square-root-error (Linnik,1962). Both, the empirical distribution of the mean search time and the best approximation by equation (2), for 4 values of parameter p (0.025, E(k) = 0.16; 0.04, E(k) = 1.24; 0.07, E(k) = 10.8; and 0.2, E(k) = 101; curves 1, 2, 3 and 5 correspondingly) are presented on Fig. 2. Evidently, the relatively good approximation was obtained for the small values of E(k), namely curves 1, 2 and 3 on Fig. 2. Thus the expression (2) can be satisfactory used for the description of the visual search in the range of seconds to few tens of seconds. The goodness of the approximation for the visual search under the large values of E(k) and values of p approaching to p_o is worse. The difference is significant at the 1% level according to the two-sided Kolmogorov test (van der Waerden,1960).

Further, the found estimates $\tilde{\gamma}$ and $\tilde{\tau}$ of parametres γ and τ were used for the determining of the sampling esimate E(t) of the mean search time for the textures with the different values of p.

As far as the refusals took place in experiment, the estimate $\tilde{E}(t)$ can not be calculated as $(\sum_{i=1}^{n} t_i)/n$, where n is the number of presented stimuli. Therefore, in general (in the presence of the absence of refusals) the estimate $\tilde{E}(t)$ was found by formula (4).

Further we shall call the estimate $\tilde{E}(t)$ by the mean search time and for the convenience we shall denotate it as $\bar{t}$, that is:

$$\tilde{E}(t) = \bar{t}. \qquad (8)$$

As it is shown on Fig. 3 the results of the present experiments confirm the supposition that the mean search time is determined by the expectation value $E(k)$ of the appearances of the background sections having the similar mean density as the test configuration.

The dependence of the mean search time $\bar{t}$ on the number of the areas $E(k)$ (see Fig.4) is approximated by the formula:

$$E = a\,E(k)^{\varkappa} + b. \qquad (9)$$

It is evident from (6) and (7) that

$$E(k) = C_{n_o}^{m_o} E(k^*)$$

and consequently, for $\bar{t}$ in terms of $E(k^*)$ we have the expression:

$$\bar{t} = a(C_{n_o}^{m_o})^{\varkappa} E(k^*) + b$$

The parameters a, b and $\varkappa$, determined by the least square error method (Linnik,1962), have the following values:

$$a = 4.23,\ b = 3.14,\ \text{and}\ \varkappa = 0.76.$$

One usolved problem remains, as the experiments carried out do not allow to make the unambigous decision which set of the variables, the mean density or the regularity of the distribution, was used by the subject during the visual search. It was usually proposed (e.g.Johnston, 1965) that the search time is proportional to the number of the background elements having certain similarities with the test object. Proposing that the similarities are defined by

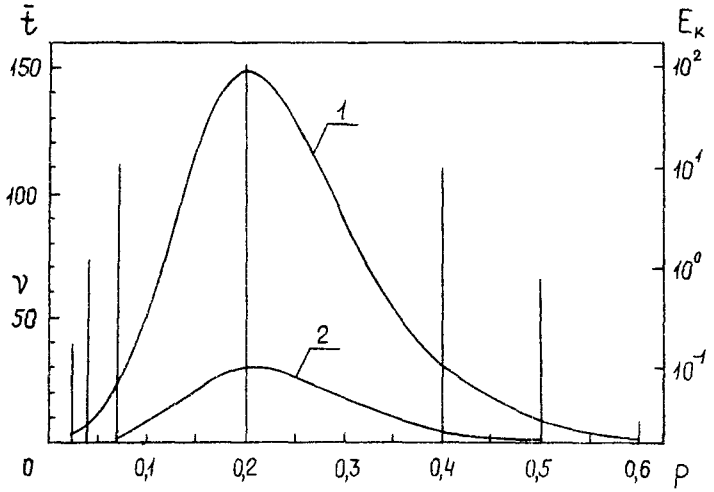

FIGURE 3. The mean search time $\bar{t}$ in seconds (curve 1), the number of refusals ν (curve 2) and the expectation value of the background area, similar to the test object by the mean density, E (k) (vertical lines) as the function of parameter p.

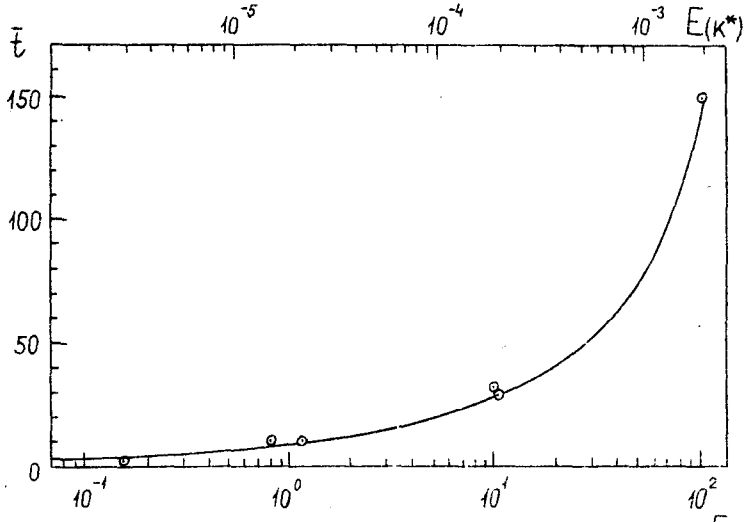

FIGURE 4. The dependence of the mean search time $\bar{t}$ (sec) on the expectation value of the background areas, similar to the test object by the mean density E(k) and by the properties of distribution regularities $E(k^*)$: the empirical data are shown by the points.

the first and the second order statistics of the visual texture the supposition, that the power $\varkappa$ in the equation (9) must be equal to 1, follows immediately. But a certain difference between expected and the actual value of $\varkappa$ can mean that the observer did not use the same criteria when the background density varies from the very small values of the texture density to the large values however the numerical values of E(k) and E(k*) are constant in some cases. In spite of the mentioned discrepancy, it can be maintained that the supposed statistical features, taking into account the similarity between test object configuration and the background texture, are an appropropriate measure of the complexity of the visual search task. Thus the formulas (4) and (9) with the postulated identity (8) allow to obtain the dependence between parametres γ and τ of the exponential function describing the visual search time distribution and parametres of the random visual texture M, p and p_0 defining the similarity of the test configuration and the remained visual texture.

3. Part II.

3.1. Method

The dependence of the parameter λ on such factors as the angular size of the test object - α, the angular size of the search field - 2β, the contrast of the test object against the background - k, and the background luminance - B was determined for the case of single object search of the small size on an uniform background (Travnikova, 1977):

$$\lambda = \frac{c\, k^2\, \alpha^3 B^{1/3}}{(2\beta)^2}, \qquad (10)$$

where c is a certain constant.

The results of other published studies of the visual search performance as a function α and 2β have the qualitative character (Enoch, 1959; Johnston, 1965; Kushpil' et al., 1975, 1976). Therefore, the present experiment was carried out to establish the analytical relation between parameter λ and the angular sizes of the test object and the search field.

Four types of visual displays were used (Fig.1).The first type of displays are the textures described in part 1 of this study (Fig. 1A). The textures had the different number of elements per display diameter: 128,256,384, and the same probability of the black elements appearance,equal to 0.3. Another three types of used displays was shown on Fig. 1B, 1C and 1D. The test object has the form of a circle and is always placed on one of the background lines.

The presentation and observation conditions were similar to that decribed in Part 1. The field size was varied by the circular masks of the different diametres. The size of the test object is varied by the change of the projection scale magnitude.

TABLE 1. The search field sizes used in the study and the corresponding test object sizes.

Stimulus types (Fig. 1)

A				B , C , D	
Angular size of the search field	Test object size Number of elements per diametre			Search field size	Test object size
	128	256	384		
19°54'	0°46'	0°24'	0°16'	20°	0°30'
38°40'	1°34'	0°46'	0°32'	40°	0°58'
55°30'	2°22'	1°10'	0°48'	60°	1°23'
70°06'	3°10'	1°32'	1°04'	80°	1°45'

The monocular viewing condition with the dominant eye was used in the experiment.Seven subjects with normal vision took part. Each subject was shown in random order 29 different displays of the described types for every search field size and corresponding test object size. The displays of one type differed by the spatial position of the test object.The test object has 29 possible locations regularly distributed over the search field.The probability of the object appearance in any of these places is equal.The search time exceeding two minutes is treated as a refusal.

3.2. Results and discussion

The empirical distribution function of search time found fits well to the exponential distribution function (2)which parametres were estimated by the method of least squares . The agreement is significant at the 1% level according to the two-sided Kolmogorov test (van der Waerden,1960). On Fig.2 (curve 5) the results of one subject are presented for the field size 70°06' and number of elements per field diametre 38.4. as an example.

Let us consider the experimental material obtained. The dependence of the mean search time $\bar{t}$ on the angular size of the search field 2β under the constant ratio of the test object size to the search field size is presented on Fig.5. There are no remarkable dependencis of $\bar{t}$ upon 2β and these results seem to be quite reasonable. The constant ratio of the test and search field sizes means that the number of the background areas which potetentially would have the similar properties with the test object remains constant.

There are significant differences between visual search times for different types of the textures. The least mean time takes place under search on the background of type B (Fig. 1). When the search field has been filled by figures, the sizes of that are equal to the test object size (the background of types C and D, Fig.1) the search time increases and it is more for the background with objects more similar with the test object (type D).

The increase of the mean search time with increasing of the number of elements per diameter of the search field was observed. So, the mean search time $\bar{t}$ on the visual texture having 384 elements per diameter of the field is about ten times higher as the search time for the texture with 128 elements per diameter. Thus the visual search time is proportional to the number of background elements and the visual search time can be used as a tool for the determination of the complexity of the visual texture.

Besides the above mentioned facts, there can be observed a certain increase of $\bar{t}$ for the large field sizes. It seems to be due to exceeding a certain range of the comfort

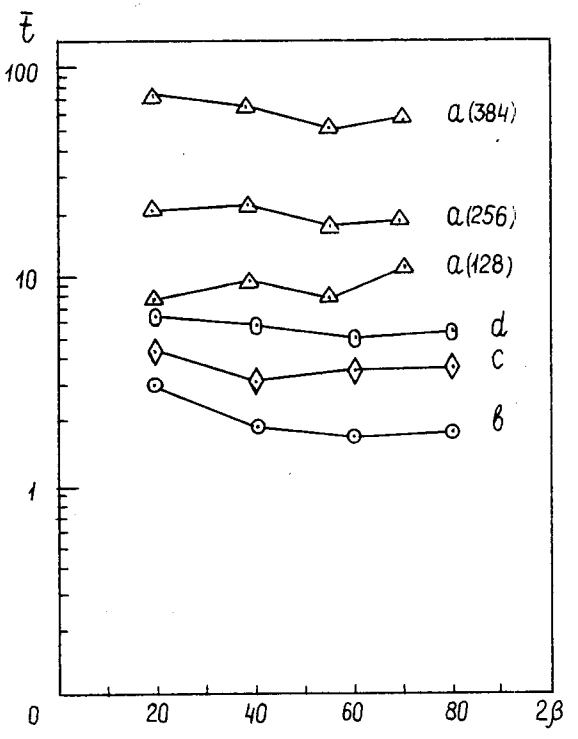

FIGURE 5. The mean search time $\bar{t}$ (sec) as the function of the angular size of the search field 2β (deg) for the different background types. The signatures on the figure are that determined on Fig.1 and Table 1.

when the visual search task can be performed without remarkable head movements.

The dependence of $\bar{t}$ on the test object size α for the different search field sizes is presented on Fig. 6. The visual search time rises rapidly with the decreas of the test object size. As it follows from studies B aurova et al. (1966), Mansurov (1964) and other ones, the recognition time rapidly increases with decrease in the object size and rises to infinity approaching to the value of the recognition threshold. Thus, the threshold value should be taken into consideration in the description of the visual search. For the sake we look for the dependence of the parameter $\bar{t}$ on sizes of the test object and the test field size in terms of:

$$\bar{t} = g\left[1 + \frac{1}{(\alpha - n\alpha_0)^{\eta}}\right]\left(\frac{2tg\beta}{\alpha}\right)^2\left(\frac{tg\beta}{\beta}\right)^{\sigma}, \quad (10)$$

where $n\alpha_0$ is the threshold value of the test object detection, and α_0 is the mean resolution threshold of the human eye for the most visual tasks (that is 1'), and n is the linear number of elements in the test object by which the test object can be discriminated from its background; g is the factor which takes various factors into account, affecting the visual search performance (complexity of the texture, mean luminance and so forth); η and σ are certain powers.

The parametres g, $n\alpha_0$ and powers η and σ were defined by method of the least square error on the basis of estimates $\bar{t}$, obtained accordingly (4) and (8) from the respective distribution functions. With this gone in view, the results for all 7 subjects, all search field sizes with the mean density p = 0.2 have been used. The relationship (10) is in close agreement with the experiment (Fig.6) when $n\alpha_0 = 6'$, $g = 1.64 \cdot 10^{-3}$, $\eta = 0.33$ and $\sigma = 1.13$.

As seen in Fig.7, the parametres of the exponential distribution γ and τ are not independent. The relationship between two parametres can be presented by a straight line:

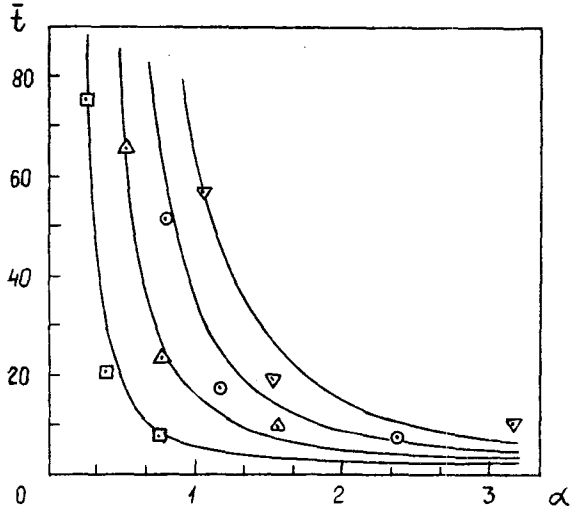

FIGURE 6. The mean search time $\bar{t}$ (sec) as function of the test object angular size α (deg) for the different types of the visual textures sizes 2β : $19^{\circ}54'$ - ▣ , $38°40'$ - ▲ , $55°30'$ - ⊙ , $70°06'$ - ▼ , the approximation functions are shown by the continous curves.

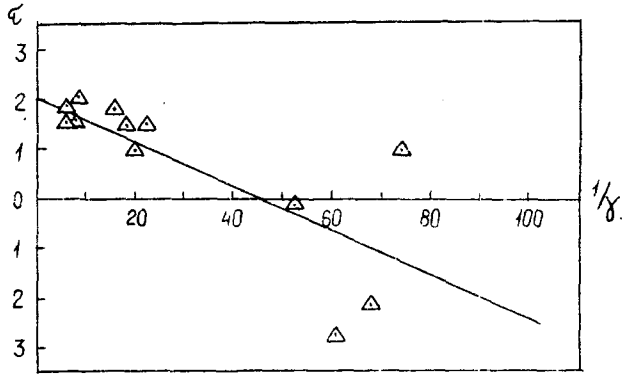

FIGURE 7. Relationship between the parametres of the exponential distribution γ and τ . Points - the empirical data; curve - the best approximation.

$$\tau = \tau_0 - \frac{c_0}{\gamma} \quad . \qquad (11)$$

The best approximation in the sense of the least square error was obtained with the values : $\tau_0 = 2.0$ and $c_0 = 0.04$.

In consideration of (4), (8) and (11), the distribution function of the visual search time according (2) will have a form:

$$P(t) = 1-\exp(-c_0) \exp(- \gamma [t-\tau_0]).$$

The interpretation of the presented formula can be easily performed : τ_0 is apparently the latent time of the observer, and c_0 is the correction on deviation of the distribution function of the visual search time from the exponential function.

It follows from the last expression that, in the most practical cases, for the calculation the sufficient accuracy the following relationship can be used:

$$\gamma \approx \frac{1}{\bar{t}} \quad .$$

So, a set of regularities of the visual search on the complex background were obtained on the basis of our experiments.

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MOTHER-INFANT INTERACTION : A LONGITUDINAL STUDY OF BEHAVIOURAL INTERRELATIONS

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Abstract. A longitudinal study of naturalistic mother-infant interaction of 10 dyads from infant ages 2 months to 6 months was undertaken to analyse interaction patterns and find out some possible relationships between mother and infant behaviours. The results hypothetically reveal the mother-infant interrelations' system to be one of directed towards causing maternal behavioural consistency and infant's behavioural variability. The extraction of self-regulatory and interactive components in mother-infant interaction introduced by Thomas and Martin (1976) was performed in the present data. The self-regulatory component has been proved to cater for larger part of mother and infant behavioural activity, and to cause the development of the same component in the interaction partner. The present study applied the cross-lagged panel correlation analysis to the longitudinal data to reveal causal connections between interaction variables. Some problems of the CLPC application are discussed.

1. Introduction

Contemporary child psychology has turned its attention towards early infancy and mother-infant interaction at that age without presenting too many theorethical considerations, largely for the pleasure to demonstrate "how competent infants are" at some very early age. Although the research devoted to early interaction is mostly empirical, it is natural to have some underlying implicit general ideas of the process under study.

It was at about the middle of the 1960ies that infant-mother interaction as a process (and not a result variable as the "attachment" researchers practically use it) began to receive attention and together with that there appeared the general idea of mother-infant interaction as a "two-way street" (Korner,1965). The most influential general idea of that interaction of the 1960ies was evidently expressed

by Bell (1958,1971) as his "control limits" concepts for the infant and the adult. The idea simply declares that both the adult and the infant have got a notion of a certain range of optimal activity of the partner, with the lower and upper limits for either side. The mutual interaction is viewed as a homeostatic process of keeping the activity of the partner in the optimal range. An analogous general homeostatic idea is expressed by Stern (1974a,p.404). In the experimental studies, the process of mother-infant interaction has begun to be measured as a true mutual behavioural exchange. Usually, stochastic methods (mostly Markov chains) are used to analyze the data of natural observations. These methods tend to bring with them an implicit idea of absolute temporal influences between the behaviours of the mother and the infant, i.e. any behaviour the mother displays at time t-1 will contribute to the fact of occurence of some behaviour by the infant at time t , and vice versa. The implicit idea of temporal influences can be applied in three ways in various studies: a) as an absolute influence of maternal behaviours on those of the infant without reciprocal influences from the latter (an idea rather widespread in educational thinking), b) as an absolute influence of infant behaviours on those of the mother without reciprocity from the mother, c) as mutual absolute temporal influence, i.e. supposing that behaviours of both partners influence each other. The important general idea underlying all these studies is that the partner's behaviour is the main and principial determiner of the other partner's behaviours - not clearly in individual behaviours cases but in the markov transition matrix. An alternative to this is the general notion that the behaviours of the two partners are not rigidly interconnected, that there exists some freedom of behaviour for each partner in the mother-infant dyad,. There have been speculations concerning the presence of loose coupling in the interrelationships between living systems (Glassman,1973), and there is no reason why the mother-infant interaction should be considered coupled rigidly rather than loosely. Thomas and Martin (1976) have performed a re-analysis of some experimental data from the point of view of possible self-regulatory and interactive components present in the determination of mother and infant behaviours in dyads. This kind of approach

could be regarded as the relative temporal influence between the mother and infant behavioural phenomena: there exists some interdependence between the partners in the determination of their behaviours (the interactive component) but at the same time the partners can behave independently of each other (due to the self-regulatory component).However, the problems become more complicated when we proceed from the general thinking of mother and infant behavioural reciprocity as a whole to the study of specific behaviours and their interrelations. We must note that the studies of mother-infant interaction via the use of Markov processes are most often performed on some specific behaviours extracted from the general context of interaction (Lewis, Lee-Painter, 1974; Stern;1974b, Jaffe, Stern,Peery,1973; Stern, Jaffe, Beebe, Bennett, 1975) and not on behaviour complexes which could be considered more functional in interaction than single behaviours.

For our presentation, interrelationships between mother and infant behaviours present interest in two domains.Firstly, the role and the influence of maternal vestibular and tactile stimulation on infant behaviour is of interest to us. Secondly, the role of mutual vocalizations in mother-infant dyads and infant visual responses to maternal talking are dealt with in the experimental part of the present article.

It has been firmly established in the practice of infant caregiving that vestibular and tactile stimulation are powerful infant soothing techniques. Indeed scientific investigation has also proved this by explicating more thoroughly what parametres of the stimulation are most efficient in soothing and influential on the infant development. Korner and Thoman (1972) have found that vestibular stimulation had a more noticable soothing effect on the neonate than contact stimulation. Pederson (1975) and Pederson and Ter Vrugt (1973) have demonstrated that both the frequency and amplitude of rocking of the 2 month olds are important parametres in soothing, with the frequency of about 70 rocks per minute having the maximum effect. Analoguous results have been achieved by DeLucia (reported in Lipsitt,1971, pp.17-18) on 1-month infant. De Lucia has obtained a conditioning effect

with rocking as a reinforcement: infants can learn to become quiet in order to obtain vestibular rhythmic stimulation. Some studies have demonstrated the facilitative affect of vestibular stimulation in infant general development: Neal (cited via Perderson and TerVrugt, 1973,p.127) has provided an experimental group of prematures with special sessions of vestibular stimulation which facilitated the motor development of these premature infants in comparison with a control group with no such vestibular enrichment, Kantner, Clark, Allen and Chase (1976) and Clark, Kreutzberg and Chee (1977) have demonstrated the facilitative effects of vestibular enrichment during 4 weeks among infants 3 to 13 months of age on their motor skill development.

It is interesting to note that besides the soothing effect, vestibular stimulation has been found to be effective in alerting the neonate (Korner,Thoman,1970, Fredrickson , Brown, 1975, Gregg, Haffner, Korner,1976). These authors demonstrated that it was not the upright position of a neonate per se, but the vestibular stimulation provided in the course of conveying the baby to the upright position that entailed visual pursuit by the neonate. In this case, indeed, the vestibular stimulation can not act independently from proprioceptive and tactile stimulation (Fredrickson, Brown, 1975) so the whole complex of infant position changing with the vestibular stimulation as the leading component can be considered a determinant of infant visual inspection of the environment. This is quite logical,if we take into consideration the fact that the vestibular system is one of the first to mature.

Proceeding to the reciprocities connected with maternal vocalizations, we can see that those play a lesser mother-based deterministic role than the vestibular stimulation. Lewis (1972,p.112) has shown that of all the maternal vocalizations that appeared in the dyads of mothers with their 3 month old infants, maternal vocalization seems to be a response to infant vocalization in 60% of the cases, and an initiator of the infant vocalizations in the remaining 40% of the cases. If we re-analyze Lewis's (1972 , p. 112, Table 5) data so as to find out the general role of mater-

nal vocalizations (generalized to all infant behaviours), the difference 64%-36% in the direction of maternal vocalization as a response to any infant behaviour. As to various infant behaviours to elicit maternal vocalizations, infant movement and fret/cry were found to be most influential, wheras smile occured as a response to maternal vocalization rather than an elcitor. The data presented are the result of the study of 32 infants and their mothers, with a cross-sectional paradigm and group data. The individual differences are left without special regard.It is indeed the great variability among neonates and infants, and in case of the study of interaction among various mother-infant pairs, that makes methodological problems of the research in early ontogenesis more complex than those of older ages . The other serious methodological problem in psychological research is that of the causal relationships. Overwhelmingly we obtain simple correlative data in the studies of infants and their mothers,and do our best (and often more) to give the correlations obtained some sound causal interpretation.

The first problem of individual variability in infant research can be partly solved by the study of individual cases instead of group data (Thoman, Acebo, Dreyer, Becker, Freese,1977) . The latter difficulty seems to be lessened via the application of more contemporary methods of causal analysis into the research field of early ontogenesis.Porges (1976) has called for different new methods to be applied , and some methodological innovations have already been applied. One of the recent developments in applying the methods of causal analysis to behavioral research is the application of cross-lagged panel analysis (Kenny,1972,1975; Crano, Kenny Campbell, 1972, Crano,1977,1973; Atkin et al., 1977).

The aim of the present study was to try to find certain patterns of mother-infant interaction in observational data of mothers and their young infants gathered longitudinally at the homes of the infants. The concrete aims were threefold: Firstly, to study the influences of maternal and infant behaviours on each other. Secondly to analyse the interaction data, as determined by the self-regulatory and interactive components. Thirdly, we made an attempt to study cau-

sal relationships between mother and infant behaviours through the application of gross-logged panel correlation analysis to our longitudinal data.

2. Procedure

The natural observation sessions lasting a hour were performed on 10 mother-infant pairs on the basis of the behavioral catalogue presented in Table 1. The observations took place at homes, the observer did her best not to drew attention to herself. The 1 hour general observation was divided into 10-second periods, changes among which the observer could detect from a tape recorder replaying to her auditory clicks in every 10 seconds. The observer wrote down all the behavious that occured in every 10sec period as well as well as could be coded via the items included into the behavioural catalogue. The mother was asked to behave with the infant "as she usually does", without any special regards to the observer. Certainly it is impossible to control the precision with which this instruction was followed. There were 5 observers specially trained to make observations[1]. The interobserver reliability of the records was obtained via training to use the behavioural catalogue in simultaneous observation of a "training" mother-infant dyad not included into later analysis, and by pairwise comparison of the observers on the first observation sessions (the first sessions were performed in pairs, the following ones by one observer only). The per cent of observation record similarity was 74-90%. This can be considered to be higher than in Lewis (1972) study (rhos 0.4 to 0.6).

The problem with our observation system is the application of arbitrary 10 second intervals for data fixation. This was determined by practical problems of the observers' inability to write the behavioural codes down in greater tempo. Some of our behaviours coded (vocalizations, smiles,

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[1] the help in data collection and analyses provided to the second author by Ene Talvist, Mare Pappel, Kadri Ojamaa and Kaja Prügi is gratefully acknowledged.

TABLE 1. The Behavioural Catalogue used as the Basis for Observations

Partner	Code	Description
INFANT	Iv	Infant vocalization - any vocal production other than distressful crying
	Im	Infant movement - any movement with legs or hands, or whole body
	Ile	Infant looks at envidonment: eyes open, visual interest towards environment in general, i.e. not at adult, not at her own body, not at any specifiable object.
	Ila	Infant looks at adult : visual interest towards adult, usually mother.
	Ilo	Infant looks at object
	Ilb	Infant looks parts of her own body
	Icr	Infant cries.
	Ism	Infant smiles.
MOTHER	Mvoc	Mother talks to infant
	Mt	Mothers provides tactile contact
	Mv	Mother provides vestibular contact
	Mso	Mother shows infant object.
	Mtv	Mt + Mv
	Mtvoc	Mt + Mvoc
	Mvvoc	Mv + Mvoc

etc.) could in some cases be much less in duration than the 10 second period, and may have occured twice or more the coded data. However, at least as vocalizations are concerned, Fogel (1975) has demonstrated that infant vocalizations in dyads tend to occur in runs lasting (in his data) about 10 seconds (mean = 10.4 sec). If this is the case, and

as we know the maternal speech also occurs in phrases rather than simple words or syllables, our system may be not too robust after all.

The infants were 10 children whose addresses were obtained via local medical authorities. The children were healthy, 4 males, 6 females. The first observations were done when the infants were 2-2,5 months old. The observations were repeated in approximately monthly intervals for 4 times. The infants were 5.6-6.5 months old at the last observation session.

3. Methods of data analysis

As we outlined the aims of our present study above, our data analysis methods were threefold:

1. Analysis of stochastic interrelationships between maternal an infant behaviours. This was done by using Markov chains. In the Markov transition matrices, the mother and infant behaviours outlined in Table 1 served as both the row and column data, so the time t to time t + 1 transition frequencies and conditional probabilities from any maternal or infant behaviour to any other maternal or infant behaviours were obtained (See Figure 1). The Markov chains were constructed for each mother-infant pair individually at the beginning, and later summed into a group transition matrix for each age group of the infants. Besides conditional probabilities of behaviour x occuring at time t + 1 in case behaviour y has occured at time t , the absolute probability of each kind of behaviour occuring during our given observation session was obtained (Row probabilities on Fig. 1) . Those absolute probabilities were used in the cross-lagged panel analysis outlined below. Besides, on the basis of individual Markov chains, general data for extracting the self-regulatory and interactive components were obtained.

2. Analysis of interactive and self-regulatory components in mother-infant interaction. Thomas and Martin (1976) have outlined some models to cater for infant-adult interaction data from the viewpoint of those components. They have outlined models for both continuous as well as discrete cases. They argue that a theory of interactive behaviour should spe-

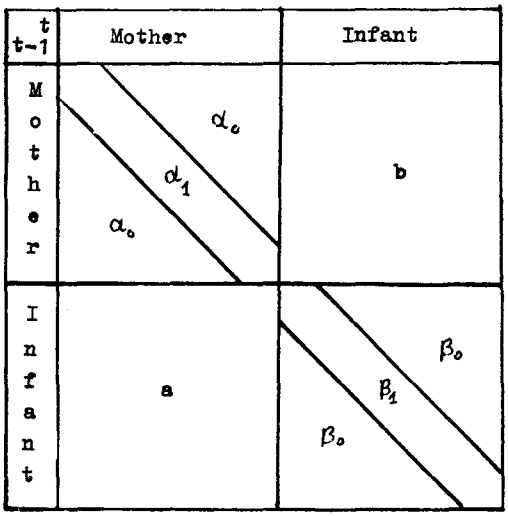

Figure 1. The Markov transition matrix of maternal and infant behaviours with the explanation to the extraction of self-regulatory and interactive components from the matrix.

cify how an interacting member is affected by the partner's and his/her own behaviours occuring in temporal sequences (Thomas, Martin,1976,p. 141). We here use the discrete state model proposed by Thomas and Martin (1976, pp. 151-155). The self-regulatory component of the adult is characterized by the following parametres:

α_0 - the tendency of some behaviour by the adult to initiate some other behaviour at the next observation interval (a measure of behaviour VARIABILITY)

α_1 - the tendency of maintenance of the adult's behaviour in the successive observation intervals (a measure of behavioural CONSISTENCY).

The same component for the infant is characterized by:

β_0 - the tendency of some infant behaviour at t-1 to initiate some other infant behaviour at time t (a measure of VARIABILITY)

β_1 - the tendency of maintenance of the same infant behaviour at time t when it occured at time t - 1 (a measure of CONSISTENCY).

The interactive component for the adult is characterized by the parametre

a - the effect of infant behaviour at time t-1 on adult behaviours at time t.

The respective measure for infant is denoted by b. So the adult behaviour is characterized by:

$$Y_{ad} = \alpha_0 X_1 + \alpha_1 X_2 + aZ \qquad (1.)$$

and the infant behaviour by:

$$Y_{inf.} = \beta_0 X_1 + \beta_1 X_2 + bZ \qquad (2.)$$

As our observational data include multiple behaviours (See Table 1) and Thomas and Martin (1976) analysis is performed on single behaviour Markov matrices, the way to find the abovementioned parametre values is different from theirs. In our data, we generalize from individual mother and infant behaviours to the behaviour of mother and infant in general (see Figure 1 for explanation). These parametres for each observation dyads were found, for 10 dyads on 4 occasions each. The parametres themselves are used in our cross-lag-

ged panel analysis to try to reveal some possible causal mechanisms hidden in the data.

3. Causal analysis of interrelationships among behaviours through the cross-lagged panel correlation technique (CLPC). The CLPC technique is a method of testing for preponderance of causality relationships between correlated variables. This becomes possible in panel data with synchronous fixation of the variables and the study of cross-lagged correlation coefficients (Kenny,1975, 1973,1972). Our data make it possible to use the three-wave two-variable models (3W2V) proposed by Kenny (1973,pp.158-162). These models are not dependent upon the existence of between-variable proportionality that are important for the usually applied two-wave two-variable (2W2V) models. We have not come across the application of the 3W2V model in the research literature on ontogenetic psychological studies.

In the 3W2V model, the main information about the causality preponderances of variables X and Y are obtained from the two correlational tetrads (see Kenny,1973, for further explanation):

$$\rho_{X_1Y_2} \cdot \rho_{X_2Y_3} - \rho_{X_2Y_2} \cdot \rho_{X_1Y_3} = k \qquad (3.)$$

$$\rho_{X_2Y_1} \cdot \rho_{X_3Y_2} - \rho_{X_2Y_2} \cdot \rho_{X_3Y_1} = l \qquad (4.)$$

If the cross-lagged common factor leads from X to Y, $l = 0$ and $k \neq 0$. If it leads from Y to X, the picture should be the contrary, i.e $l \neq 0$ and $k = 0$. If $k = l = 0$, we are dealing with the case of the causation of X and Y by some third variable Z.

If $k < 0$ and $l < 0$, the underlying assumptions of the 3W2V model are not met and the model does not allow overdue generalizations.

In our analysis of the CLPC, we were met by certain problems that stem from our small N (N = 10) and the fact that we use Spearman rank coefficient in our correlational analysis. Power data could not be applied to the analysis we performed, thus our conclusions remain tentative and we well understand the possibilities of existing errors due to sampling, procedures etc. In order to characterize the relation-

ships of k and l (formula 3. and 4. above), we used their ratio

$$m = \frac{k}{l} \qquad (5.)$$

We also arbitrarily defined the limits for k and l for cases they could be considered equal to 0 : $-0.1 < k,l < 0.1$.

4. Results

The data on the transitions from maternal behaviours to those of the infants and vice versa are presented in Tables 2 and 3. The interactive component of the behaviours, i.e. the probabilities of transition from a certain infant behaviour to various maternal behaviours and the other way round are presented in these tables. As we can see the two conditions I → M and M → I (infant behaviours influencing the maternal ones and vice versa) are largely symmetric . The notable exception is the case with "Infant looks at object" and "Mother vocalizes" ($P_{I \rightarrow M} = 0.427$, $P_{M \rightarrow I} = 0.292$, $t = 3.03$, $p = 0.004$) and "Mother shows object" - "infant looks at object" ($p_{M \rightarrow I} = 0.4$, $P_{I \rightarrow M} \equiv 0.237$, $t = 3.8$, $p = 0.0003$). This means that the maternal speaking is quite naturally a response to infant looking at some object, rather than an initiator of the infant looking at the object at the ages studied. It would be quite illogical the other way round. But the maternal behaviour of showing some object to the infant, a well-known way of drawing the infant's attention to something, appeared to be more an initiator of infant looking at the object than a response. This too is a logical and interpretable outcome.

Taken the general symmetry in M → I and I → M conditions, a result somewhat at odds with Lewis's (1972) data - probable because the emphasis in our research is on infant visual orientation rather then other behaviours, we can see that the overwhelmingly popular behaviour for the mother both to initiate the infant's behaviours as well as to respond to them, is vocalizing. It is interesting to note that this vocalizing tendency does not change over months. The only significant difference between I→ M and M → I conditions was found at the infant age of

2..3 months in case of the infant looking at the environment ($t = 2.26$, $p < 0.05$). It appears that the mothers tend to comment on the infant's looking at the environment more than is the influence of maternal vocalization on that behaviour (47% vs. 32.1%). This difference disappears at the next age level, and even tends to become raverse by the age 5...6 months (41% vs. 50%, $t = 1.23$, n.s.). This can be viewed as the development of the function of maternal speech input: at the beginning, when the infant's visual activity develops at ages 2...3 as a new achievement of the infant, the maternal speech is not influential on it but merely frames its occurence. Later, the mother's speech may turn the infant's visual attention towards some environmental objects not specifiable in our study, or to alert the infant visually in general. In comparison to these data, the evidence about infant's looking at mother seems fairly constant in our material: both I → M and M → I conditions are equal, with slight and nonsignificant general tendency to indicate the more active role of the infant (in total % over 4 age levels' 47.9 vs. 40.4 , $t = 1.60$, n.s.) . As far as infant's looking at objects is concerned, the infant is the active side in making the mother speak over all 4 age levels. Although the monthly comparisons are not significant, evidently due to small general frequencies (Student's t-s : 2...3 months 1.24, 3...4 months 1.6, 4...5 months 1.55, 5...6 months 1.46), the general comparison summed over months (42.7% in I → M condition vs. 29.2% in M → I condition, $t = 3.12$, $p < 0.01$) as well as the direction of the comparisons give evidence that mothers rather respond to the infants' looking at some specifiable object than turn the infants' attention to these objects via their speech. In the latter case of infant looking at object, the maternal showing an object to him (Mso) appears to be an active infant-leading behaviour of the mother's repertoire (40% of all M → I conditions are covered by Mso, wheras only 23.7% of all I → M conditions are covered by Mso , $t = 3.91$, $p < 0.001$, if the data summed over age levels are used). Thus, the mother tends to <u>respond</u> to the infant's

TABLE 2. The transitions from maternal behaviours to those of the infants (M → I) and vice versa (I → M). Percentages are found from the general sum of transitions in either conditions

INFANT BEHAVIOUR	Age	MOTHER'S BEHAVIOUR																		Σ_f	Σ_f
		Tactile/vestibular				Vocalisation				Tactile				Vocalisation + Tactile				Shows object					
		I → M		M → I		I → M		M → I		I → M		M → I		I → M		M → I		I → M		M → I		I → M	M → I
		f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%		
Looks at Environment	2-3	6	8	5	8,9	37	47	18	32.1	18	23	12	21.4	11	14	16	28.6	7	9	5	8,9	79	56
	3-4	12	15	14	15,1	26	33	30	32.2	7	9	15	16.1	23	29	27	29.0	11	14	7	7,5	79	93
	4-5	6	7	8	10,4	30	36	23	29.8	21	25	25	32.5	16	19	15	19.5	10	12	6	7,8	83	77
	5-6	12	13	10	11,4	39	41	44	50.0	14	15	13	14.8	25	26	16	18.2	5	5	5	5,7	95	88
		36	10,7	37	13,0	132	39,3	115	40,5	60	18	65	22,9	75	22.374		26.0	33	9.8	23	8.1	336	284
Looks at the mother	2-3	1	2	0	0	29	53	27	48.2	8	15	9	16.1	12	22	11	19.6	5	9	9	16.1	55	56
	3-4	3	7	5	10	15	33	17	34	6	13	6	12	19	42	19	38	2	4	3	6	45	50
	4-5	3	6	3	4.8	23	45	31	49.2	12	23	17	27	6	12	3	4.8	7	14	9	14.3	51	63
	5-6	4	6	7	9	39	56	37	47.4	14	20	12	15.4	7	10	10	12.8	6	9	12	15.4	70	78
		11	5	15	5.4	106	47.9	112	40.4	40	18	44	15.9	45	20	43	15.5	20	9	33	11.9	221	277
Looks at object	2-3	3	7	1	2	10	25	7	14.6	5	12	9	18.8	7	17	8	16.7	15	37	23	47.9	40	48
	3-4	1	2	4	7.2	21	48	16	29.1	2	5	2	3.6	10	23	7	12.7	10	23	26	47.3	44	55
	4-5	1	1	1	1.7	23	40	16	26.7	13	22	16	26.7	11	19	9	15	10	17	18	30	58	60
	5-6	6	8	1	1.3	38	52	31	40.2	8	11	10	13.0	5	7	6	7.8	16	22	29	37.6	73	77
		11	5	7	2.9	92	42.7	70	29.2	28	13	37	15.4	33	15.3	30	12.5	51	23.7	96	40.0	215	240

visual interest towards some object by framing this interest verbally, wheras she can actively draw the infant's interest by showing the object. It is interesting that the object showing remains effective almost similarily during all the age levels, but this finding indeed may be trivial since the parents can be effective to show infants and older children some objects to draw their attention to thom during considerable age periods.

The above data may be limited because we can not extract pure information on maternal behaviours bringing to various infant behaviours since the cases of M → I were presented in Table 2 as percentages of any influential mother's behaviour out of the overall number of given infant response behaviours (i.e. Ile,Ila, Ilo separately).It might be of interest to add some information about the influence of various maternal behaviours on the distributions of the 3 infant behaviours under consideration (Ile,Ila,Ilo). These data are presented in Table 3. As can be seen, all the maternal behaviours except showing objects lead to infant's looking at the environment. Only maternal speaking makes the infant looking at the adult more frequent, equal to looking at the environment ($t = 0.25$, n.s.). We may hypothesize that 2 patterns of mother-infant interaction can be found in early interactions - one,the "interactive" one being based on the vocal interaction mode and eye-contact, the other, the "cognitive enrichment" mode, being based on maternal tactile-vestibular contact with the infant and functioning as an activator of the infant's visual interest towards the environment which may entail some visual enrichment necessary for the infant's cognitive development. Our present data, however, do not allow us to study these hypothetical patterns more efficiently.

These results were obtained on the basis of summary data - the very approach we have criticized above. As we have small N ($N = 10$), sampling of the cases and the results based on the given sample may be erroneous.

TABLE 3. The percentages of infant behaviours following the maternal behaviours (data summed over 4 age levels)

Maternal behaviours \ Infant responses	Looks at environment	Looks at adult	Looks at object
Tactile contact	44.5	31.1	24.4
Speaking	38.3	37.3	23.4
Speaking + tactile	50.3	29.2	20.5
Tactile + vestibular	62.7	25.4	11.9
Showing objects	15.1	21.7	63.2

Let us look at the individual results of mother-infant pairs as revealed by the analysis of self-regulatory and interactive components in the ways outlined above. The 6 parametres of the 10 infant-mother dyads over 3 age levels are presented in Table 4. As can be seen in that Table, the self-regulatory component for both mother (α_0, α_1) and infant (β_0, β_1) tend to be greater than their respective interactive components (a,b). This is in full concordance with the argumentation of Thomas and Martin (1976) about the existance and importance of the self-regulatory component in early adult-infant dyads. In order to find out possible causal relationships between these components, the CLPC technique was applied to the above data. Spearman rank-order correlations were computed between all the 6 parametres at 3 age levels. The resulting 18 x 18 triangular matrix was analyzed with the 3W2V model of the CLPC (Kenny,1973). The results are presented in Table 5. Caution in interpreting the data in Table should be introduced due to small N and the arbitrariness of CLPC tetrade comparison criteria. Besides, the CLPC analysis reveals some possible causal relationships rather than others in case several assumptions be satisfied. If they are not, we can not make inferences on the lack of some unspecified causal relationships between the given variables.

The data reveal the following hypothetical causal relationships: $\alpha_1 \rightarrow$ a, that is, the consistency in maternal behaviours entails the developments in the maternal behaviours as responses tc the infant's behavioural attempts; at the

TABLE 4. The self-regulatory and interactive components of 10 mother-infant dyads over 3 age levels

Dyad	Parametre	Age Levels		
		2-3 months	3.3-4 months	5-6 months
1. Indrek	a	0.034	0.016	0.023
	α_0	0.436	0.294	0. 280
	α_1	0.256	0.470	0.440
	b	0.282	0.353	0.308
	β_0	0.073	0.210	0.240
	β_1	0.893	0.774	0.405
2. Jaanus	a	0.50	0.545	0.204
	α_0	0.462	0.454	0.129
	α_1	0.392	0.339	0.597
	b	0.146	0.211	0.274
	β_0	0.092	0.045	0.168
	β_1	0.463	0.403	0.689
3. Casper	a	0.343	0.013	0.050
	α_0	0.285	0.368	0.342
	α_1	0.576	0.544	0.289
	b	0.14	0.016	0.04
	β_0	0.224	0.282	0.257
	β_1	0.433	0.699	0.694
4. Kristina	a	0.14	0.068	0.251
	α_0	0.362	0.391	0.268
	α_1	0.379	0.275	0.438
	b	0.277	0.324	0.214
	β_0	0.099	0.053	0.153
	β_1	0.771	0.749	0.579
5. Inga	a	0.23	0.33	0.106
	α_0	0.22	0.285	0.265
	α_1	0.68	0.50	0.578
	b	0.10	0.22	0.157
	β_0	0.196	0.292	0.336
	β_1	0.571	0.368	0.557
6. Eve	a	0.10	0.21	0.24
	α_0	0.40	0.468	0.356
	α_1	0.35	0.436	0.519
	b	0.21	0.10	0.12
	β_0	0.32	0.419	0.152
	β_1	0.40	0.372	0.636

TABLE 4 (continued)

Dyad	Parametre	Age Levels		
		2-3 months	3.3-4 months	5-6 months
7. Kerstin	a	0.23	0.24	0.14
	α_0	0.459	0.341	0.420
	α_1	0.369	0.261	0.469
	b	0.17	0.39	0.12
	β_0	0.054	0.108	0.294
	β_1	0.717	0.669	0.559
8. Hannes	a	0.115	0.049	0.05
	α_0	0.366	0.320	0.30
	α_1	0.553	0.40	0.45
	b	0.081	0.30	0.279
	β_0	0.027	0.26	0.19
	β_1	0.621	0.672	0.753
9. Kirsti	a	0.271	0.155	0.103
	α_0	0.319	0.276	0.356
	α_1	0.261	0.303	0.274
	b	0.412	0.413	0.361
	β_0	0.236	0.20	0.195
	β_1	0.50	0.649	0.714
10.Kadri	a	0.229	0.293	0.22
	α_0	0.204	0.293	0.135
	α_1	0.58	0.356	0.221
	b	0.225	0.343	0.644
	β_0	0. 143	0.180	0.311
	β_1	0.619	0.534	0.469

same time, $\alpha_0 \rightarrow \beta_0$ i.e. maternal behavioural variability seems to be a cause rather than a result of the infant behavioural variability. It seems logical enough that $a \rightarrow \beta_1$: the way the mother behaves in response to the infant entails the infant's behavioural consistencies. The mother's behavioural consistency seems to be caused by the infant's behavioural responsivity to the behaviours of the mother ($b \rightarrow \alpha_1$) as well as by the infant's behavioural consistency ($\beta_1 \rightarrow \alpha_1$). Inside the infant's interaction

TABLE 5. The values of the CLPC tetrads in case of the 6 parametres of the mother-infant dyad comparison

Variable	a	α_0	α_1	b	β_0	β_1
a	XXXX	k* = -0.005 l* = 0.0356 m* = 0.14 XXXX	k = -0.059 l = -0.172 m = 0.34 k = -0.081 l = -0.002 m = 40.5 XXXX	k = -0.018 l = 0.0125 m = 1.48 k = -0.123 l = 0.094 m = 1.35 k = 0.034 l = -0.1534 m = 0.22 XXXX	k = -0.006 l = 0.047 m = 0.128 k = 0.178 l = 0.046 m = 3.86 k = -0.374 l = 0.162 m = 2.31 k = -0.176 l = 0.046 XXXX	k = 0.317 l = -0.005 m = 66.0 k = 0.031 l = -0.02 m = 1.82 k = 0.022. l = 0.141 m = 0.16 k = 0.025 l = -0.089 k = -0.0009 l = 0.087 m = 0.01 XXXX
α_0						
α_1						
b						
β_0						
β_1						

* - see formula (3.), (4.), (5.).

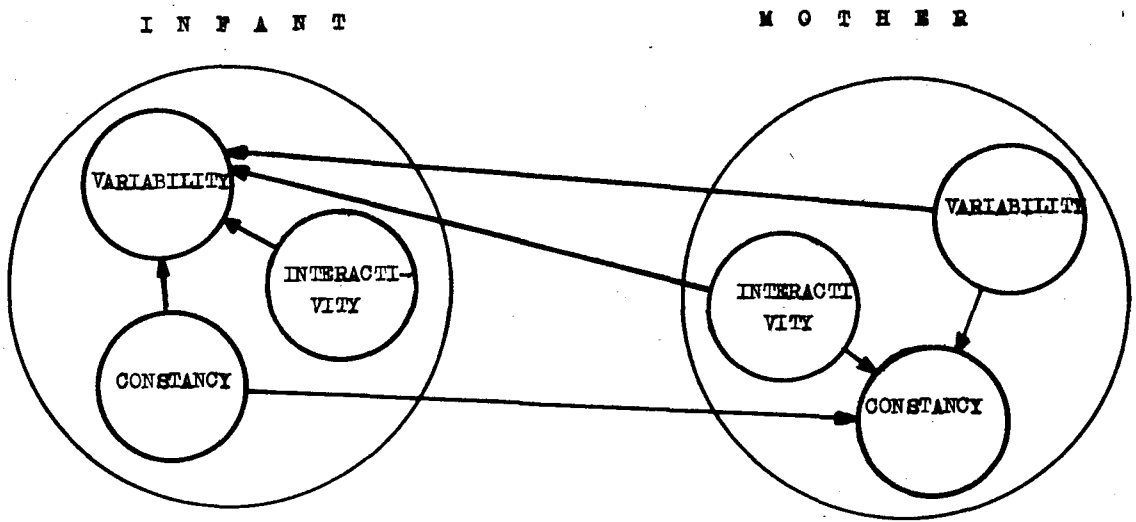

FIGURE 2. The hypothetical causal relationships between self-regulatory and interactive components of mother-infant dyads as revealed by cross-lagged panel correlations.

components, his responsivity to maternal behaviours entails variability in the infant's individual behaviour ($b \rightarrow \beta_o$). These results (see Figure 2 for a complex picture), however hypothetical, point to an intricating consistency in directions of influences: in infant, every direction of influence is directed to VARIABILITY in behaviours, while in mother everything is directed to CONSISTENCY.

5. Discussion

At the beginning of our discussion, we must once more caution our reader to consider the possibilities that our data collection procedure and analysis methods may have brought some artefacts to our results. Firstly, the 10 second time interval we used at data collection was arbitrarily set bearing in mind the abilities of the adult observers. Secondly, we have managed to study only a rather small number of adult-infant dyads, and the longitudinal design of the present study does not eliminate possible idiosyncracies due to sampling present in our data.

However, if we think these artefacts are within tolerable limits, our data can help to put forward some more general problems concerning mother-infant interaction development and its research. Firstly it is the problem of how to conceptualize the mother-infant interaction process. The usual emphasis on the interactive side of the interaction, i.e. the way how some behaviour of a partner influences the behaviour of the other one without any regard to how it influences the partner him/herself, and via that influence cause some other changes in further interaction. Mother-infant interaction seems to be more adequately considered as a loose coupling of two independent partners, with both behaving generally in rather individual ways, only at some time periods becoming more or less closely connected with each other. This, indeed, is more in concordance with our intuitive understanding of the natural interaction between an infant and an adult, and perhaps even that of two adults (or infants). Thus, it remains only a great wonder how " inter-

actionist" the thinking of the researchers on interaction is as they have generally succeeded in not noting the limits of interactiveness in the behaviours of the partners.

Our data tentatively hypothesize that some causal relationships exist in the process of adult-infant interaction development between interactive and self-regulatory components of the dyadic partners. It is intersting to note that there exists a two-sided causal influence between maternal and infant behavioural indices: the INFANTS behavioural consistency (the tendency to pursue in some behavioural sate) tends to cause MATERNAL behavioural consistency (the more the infants behave in some specified way for a longer time, the more the mother learns to behave in a non-variable way). From the side of the variability in behaviour (the tendency to alternate behaviours), MATERNAL behavioural variability tends to cause that of the INFANT :the infants of the mothers who are variable as to their behavioural strategies in themselves, tend to become more variable in their behaviours in the course of time. Unfortunately the arbitrary criteria used in our CLPC analysis did not allow us to reveal any causal connections between the consistency and variability components of infants or mothers themselves. If we lift the criteria a little, it appears that there is a tendency of maternal variability causing maternal consistency, and infant consistency causing infant variability in behaviours . If we add the interactive components' influences to this picture, it appear that in infant, all factors tend to entail v a r i a b i l i t y of behaviours (either directly or through influences on behavioural consistency by the maternal interactive component), wheras in mother, all factors tend to bring with them c o n s i s t e n c y in behaviours (see Figure 2). This system seems to be one of continous inventions of new behaviours by the infant which mother tries to control, or not to take into account and retain her behavioural strategies continuously. Now, the fact of infantile "creativity" at the background of maternal rigidity of behaving may be a general model of the infant development in ontogenesis. The trivial two-component understanding brought into infant-adult interaction research by

Thomas and Martin (1976) is valuable in finding solutions of the causal influences problem. The problem with the analysis above is of course that of immediate sequentialism : as in Markov processes, only the transitions from some behaviour at time t to some behaviour at time t + 1 are taken into consideration, wheras the possible longer sequences of 3 or more time intervals are not subjected to analysis. Probably the use of same type of generative grammars can help to overcome that problem.

Although we have strongly emphasized the need for longitudinal research on mother-infant interaction through individual cases, our analysis of summed data may help to advance some hypothesis concerning the various functional patterns in the early interaction. We hypothesize that there exist at least 2 alternative functionally different patterns of interaction in the mother-infant discourse : firstly, an "interactive pattern" or a dialogue mode that is activated by the infant behaviours and leads to infant looking at mother-mother vocalizing reciprocity. Secondly a "cognitive enrichment" interactive pattern, where the mother by her tactile and vestibular stimulation is the initiator and which leads to the infant's visual pursuit of the environment, thus providing the young organism with the visual stimulation necessary for his normal cognitive development. This has been registered already among newborns (Gregg, Haffner, Korner , 1976; Fredrickson, Brown, 1975) and can be found in our summarized data on later ages as well. The only novelty here is to consider this "an interaction pattern" rather than a simple cause of maternal stimulation. The existance of interaction patterns of this kind needs further experimental study.

And, finally, our application of the cross-lagged panel correlation technique seems to show that further application of this method on ontogenetic development data may be of value in revealing causal relationships. However, these "causal relationships" between some two measures should be interpreted cautiously, since this method allows only preponderance of causes to be found out (i.e. X causes Y more than the other way round) and we can never conclude that some causal relationship does <u>not</u> exist if not revealed by CLPC. And the

"causality" attribution may depend on the data analyzed rather than a pure application of the method. The parametres to what CLPC is applied should me meaningful in themselves, and it is only then that some interpretable results appear in CLPC.

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MATERNAL SUBJECTIVE CULTURE: AN EXPERIMENTAL STUDY OF THE POST-PARTUM COGNITIVE PHENOMENA

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Abstract. A study of ratings of a number of concepts (myself, ideal woman, child, delivery etc.) along 20 bipolar Semantic Differential scales was performed on 75 women during the first week of the post-partum period. The analysis of concepts' distances in 4-dimensional semantic attitude space and 5-dimensional personality variables' space was performed. There were differences in the personality variables' and attitude structures among primi- and multipara, the mothers of males or females, and among women with different abortion histories. The data tentatively show that the cognitive structures of women with different medical and other background parametres differ, and that further studies are needed to reveal the causes and behavioural consequences of these differences. The present data can be considered as normative for further studies of post-partum period psychological phenomena since the subjects were a reasonably homogeneous group as far as the medical side of their deliveries were concerned.

1. Introduction

In the light of recent increase of interest toward neonatal age among child psychologists and psychological phenomena by pre- and perinatologists and pediatricians, the neglect of the maternal post-partum behavior and cogni-

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tive structures seems to indicate a general over-concern with the neonate in our infant-directed fields. There are very few studies which have tried to study the maternal behavior after partuition, mostly during her first contact with the baby (Klaus, Kennel,1970,Macfarlane,1977). The cognitive side of the mother has not been studied,although it may be important to start looking at the process of maternal and infant mutual adaptation as early as possible,including the cognitive aspect of this interlocution. A number of theoretically-minded researchers (Bell,1968,p.88;Newson,1974,p. 254; Hubert,1974; Richards, 1971, p. 37; Lissina,1975) have emphasized the role of the maternal evaluation of the infant's properties in the process of child development. Some studies have tried to establish relationships between expectant mothers' attitudes and later (Robson, Pedersen,Moss, 1969) child behavior and complications of the delivery (Davids, DeVault,1962), or to find out possible changes in the moods and attitudes in the course of pregnancy (Murai,Murai, 1976, Meigas,1976). Practically no research on immediate post-partum cognitive phenomena has been found by us in our reading of the research literature. In case we are interested in the study of the structure of multiple factors causing the variability in mother-infant mutual adaptation and infant development, the cognitive factors like attitudes and personality variables of the mother could play some role, either alone or more probably in close connections with other factors. These interrelationships can be found in longitudinal studies where the different factors to be studied are measured on the same subjects. There is some evidence that some maternal child-rearing attitudes are not subject to changes in the course of the first year of life: maternal control tendencies as well as her hostility were found highly correlated between postpartum and 12-month examination (Goldstein, Taub Caputo , Silberstein,1976). No significant correlations were found with perinatal and prenatal events. Osofsky and Danzger (1974) have pointed out an interesting complementarity of mother and infant characteristics: mothers who are more attentive towards their children tend to have more responsive

babies than nonattentive mothers. However, that result is purely correlative, no exact ways of how this is achieved can be found out.

The present study is devoted to the problem of maternal cognitive structures in the immediate post-partum period. We are interested in the way these structures differ between groups of subjects that differ in some pre- or perinatal or social parametres. We also try to establish the relationships between various medical parametres and the cognitive measures of the young mothers to test the possible causal connections between medical antecedents and psychological consequences.

Now it is necessary to explicate what we bear in mind when we speak of "cognitive structures" and the like. In the present study, we use the method of Semantic Differential to measure the cognitive phenomena: attitudes and personality variables, the phenomena Osgood (1977,1974), has termed the "subjective culture". Practically we study self-reports of young mothers on Semantic Differential scales. Thus, we work with emotional ratings of certain objects from the psychological aspect of the study, and with medical information concerning pregnancy and delivery from the biological aspect. In addition, some socio-economic parametres are included to characterize the young mothers. The whole study is more of hypothesis generating than of hypothesis testing character. The cross-sectional data of the present study are partly included into a more thorough longitudinal project of the study of early influences on later mother-infant interaction and infant cognitive development.

2. Method

The following data were obtained to characterize the mother, her educational and socio-economic background and family: age, education, marriage status, characteristics of her work, monthly salary, housing conditions, mother's father and mother ages and education, number and ages of brothers and sisters, mother's own birth order, consumption of alchohol and smoking. The child's father was characterized by his age, education, and smoking. The medical infor-

mation used in the study can be grouped into the following clusters:

1. Obstetric and gynecologic history: parity, abortion history (either spontaneous or medical, ages), menstrual history, genetic abnormalities of the mother.
2. Pregnancy history: toxemia.
3. Delivery conditions: presentation, length of delivery , blood loss, delivery complications, fluid complications, placentar,complications, uterine operations etc.
4. Neonate's state : Apgar 1 and 5 minutes, asphyxia, skin color, cry,birth weight, birth height, head circumference, gender, cord turned around neck.
5. Post-partum data: breast feeding start, lactation difficulties.

The Semantic Differential was performed with the following objects to be rated : ME, CHILD, DELIVERY,IDEAL WOMAN, HUSBAND, other children (if multipara).

The subjects were interviewed on the 4th-5th day after delivery. They were asked to rate the objects on the Semantic Differential, and information on sociological, family and other factors was obtained during free interview. The interview data were complemented by analyses of the medical files.

The Semantic Differential included 20 bipolar scales chosen from a pool of 50 used by Meigas (1976). In order to standardize the Differential for the given objects and subjects, a between-scales correlation and factor analysis was performed, which revealed 12 independent factors (see "Results" section).

3. Subjects

The experimental group subjects were 75 women of the ages 18 to 42 (mean age 25.1 years,s.d. 5.4. years), The distribution by age was skewed so that 70 of the 75 subjects were at the age range 18-32. 67 of them were married (69.3%), 5 single (6.7%), others widowed. The fathers of the newborns were 20-44 years old (mean age 27.6 years, s.d. 5. years). The mothers were largely primiparas (44 or 58.6%) . The length of the labour was from 1 to 33 hours, with 10.2 hours as an average (s.d. 6.0 hours). The neonates were 40

males and 35 females. Their state after delivery was generally normal - there were only 4 asphyxiated infants among the 75. 2 of the 75 neonates were pre- or postmature. The weight varied from 2740 g to 4670 g (mean 3716 g, s.d. 434.5 g),the height 46 to 54 cm (mean 50.1 s.d. 2.1), head circumference from 33 cm to 38 cm (M = 35.5, s.d. 1,1). 74 of the infants had 1 minute Apgar score of 7 or higher, and none had 5 minute Apgar scores of less than 8. The breast feeding for 69 of 74 infants was started on the 2nd or 3rd day after delivery. 72 of the neonates were delivered in head presentation, 3 - in breech presentation. The blood loss of mothers during the delivery was related to complications of delivery and operations, and varied from 50 to 900 ml (mean 259 ml, s.d. 127 ml). The number of complications in the delivery process was small: 16 of the 75 subjects had preliminary membrane ruptures, 5 had primary or secondary delivery weakness. The subjects were healthy during the delivery: of 75 there were 6 cases of nephropathia and hydropsia, 2 cases of hyper- and hypotonia, and one case of anemia. The children born were in good condition, except for one case of moderate asphyxia. 11 of the 75 subjects were Rh^- , and in 18 cases the children were born with the umbilical cord turned around the neck.

It can be seen that from the obstetric point of view,our subjects and their newborns can be considered a group of normal range cases. This fact would certainly make it less probable that any considerable relationships are present in the data between medical and attitude parametres.However, it is prefarable for a pioneer study of the area to have an homogeneous group of cases so that the possible reproductive casualty factor may be minimized. Since the present investigation is limited to the post-partum period, causal relationships of the subjective culture of the mothers and the medical parametres of pregnancy and delivery can not be established and the data could fairly serve as a normative group for further studies.

The control group consisted of 23 females (university students) (mean age 21.2 years, s.d. 0.83 years, age range 19 to 25 years) who were predominantly not married (2 mar-

ried out of 23) and only one of them had a child. No information of the control group medical histories was available.

4. Results

In order to make the Semantic Differential technique appropriate for the given subjects and objects rated on the 20 bipolar scales, the factor analysis (Varimax rotation) was performed on the experimental group data to group the 20 scales into factors. By this method the 20 scales were grouped into 12 independent factors, with reasonably good commonalities ($Hs \geqslant 0.648$) and rather even distribution of the percentages of variance covered by the factors (maximum 11.13% in case of the first factor, minimum 5.13 in case of factor 12). The composites of the factors with the respective loadings are given in Table 1. As can be seen, the factors themselves can be grouped into 2 semantic categories: those denoting personality variables (factors 3, 6,8,11,12) and those denoting general attitudes (factors 4, 5,9,10). The latter category is a rough equivalent of the EPA dimensions found usually in the Semantic Differential , with the notable exception of the evaluation dimension consisting of two independent factors: "Evaluative Beauty" (factor 5) and"Subjective Goodness" (factor 10) as they may be called. The factors 1, 2 and 7 are not included in the following analysis due to their semantic fuzzyness or irrelevance to our aims.

All the ratings given to the objects rated by subjects in the experimental and control groups were transformed into factor scores by first transforming them into the z-score and later multiplying them by the corresponding factor loading. The present analysis is based on the analysis of the ratings of 4 concepts: MYSELF, WOMAN, DELIVERY, CHILD. In order to subdivide our experimental group into subgroups for comparisons of the SD data, the medical and socio-economic information was fed into the computer to group the subjects on the basis of various parametres. In addition, some implicitly important information about the medical side of the pregnancy and the delivery was used to form the subgroups of the subjects for further comparisons. We will present the

TABLE 1. The results of the factor analysis of 20 bipolar adjective scales used in the study

Factor 1	loading	Factor 2	loading
20. hoolas-hooletu (careful-careless)	0.738	18. arg-julge (cowardly-courageous)	0.779
17. mahe-järsk (gentle-harsh)	0.698	15. kartlik-kartmatu (fearful-fearless)	0.795
10. elav-tuim (lively-dull)	0.569		
11.13%		7.64%	
Factor 3		**Factor 4**	
5. erutav-rahustav (exciting-calming)	0.885	4. jõetu-jõuline (strengthless-strengthful)	-0.811
11. rahutu-rahulik (anxious-sedate)	0.564	6. tugev-nõrk (strong-weak)	0.799
7.5%		7.41%	
Factor 5		**Factor 6**	
3. ilus-inetu (beautiful-ugly)	0.886	8. kannatlik-karsitu (patient-impatient)	0.556
14. meeldiv-ebameeldiv (pleasant-unpleasant)	0.619	17. mahe-järsk (gentle-harsh)	0.836
7.28%		6.17%	
Factor 7		**Factor 8**	
19. vali-vaikne (stern-tranquil)	0.931	9. pinges-lõtv (stressful-loose)	0.945
5.98%		5.62%	
Factor 9		**Factor 10**	
2. passiivne-aktiivne (passive-active)	0.940	1. hea-halb (good-bad)	0.916
5.54%		5.43%	
Factor 11		**Factor 12**	
13. karm-hell (rough-tender)	0.946	16. liikumatu-liikuv (immobile-mobile)	0.966
5.33%		5.13%	

results separately for each classification performed

A. The c o n t r o l g r o u p. The ratings by the control group subjects of the 4 objects were converted into factor scores by the standards obtained in preparing the SD for the study on the experimental group. The distances between the 4 objects rated are presented in Table 2 for both attitudinal and personality variables. In order to make the data of the distances matrix more figurative, a method of cluster analysis based on a successive grouping of objects into clusters as progressing from the nearest objects up by the dendrogram (Duran,Odell,1977). The dendrogram depicting the attitudinal data of the control group is presented in Figure 1, and that of personality variables in Figure 2.

TABLE 2. The analysis of distances between rated concepts in N-dimensional space. The distances of the objects in attitude dimensions' space are presented above the main diagonal (N=4), the distances of the objects in personality space - below the diagonal (N=5)

Concept	MYSELF	WOMAN	CHILD	DELIVERY
MYSELF	XXXXX	1.01	1.75	1.08
WOMAN	0.51	XXXX	1.26	1.19
CHILD	0.43	0.66	XXXXX	1.51
DELIVERY	1.16	1.39	1.04	XXXXX

As can be seen, neither attitude structure nor personality variables show great differentiation in the control group. This is only natural, since some of the objects rated at the Semantic Differential seemingly did not constitute important subjective phenomena for this group (child, delivery).

Further analysis of the data progressed as follows. The subjects were classified by the computer into homogeneous groups according to some parametres. The groups including a greater number of subjects were analyzed as to the parametres for which they appeared homogeneous, and as to the distances in the Semantic Differential ratings.

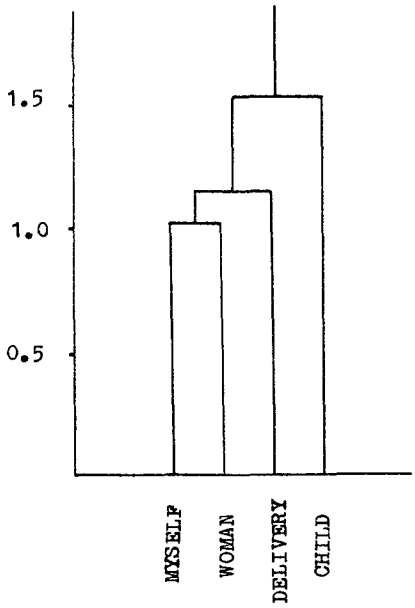

Figure 1. Dendrogram depicting the structure of attitudes of the control group

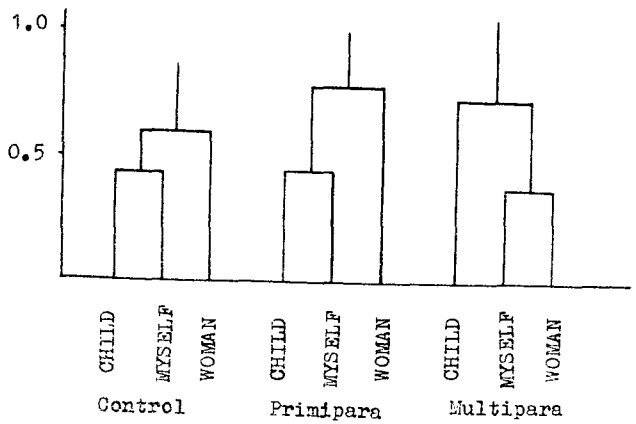

Figure 2. Dendrogram of control group, primiparous and multiparous women ratings as measured by personality dimensions

The first classification of subjects was performed with the delivery parametres in general as the basis for typology. The parametres were: parity, length of labour, number of spontaneous and medical abortions in anamnesis. The two more numerous groups were differentiated by the parity parametre without abortion history. The primiparae group (N=29) had the length of labour greater than the multipara group (N=14), although the difference was not statistically significant (primiparae M=10.47 hrs, s.d. = 3.41 hrs, multiparae M = 8.85 hrs , s.d. = 2.24 hrs, $t = 1.91$ $p > 0.05$) . The abortion cases were entirely atypical for these two groups obtained: there were 3 cases of spontaneous abortions in the primiparas group and 2 in the multipara group, with no cases of medical abortions.

The distances between rated objects among the primiparas and those for multipara are presented in Table 4. As can be seen, the two groups tend to differ minimally in their MYSELF concepts for both attitude and personality ratings. The same tendency can be seen in the comparisons of both groups with the control group data along respective objects. This seems to show that on the whole the self-concepts of women seem to be similar in spite of their differences in childbearing. As a general tendency, it evidently characterizes some cultural norm of "me-femaleness". It is interesting that the normative ratings of the "ideal woman" seems to change with the parity - more away from the primaparous and control group understanding to greater associations with the children. The data indeed do not allow any speculations about this as a possible developmental tendency of "mothering role" rather than a simple difference of initially different groups. The dendrograms along attitude parametres for the two groups are presented on Figure 3, and along personality dimensions on Figure 2.

Among the interrelationships of the concepts rated, an interesting pattern emerges. When the distances are computed over attitudinal factors, the multipara seem to evaluate themselves as more similar to the ideal woman, and tend to relate the ideal woman to child more than the primipara. As to the distances between concepts along personality vari-

TABLE 4. The distances between the rated concepts in N-dimensional space. Attitude dimensions' distances are presented above the main diagonal, personality dimensions-below.

A. Primipara

Concept	MYSELF	WOMAN	CHILD	DELIVERY	CONTROL GROUP
MYSELF	XXXX	1,56	1.31	1.03	0.48
WOMAN	0.69	XXXX	0.85	1.73	0.98
CHILD	0.43	0.86	XXXX	1.76	1.11
DELIVERY	1.71	2.21	1.59	XXXX	0.33
CONTROL GROUP	0.67	0.97	1.14	0.70	

B. Multipara

Concept	MYSELF	WOMAN	CHILD	DELIVERY	CONTROL GROUP	I-para
MYSELF	XXXX	0.81	1.10	0.96	0.47	0.31
WOMAN	0.36	XXXX	0.47	1.60	1.15	1.27
CHILD	0.74	0.69	XXX	1.92	1.23	1.02
DELIVERY	1.46	1.48	0.95	XXXX	1.28	1.28
CONTROL GROUP	0.89	0.97	1.50	1.27		
I-para	0.37	0.65	0.57	0.71		

ables, the primipara tend to rate themselves more close to the CHILD than to the IDEAL WOMAN, heras among the multipara the pattern is opposite. Here too, no argumentation about possible changes in attitudes and personality ratings along developmental lines is unwarranted. Undoubtedly the primipara group may change in their SD ratings when they become multipara in the course of time, but the developmental component and individual consistent component of the ratings can be separated only in longitudinal analysis.

The second typology of mothers was performed with the following newborn's characteristics as the classification basis: neonate's sex, asphyxia,pre-,postmaturity or in term,

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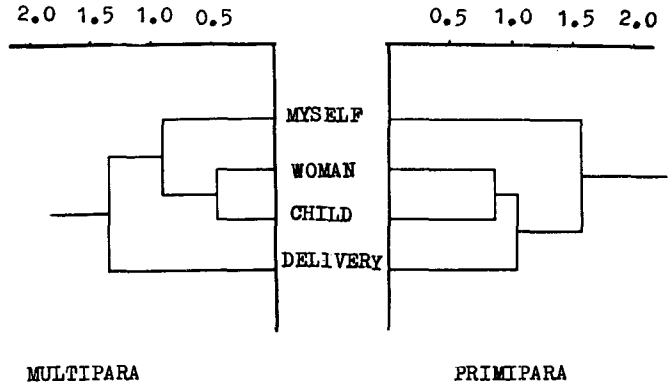

Figure 3. Dendrogram depicting the attitude structure of primi- and multipara

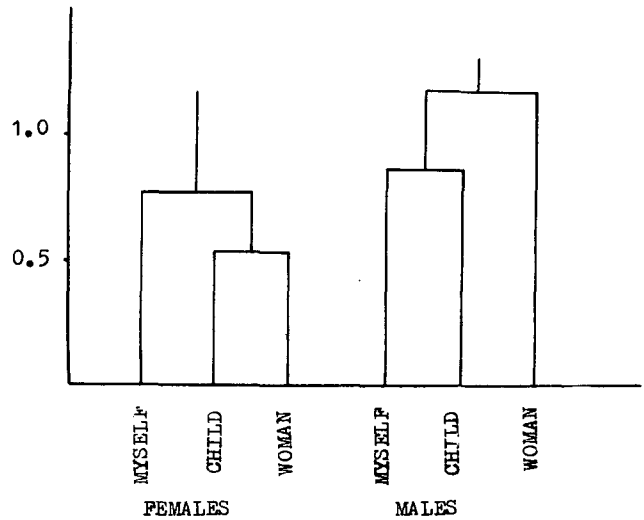

Figure 4. Dendrogram depicting the relationships between three personality ratings in groups of mothers of females and males.

skin colour, cry, weight at birth, height, head circumference, Apgar 1 and 5 minutes, the start of breast feeding . The two groups with a greater number of subjects were clearly differentiated by the newborn's sex (22 subjects in the male and 24 in the female group). Both groups of infants were unasphyxicated, had normal cry, skin colour after birth, were in term, and had no Apgar 1 rating lower than 7, in the majority 8 or 9. The birth weight for both groups was virtually similar (males: M = 3826 gm, range 2950-4400, females M = 3898 gm, range 2970 -4440).

The matrices of distances in the 5-dimensional personality variables' space are presented in Table 5. As can be seen, mothers of their female newborns consider the child to be more similar to themselves and to the ideal woman than the mothers of the male infants (consult Figure 4). This shows that there exists a difference in the cognitive structures of the mothers depending on whether have given birth to a male or a female. This demonstrates the difference in maternal cognition of the infant's sex from straight after the birth. This differential cognition can be the basis of further sex-role differentiation of the infants via maternal behavior . However, our data do not allow any speculations on how this differential cognition of the child's personality has appeared in the course of pregnancy and possibly when the actual sex of the child is revealed to the mother straight after the birth.

TABLE 5. The distances between rated concepts in the 5-dimensional personality variables' space. The distances of the "male infant" group are given above the main diagonal. The main diagonal consists of distances between similar concepts along the two groups. Below the main diagonal, the distances of the "female infant" group are presented

Concept	MYSELF	WOMAN	CHILD	DELIVERY	Control group
MYSELF	0.28	1.0	0.84	1.2	0.62
WOMAN	0.91	0.85	1.33	2.04	0.81
CHILD	0.52	0.58	0.92	1.15	1.24
DELIVERY	1.58	2.24	1.95	0.34	0.87
Control group	0.74	1.18	1.48	0.64	

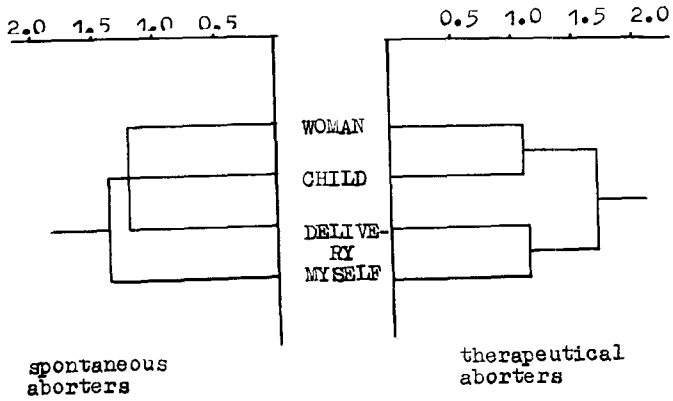

Figure 5. Dendrogram depicting the attitude structure of spontaneous and therapeutic aborters.

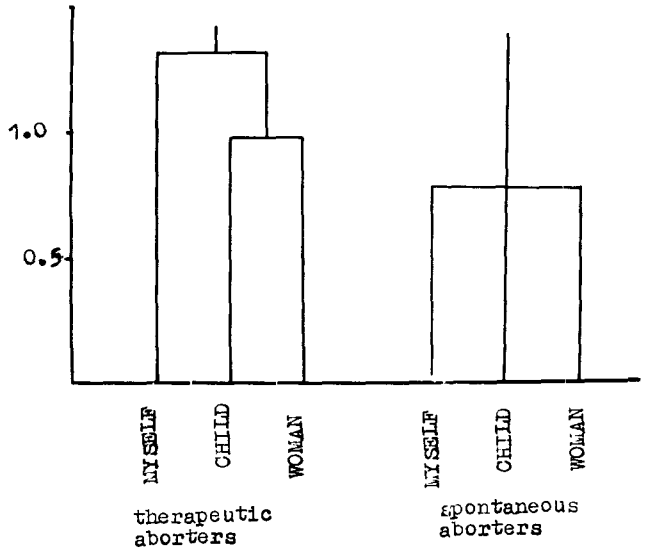

Figure 6. Dendrogram of the clustering of rated personalities in the therapeutic and spontaneous aborters groups.

The typologies presented above were performed on multiple descriptors. However, it might be of interest to look at some typology based on a single criterion. In our study, we classified the subjects as to their abortion history. The group of medical abortions included subjects of only medical abortions with no spontaneous ones. The spontaneous abortion group included subjects with at least 1 spontaneous abortion irrespectable to the number of medical ones. This kind of criterion was included because the motives for medical abortions were not obtainable from the existing data, and the sheer distinction of medical spontaneous abortions may be misleading because the actual causes for abortions were not revealed. The two groups consisted of 11 (medical abortions group) and 10 (spontaneous group) subjects.

The distances of the concepts rated on the personality variables are presented in Table 6A; the attitude distances in Table 6B and on Figure 5, for both groups. The interesting finding from the data is that the personality distances of the spontaneous abortion group for the 3 concepts (MYSELF, WOMAN,CHILD) seem to be less than those of the medical abortion group - the cognition of personalities of the three figures seems more integrated (see Figure 6). Turning to the attitude distances, the only difference between the two groups is in the distance between WOMAN and the DELIVERY: for the spontaneous abortion group, this distance is smaller than for the control group and the distance is greater for the medical abortion group. This is consistent with the popular idea of the aborters on demand being psychically more oposed to childbirth while the spontaneous aborters may have cognitive problems of <u>not</u> being able to deliver uneventfully. Two points must be stressed here that make the above results even more noteworthy: 1) the subjects of both groups have just prior to testing gone through an uneventlul normal delivery, thus the cognitive problems related to abortion history should have been attenuated, 2) the groups were not pure: "abortion on demand" and "abortion on because of medical necessities" were not specifiable in the medical abortion group.This should make it possible that an artefact due to "abortion because of medical necessities" is present in the data.

TABLE 6. The results of spontaneous abortion group (above the main diagonal) and medical abortion group (below tha main diagonal) in distances of the concepts rated. The main diagonal includes the distances between the groups on the respective concepts

A. Distances along personality variables

Concept	MYSELF	WOMAN	CHILD	DELIVERY	Control group
MYSELF	0.76	0.71	0.71	1.39	0.85
WOMAN	1.56	0.44	0.91	1.63	0.79
CHILD	1.07	0.97	0.76	1.41	1.31
DELIVERY	1.34	2.05	1.64	0.82	0.99
Control group	1.06	0.97	1.61	1.33	

B. Distances in attitudinal space

Concept	MYSELF	WOMAN	CHILD	DELIVERY	Control group
MYSELF	0.57	1.23	1.79	0.97	0.61
WOMAN	1.54	0.70	0.96	0.96	1.01
CHILD	1.24	1.09	0.84	1.75	0.66
DELIVERY	1.11	2.36	1.55	1.55	0.35
Control group	0.89	0.88	1.31	1.51	

It can also be seen in Table 6B, that the spontaneous abortion group is closer to the control group in their ratings of CHILD and DELIVERY than the medical abortion group. This too turns our attention to the possibility that the medical abortion group is psychologically a group that tends to exclude the childbirth and the child from their cognitive structure of important subjective phenomena . However, this possibility needs a further and more reliable study.

5. General discussion

The present study can be considered a collection of normative data on young mothers' postpartum subjective culture. The most interesting findings, which, however, raise more problems than they solve, are: the cognitive structures of mothers of male and female neonates are different at the early postpartum period under study, and the difference in the distance between the concepts of IDEAL WOMAN and DELIVERY among women with spontaneous or medical abortion in the anamnesis. The first result is noteworthy because of the possibility that the differences in maternal **behaviours** toward their infants of different sexes may be a function of their cognitive representations of the children that are either formed quickly after delivery when the infant's sex is revealed, or is prepared during the pregnancy on the basis of the wished sex of the child. Be it as it may, the sex-specific stimulation can thus begin from the first episodes of infant feeding and contact with the mother. Support for this argumentation can be obtained from the studies by Robson, Pedersen and Moss (1969) who showed that certain behaviours (mother-infant gazing) are positively correlated with maternal attitudes during pregnancy - but for the male infants' group only. Goldstein, Taub, Caputo and Silberstein (1976) also demonstrate that the maternal attitudes towards infants are rather an antecedent to than a result of the infant behaviours. Indeed longitudinal studies of maternal subjective culture over the whole range of pregnancy and closely after delivery are needed to prove these speculations.

The differences between the primiparous and multiparous mothers as to their subjective culture do not allow overdue generalizations. However, the results are somehow paralleled by the behavioural observations by Thoman et al. (1972) on differences in behaviour of mothers during feeding: the primipara spend more time feeding male infants, provide more stimulation for infants in general than multipara, etc.

The finding that the subjects' abortion history is connected with their subjective culture and especially with the place of the delivery in that cognitive structure is intri-

guing. The literature on the personality characteristics of women who demand abortion have revealed some extra agressiveness and hostility, both towards their self and the fetus, as well as a tendency to dominate over others (Biele, 1971, Jacobson,Perris, Espvall, 1978). Our data seem to support the idea of differences between the medical aborters and the females in general - in the former group their concept of delivery has been driven out of the central phenomena of the ideal woman and self concepts.

However, the problems of the causation and role of the above-mentioned subjective culture differences need further study. The method of Semantic Differential seems to be a useful tool to study the phenomena in the cognition of young mothers and pregnant women. The medical parametres used should be more carefully chosen and measured. The present data may act as a normal delivery control group for further studies of abnormal cases.

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A METHOD OF DIAGNOSTICS OF A PERSON'S ATTITUDE TOWARDS AN ALARMING EVENT

Mihhail Kotik

Are you true to your wife?
CERTAINLY, VERY OFTEN!

Abstract. The article presents a simple objective method to estimate the attitude of a person towards emergency situations. The method based on the vocabulary the person uses to characterize the situation. The experimental proof for the method as well as an experimental illustration are presented, with the pilots as experimental subjects and various aviation accident situations as the objects the subjects give characteristics to. The method is considered to reveal not only the general attitudes, but also attitudes towards various aspects of the situations.

1. Introduction

We begin our article with this joke not only because it reflects its essence but because from the word chosen for appraising the frequency of an event one can judge of people's attitude towards it and beacause it gave us the idea of using this principle in psychodiagnostics and carrying out given study.

The matematician L.Zadeh(1976)- the author of the theory of fuzzy sets , showed that in concrete situations owing to the great number of factors influencing it and complicated connections between them and also the inadequate concreteness of conditions and aims of the task, it is extremely difficult to state whether the given event belongs to one or another class.

That is why he proposed to indentify the events not according to the probability of their being in the given class, but according to their belonging to a certain fuzzy set.

For the event under discussion a short series of fuzzy sets can be allegated and with the method worked out by L.Zadeh one can fix quantitavely the degree of its belonging

to each of these sets separately. So for instance, if it is necessary to fix with this method the frequency of occurence of some events: A series of fuzzy sets, corresponding to different levels of frequency indicator are given-naming every set by a certain quantor of the type "seldom", "often", "very often", etc.

In such a way we can create that or another fuzzy set being in the range of quantors from "never" - to "always" and fix whether the event belongs or not to each of these quantors. This approach was used in the given research not only by means of a mathematical apparatus, but also by the methods of expert estimations. The aim of this experiment is to control the following hypothesis:

if the persons under experiment will estimate (in per cent) the possibility of occurence of certain events and at the same time state their frequency, by a corresponding quantor, then from these estimations one can fix their relation to these events and their importance for them.

Now let us speak about the role of indicators of significance in psychology for a person in one or another event. In literature the word "significance" is used in various ways.

A.N. Leont'iev (1975) gives the definition of significance - as a certain notion about a given subject or phenomenon, about its quuality and connections with other subjects and phenomena. Besides, we can speak about their subjective reflection in the consciousness of an individual , about the sense that one or another subject has for the certain person. "Sense" - according to Vygotskij's (1956, p. 54) definition "is a unity of affective and intellectual processes".

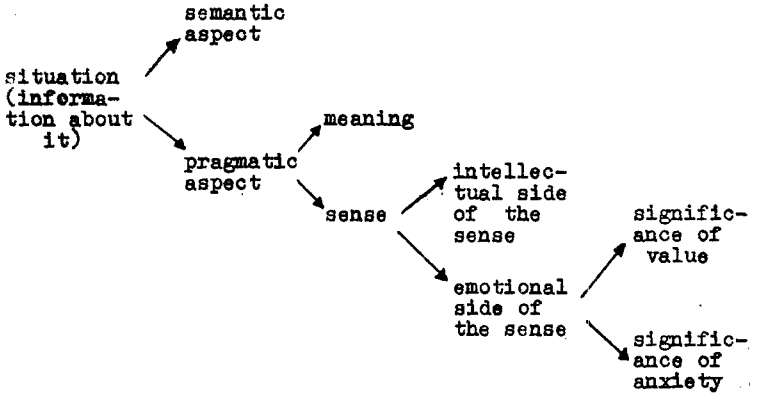
Besides the meaningful side of a subject or phenomenon in the "sense" - emotions are also caused by this meaning. Let us call this emotional side of the "sense" the "significance" of subjects and phenomena reflected in a given person.

Depending on the meaningful side of the "sense" and also on its connections with the needs and motives of the given person, emotions of various character can be found in it .

But if we take a person's activity only in productive work and the sense of tasks, arising in the course of this work, we can distinguish two main categories of emotions.

Positive emotions arising from achieving an aim or in case of favourable situations, getting valuable informations, helping to achieve it - on the one hand. And on the other hand - emotions, caused by the news or situations indicating an appearance of considerable obstacles on the way to this goal, of serious danger to this activity and to the operator himself. According to these two categories of emotions - we can speak of "<u>significance - of value</u>" in the first case and in the second case of "significance - of anxiety" of tasks and situations under discussion.

But if besides the above facts we take into consideration that the arising task or the information concerning it can be regarded from the point of view of their semantic or pragmatic aspects, we get the following hierarchy of notions from which we can see the place of the category of significance in it:



In this research we shall deal only with situations being dangerous to a person, therefore we will speak about their "significance - of anxiety".

Having formulated the notion "significance" let us speak about the importance of this factor in the subjective activity. As it is known from numerous research efforts - beginning with psychological, ending with sociological

ones - the whole structure of activity depends on person's attitude towards a certain task, on its importance for him - as well as the energetic and informational support of it by his whole organism. The experimental research carried out by Cannon (1927), Simonov (1970), Lazarus (1970) and others showed, that in difficult situations, presenting a threat to the person and demanding immediate resolute action - emotions arise in this person, that create an energetic mobilization of the organism promoting his motive and intellectual activity and in such way they contribute to the overcoming of difficulties and avoiding danger. In our research (Kotik,1974) we have assertained experimentally that the more important the task is for the person - operator , the greater activization it causes in his nervous system - and this circumstance allows the operator to solve more complicated tasks as effectively as the simpler ones.Therefore it is very important that in a difficult and dangerous situation the person must not only estimate correctly its assence, but his emotional reaction must correspond to it. This fact was corroborated by an experiment that showed that the operators most often made mistakes not because they could not solve the task properly, but because - due to some reasons - they underestimated its significance and did not make use of all available opportunities. All these facts speak about the importance of the factor of significance in the subjective activity and necessity of working out special methods of studying the regularities of formation of a person's attitude towards a certain situation, methods of estimation its significance. At present two main ways are used to state the significance of a certain situation for a person:

- the method of expert estimation, when a competent person under experiment on the basis of his own experience and analysing his own emotions in the given situation states the degree of its significance, usually expressing it by ratings

- instrumental methods of measuring the vegetative reactions of the organism (reflecting emotional processes) in real situations or in their reproduced versions; usually

the cardio-vascular reactions, cutaneus - galvanic reflexes, indicators of respiration, biorythms of brain, etc. are registered.

For the first group of methods we do not need special apparatus therefore it is easy to put it into practice, but still the self - estimation used in them does not always reflect exactly the real significance of the situation. The instrumental methods help to get more objective data of emotional reactions of a person to a dangerous situation ; but there are difficulties in creating such situations.

And so we can draw a conclusion that "significance" is an important psychological indicator of activity and there is a need of searching for new objective and more available methods of diagnostics of significance for a person in different situations.

2. Experiment I

The task of a comparatively short preliminary investigation was to study emergency situations, occurning in productive work, from the above mentioned point of view. The method of expert estimations was used - 50 specialists (safety engineers, psychologists) gave their estimations of significance in a number of situations, connected with bodily injuries of various degrees of severeness . The collection of expert estimations was carried out as follows . The experts were shown 6 categories of bodily injuries, marked by numbers according to the growth of their severeness:

1) a light injury, the worker can continue his work
2) a light injury, the worker is free from work a few days
3) an injury of average severeness, more serious that the previous one, connected with a longer period of incapacity to work
4) a severe injury - causing significant violations in the organism and needing long treatment
5) an injury leading to permanent disability
6) a mortal injury leading to lethal outcome.

Each of the experts was given a sheet of paper with axes of co-ordinates, having a length of 10 cm; on the axis of

abacissae the indicator of severeness of the injury had to be marked (significancy of the event). The first (corresponding to a very light injury) and the last, the 6-th(mortal injury) had been marked . The experts had to place the points 2 , 3 , 4 , and 5 in the interval according to their opinion about the severeness of the injuries. After that they were asked to fulfil the second part of the task. On the axis of ordinates they had to mark (in %) the possibility of occurence of these injuries. For each of the 6 cases they had to mark on the graph the possibility of its occurence when the given event turns out to be so frequent, that the arising situation had to be characterized as an emergency one.

On the basis of these points we can draw up a curve P (S), connecting the significance (S) of bodily injury and the possibility (p) of its occurence (in %%) on the level of the quantor (Q) "often" (where Qoften=const).

After statistical processing of the graphs made by the 50 experts we got a graph shown in Fig. 1.

On the axis of abcissae the average marks of the relative significance of injuries 1, 3, 4 , 5 are shown and near every point the boundaries of authentic intervals on the level $\beta = 0.999$ are marked. On the basis of these data we can conclude that there is a difference with a high level of statistical significance between the "significance" of events under discussion. On the same graph we have the authenic intervals of average estimations of possibility of occurence of each of these events (also on the level $\beta = 0.999$) speaking about the reliability of these estimations.

On the basis of the Fig. 1 we can draw the conclusion that for a very light injury the situation becomes an emergency one, if the possibility of occurence of this event exceeds 42,5%.

At the same time for a severe injury - 8% is enough for regarding the event frequent and the situation an emergency one and 1,7% - for mortal injuries. So we can divide the area of the graph (Fig. 1) into 2 parts: a zone of dangerous situations and a relatively safe zone.

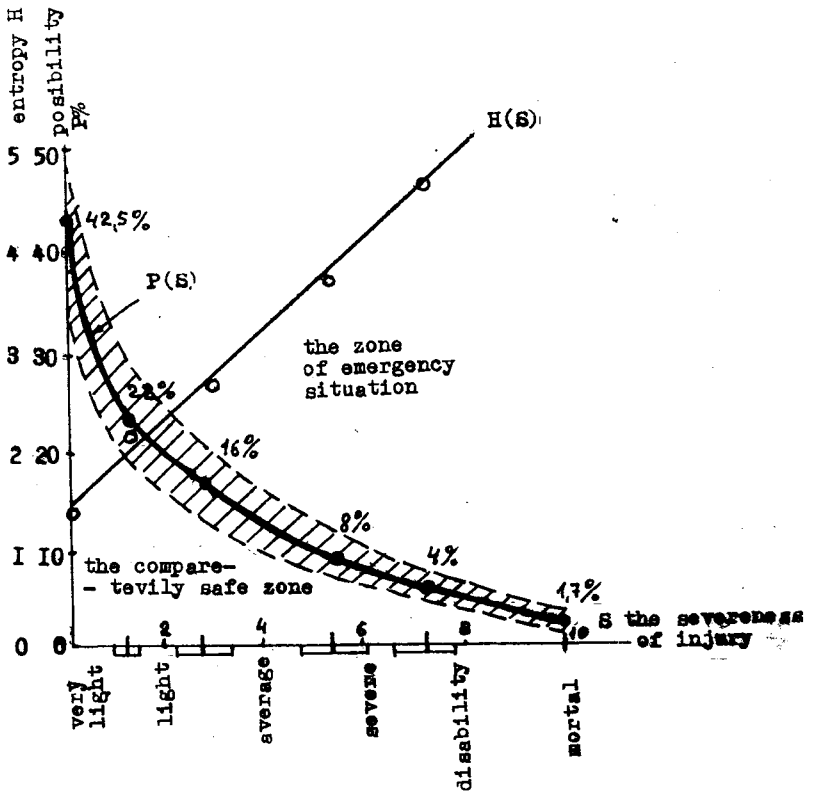


Fig.1

If we express the possibility of occurrence of an event in the form of probability (p), then on the basis of the theory of information we can find the indicator of its entropy ($H = -\log_2 p$). In this case as we see it on Fig.1 the connection between the significance of the event and the uncertainty at which we estimate it as a frequent one, turns out to be almost linear.

In general we can say: among events, belonging to the given set "of frequent ones", the one which he characterizes with a less possibility or a greater entropy is more significant for the person.

3. Experiment II

This approach was used in a concrete psychological research to find out the pilots' attitude towards various accident situations, that arise during flight because of technical reasons or his own mistakes. Because of that or some other reason the flying task may be not fulfilled and some physical danger for the pilot and the passangers may arise. Besides that the pilot's mistakes also lead to some social punishment (losing authority, removal from flight ; administrative measures).

Obviously all these factors will condition the pilot's estimation of the significance of the given situation. The task of the given research was to state the part, the specific role of the indicated factors in the formation of such estimations.

In this research we also used the method of expert ratings: 36 qualified pilots were to give their esimations on a number of emergency situations according to a special questionnaire. The following points had to be fulfilled:

1) To show the degree of alert, that exists in normal conditions of the flight in connection with the apprehension of an emergency situation. Ratings are given in 10-points system. 10 points is the maximum alert.

2) To state the significance-of anxiety of the given emergency situation in case of its arising (in the same 10-point system). Then follows a set of questions in which they had to state the possibility of arising of the indicated emergency situation and the possibile consequances. The estimations were to be given in two ways: to show the approximate chances of the possibility of the occurrence of the event and to define it in words-with a quantor of frequency. The quantor had to be chosen from the attached 11 medifyers : never, almost never, exceptionally seldom, very seldom, seldom, not often, very often, exceptionally often, almost always , always. Two such answers had to be given to the following questions.

3) To fix the possibility of occurrence of the given emergency situation.

4) If the situation has arisen, state the possibility of non-fulfilment of the flying task and non-achievement of the goal.

5) If the situation has arisen state the possibility of a flying incident in such case.

6) If the pilot is responsible for the mistakes, fix the possibility of social punishment for this mistake.

The experts-pilots were presented 18 various familiar emergency situation , 9 of them were caused by the failure of the engine, 9 - by the pilot's own mistakes. The situations were of different degrees of severeness. So there were cases when the engine stopped during the take-off; fire in the engine; among them were cases that led to a collision of aircrafts in the air, etc. All these situations and the conditions of their arising were given in great detail. The answers were processed in a computer "Minsk"-32.

4. Results

Let us compare the two events : the failure of the engine and the mistakes of the pilot. Which of them is more important for the pilot? Such a comparison can be made by the method mentioned above and it is presented in Fig. 2.

On the axis of abscissae 11 quantors (Q) are marked on equal intervals-from "never" to "always". On the axis of ordinates - the significances of possibility (p) are shown (expressed in a logarithmic scale). The significances of the entropy (N) of the event are also marked here. As we can see in Fig. 2, the characteristics got in this system of co-ordinates in the main interval of quantors (from "exceptionally seldom" to "very often") turned out to be similar to the linear ones. At the points, on the basis of which the straight lines are drawn p(Q), the authentic intervals are marked on the level of authentity $\beta = 0.95$; and at every characteristics the coefficient of correlation between the indicators under discussion is shown. On the same graph the characteristics of the same events are given in dotted line, only they are expressed as a function of the entropy H (Q).

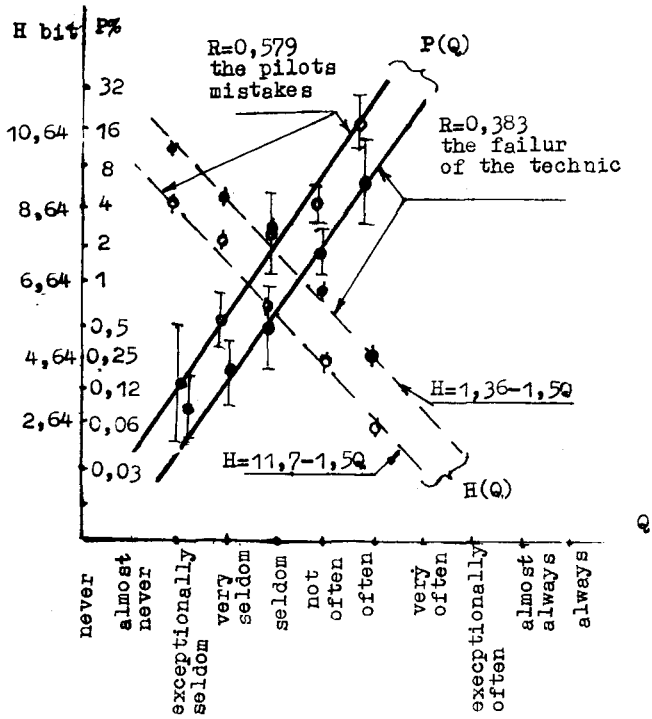


Fig.2

As we can see the graph (Fig.2) looking at the twp compared events - the failure of the engine and the mistakes of the pilot - there are considerable differences according to the indicator of possibility (p). So the experts considered technical mistakes to be "seldom" at the possibility of their occurrence 0.4%, but the pilot's mistakes- at 1,6%. The failure of the engine was considered to be "often" -at the possibility of its occurring - 7%; the pilot's mistakes at - 20%. We can conclude, that the technical mistakes are more significant for the pilots than their own mistakes. Giving a graphical interpretation of the Fig. 2, we can derive the following rule of diagnostics of the comparative significance of the event: the event is more significant, the characteristics of which p(Q) can be found towards the right and the graph.

About the higher significance of technical mistakes we can also judge from the dependence of H(Q). For every set of frequency (every quantor) the cases of technical mistakes turned out to be connected with a higher entropy than the cases of own mistakes. It means that technical reasons worry the pilots more than their own mistakes.

These results prove that from the point of physical danger the failures of an engine in general are more significant for a pilot than his own mistakes. The given approach was used in order to establish the pilot's attitude towards a non-fulfilment of the flying task because of the failure of an engine and their own mistakes. The characteristics got from this experiment are presented in Fig. 3. In this case the characteristic of technical mistakes is more towards the left side than that of own mistakes p(Q). It follows (from Fig.3) that the case of own mistakes was connected with a greater entropy than that of technical

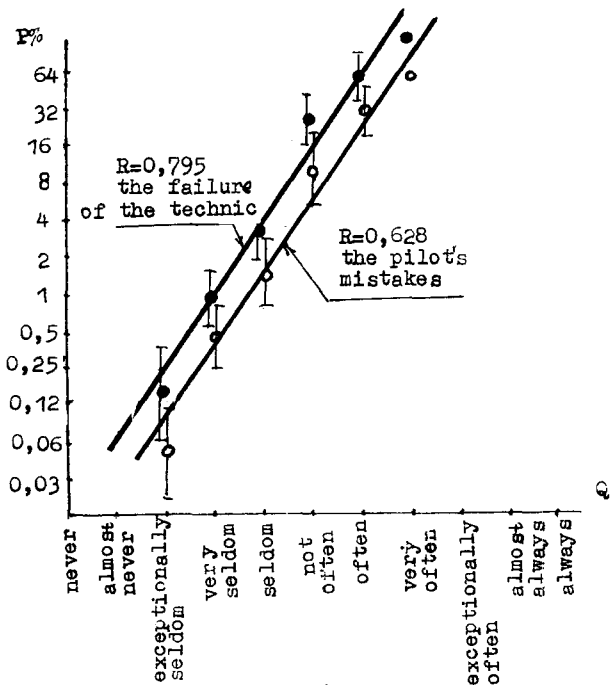


Fig.3

mistakes. So we can conclude that a nonfulfilment of a task because of one's own mistakes worries the pilots more than the non-achievement of the goal caused by the failure of the technique.

All these conclusions are in agreement with the pilots' opinions about this question. They said that tecnical mistakes lead to more serious consequences than a pilot's own mistakes.

Now let us analyse the next important question of the present research - the discovery of the relative specific gravity of various factors, making the event significant for a pilot. It is of a greater interest for a psychologist, as it allows to find out the premises from which the significance of the given situation is formed and on their basis it is possible to forecast a person's behaviour in this situation, his reliability. It makes it possible to operate with significance by changing the factors determining it. We will analyse all the data we got. For this purpose let us show in the system of co-ordinates the functional dependences p(Q) for the 4 events we are interested in: a possibility of arising of an emergency situation, a possibility of non-fulfiliment of the task because of it, a possibility of flying incident, a possibility of social punishment. These functions are represented graphicaly on the Fig. 4; the used signs are given below. (Note that in the following graphs the same signs will be used). As we can see on the Fig. 4, each of the characteristics represented on it is approximately orthogonal. Near the points, on the basis of which the straight lines are drawn, the boudaries of authentic intervals are shown (on the level of significance $\beta = 0.95$). Judging from them one can conclude that there are some reliable differences between separate characteristics.

Adding to the graph of the accepted method of diagnostics of a pilot's attitude otwards the events under discussion - we can draw the following conclusions. The most significant for the pilots is the accident itself. The next are the social punishments and the flying incident (no special difference is made between them). The case of non-fulfilment of the task turned out to be of less significance.

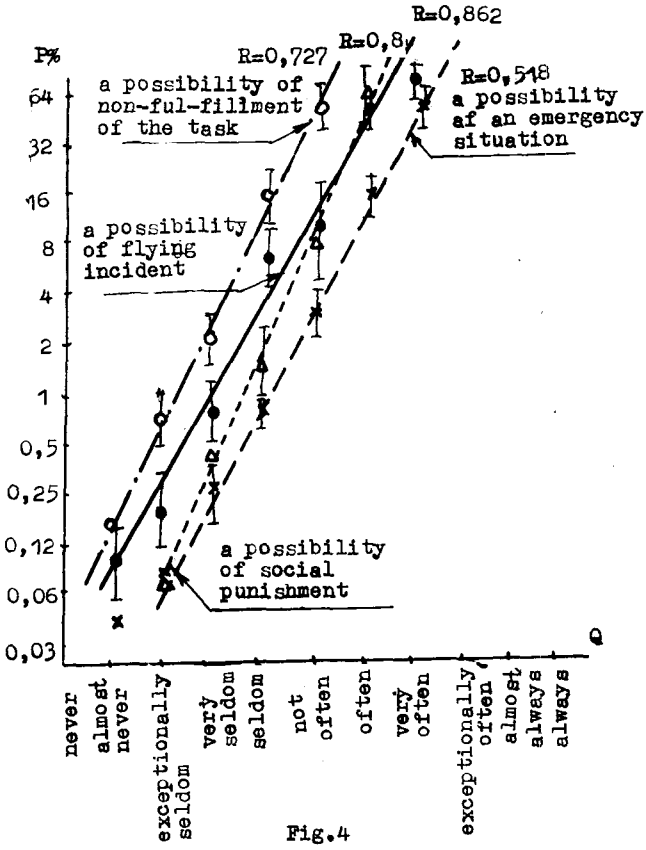


Fig.4

From the Fig. 4 another conclusion can also be drawn. For emergency situations that were estimated as comparatively rare, the most significant one seems to be the social punishment, then follows the flying incident and on the last place is the non-fulfilment of the task. For emergency situations which occur often - flying incidents are of the same significance as social punishment and the non-fulfilment of the task takes the last place.

And so the investigations showed that the most important factor, determining the significance of the emergency situation is the factor of social punishment.Such a result is conditioned by the fact that the question contained more easy and less serious emergency situations than severe ones. Most probably that is why the factor of social punishment got a higher specific valence than a rather strong emotional factor - flying incident - physical danger . But if we take into consideration that in the real practical activity of pilots - serious emergency situations also occur rather seldom and the pilots most often have to face situations of not such as great significance than the conclusion about the leading part of social factors in the formation of the pilots' attitude towards the emergency situations remains right.

K. Lager (1970, 291), having studied the activity of pilots also came to the conclusion that "a fear to make a mistake, to be moved aside or ridiculed - was of greater importance and worried them more than physical danger". In the given research it was controlled experimentally.

In conclusion,let us see how the degree of flying experience (flying qualification) influenced the estimations given by the experts. It turned out that more experienced pilots (first class) appraised the emergency situations as more significant in comparison with the pilots of the third class (Fig.5).

If we consider the estimations given by the first class pilots to be more correct, then it follows that pilots with less experience underestimate the significance of emergency situations. Such an underestimation may contain mistakes and idle compensatory possibilities of avoiding them.

5. Discussion

Let us have a look at the results of the two investigations described above, from the point of view of the connection between the indicators of an event, H, S and Q.

In the first experiment we had to deal with a number of events (bodily injuries having various significances

the same intervals in the diapasone of quantors from "exceptionaly seldom" to "very often") can also be found an approximately proportional relation. Having expressed the possibility of an event through its entropy uncertainity, from the data in Fig. 4 we shall get the graphs of Fig. 6. connecting the indicators we are interested in: the quantor of frequency and entropy.

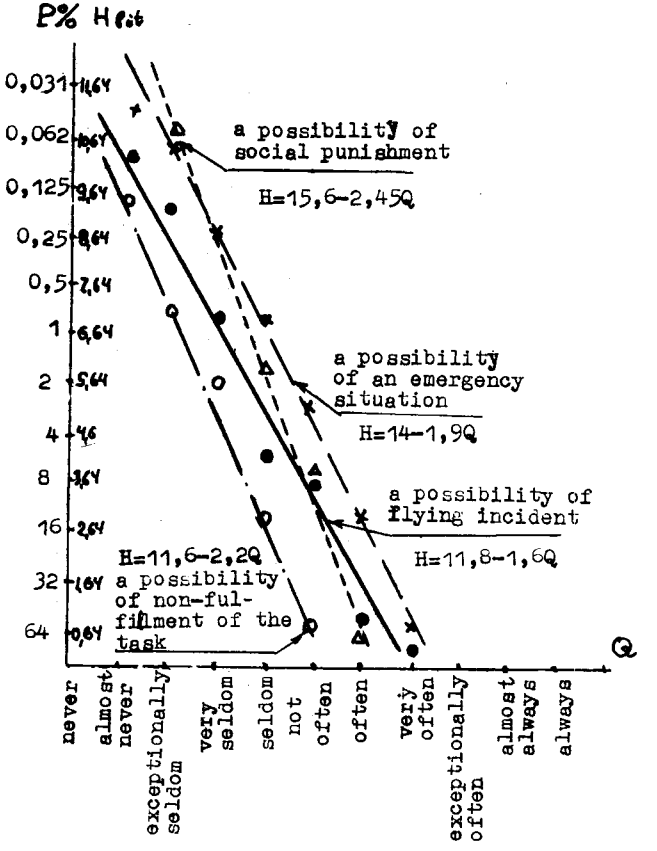


Fig.6

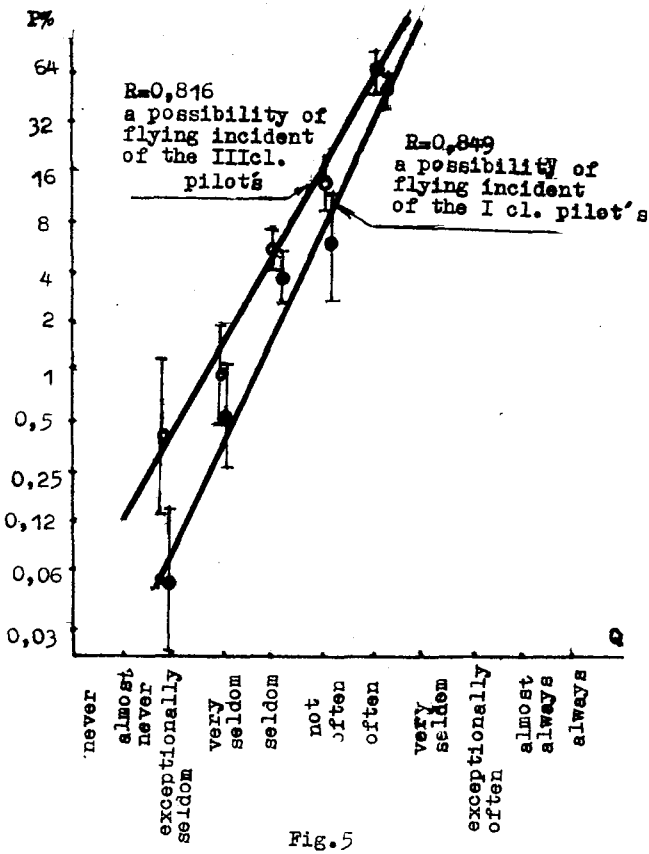


Fig.5

(S=Var), but ascribed to one set of frequency (Q often = const.). It was fixed here that the significance of events from one of such sets grows proportionally to their entropy.

In the second experiment the objects of our onvestigation were separate events of certain significance (S=const.) and their belonging to various sets (quantors) of frequency (Q = Var.). Here we were interested how the entropy of the event influences its being ascribed to that or another set of frequency. It was fixed that between the possibility of an event (in%), expressed by a scale of double logarithm and the sets of frequency (situated at

So entropy truned out to be a kind of indicator proportional to the significance of events belonging to the given fuzzy set . The belonging of the event of a concrete significance to separate sets of frequency is alsó stated in a linear dependence from the entropy this event gets. So the indicator of the event turned out to be the characteristic that conditions the significance of the given event among the other situations as well as the ascribing it to a certain set of frequency.

The inverstigations showed that entropy is the basis of such a differentiation. An explanation must be found to characterize the role of entropy in psychological processes . P.V.Simonov (1970) proposed an informational approach for analysing the origin of emotions. He proved experimentally that not only the factor of necessity, but also the factor of uncertainty of the entropy of the satisfaction of this necessity - are the sources of emotions. The indicator of entropy, characterizing the degree of psychological unexpectedness of satisfaction or dissatisfaction of the necessity, hence also the readiness of the organism for this event- in Simonov's opinion- turns out to be a strong emotional factor. That is why the significance of injuries of various degrees of severeness are connected linearly with the entropy of these events.

Now it is clear why people draw a conclusion about a frequency of an event not according to the possibility of its occurrence but on the basis of the entropy of characteristic, also taking into consideration one's attitude towards the event, which adds some emotional factors.

This method was used to diagnose the indicator of the "significance - of anxiety" of separate events. Most probably we can use the same method while using the indicators of the "significance -of value".

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О ПРОИСХОЖДЕНИИ ТЕОРЕТИЧЕСКОГО СИЛЛОГИСТИЧЕСКОГО МЫШЛЕНИЯ В КУЛЬТУРЕ И У РЕБЕНКА (Резюме)

П.Тульвисте

В статье выдвигается гипотеза о том, что теоретическое силлогистическое мышление появляется у ребенка и у людей в традициональных культурах сперва в сфере научных ("школьных") знаний, где оно функционально необходимо для решения задач, и затем в "обыденной" сфере. Излагаются результаты экспериментального исследования решения различных силлогистических задач у различных групп испытуемых, и выдвигается ряд предположений, объясняющих полученные данные.

МОГЛИ ЛИ МЕТОДИКИ МАРГАРЕТ МИД ОБНАРУЖИТЬ АНИМИСТИЧЕСКОЕ МЫШЛЕНИЕ У МАНУСКИХ ДЕТЕЙ? ЧАСТИЧНОЕ ПОВТОРНОЕ ИССЛЕДОВАНИЕ НА ЕВРОПЕЙСКИХ ДЕТЯХ (Резюме)

П.Тульвисте, А.Лапп

В статье использовали 3 методики, применяемые Маргарет Мид для выявления анимизма в мышлении детей Манус, для аналогичных целей у эстонских детей (3-7 лет). Из 75 испытуемых анимизм в мышлении был выявлен у 65 и в 66 случаях с помощью двух методик Мид. В детских рисунках анимизма выявлено не было. Авторы считают, что данные Мид и ее идеи относительно культурного происхождения детского анимизма заслуживают более серьезного отношения, и методы ее могут быть применены для выявления анимистических черт в мышлении ребенка.

КОГНИТИВНЫЕ КОНТУРЫ : ОБЗОР И ПРЕДВАРИТЕЛЬНАЯ ТЕОРИЯ
(Резюме)

Т. Бахман

Предлагаемая статья дает обзор основных исследований по проблеме формирования субъективных контуров. Охарактеризованы две группы теорий - когнитивно-организационные теории и периферические теории. Делается вывод, что возникновение субъективных контуров невозможно объяснить как следствие влияния определенного отдельно взятого фактора. Вместо этого кажется более подходящей многофакторная теория.

ЗРИТЕЛЬНЫЙ ПОИСК И СЕЛЕКТИВНАЯ АДАПТАЦИЯ
(Резюме)

Т. Бахман

Испытуемые выполняли задачу поиска целевого стимула среди нескольких дискообразных паттернов, которые были "вырезаны" из прямоугольных решеток четырех разных ориентаций. Предварительная ориентационно-специфическая адаптация снизила вероятность правильного обнаружения и локализации как целевых дисков, так и фоновых дисков, однако повышение порога для целевых стимулов было менее выраженным чем повышение порога к фоновым стимулам. Приведены возможные объяснения результатов,связанные с проблемой локализации селективности.

СПОНТАННОЕ ВОСПРИЯТИЕ ДВИЖЕНИЯ: ТОЧНОСТЬ ВРЕМЕННОГО РАЗЛИЧЕНИЯ ЗАВИСИТ ОТ ПРОСТРАНСТВЕННОЙ УДАЛЕННОСТИ (Резюме).

Д.Аллик, М. Тепп

Исследовались пороги смещения в качестве метода изучения спонтанного восприятия движения. Найдено,что точность различения временной асинхронии включения двух разнолокализованных вспышек является приблизительно обратно-пропорциональной квадратному корню пространственного удаления (сепарации) сетчаточных точек стимуляции. Приведены теоретические выводы, касающиеся проблемы обнаружения движения.

ВОСПРИНЯТОЕ НАПРАВЛЕНИЕ КРАТКОВРЕМЕННЫХ ТЕСТОВЫХ ВСПЫШЕК НА ГОРИЗОНТАЛЬНОЙ ШКАЛЕ (Резюме)

М.Раук, А.Луук

Экспериментально исследовались процессы, опосредующие восприятие зрительного направления объектов. Варьировались угловые размеры освещенной шкалы тестовых вспышек,позиция точки фиксации и позиция поворота головы. Результаты показали систематические ошибки в оценке направления тестовой вспышки. Наблюдалась тенденция ошибаться в сторону фовеальной точки фиксации. Выдвигается афферентная теория восприятия направления сигналов в поле зрения.

ЗАКОНОМЕРНОСТИ ЗРИТЕЛЬНОГО ПОИСКА НА СЛОЖНОМ ФОНЕ (Резюме)

В.И.Кушпиль, Ю.К. Аллик, Ю.В. Алексеев,
Е.К. Веселова, Л.Ф. Петрова, В.П.Смирнов

В статье приведено описание экспериментов, проведенных с целью исследования закономерностей зрительного поиска на сложном фоне.

Полученные закономерности устанавливают связь среднего времени поиска и параметров экспоненциальной функции распределения времен поиска на текстурах со статистическими характеристиками искомого объекта и фона, а также с угловым размером искомого объекта и угловым размером поля поиска. Найдено, что при поиске на сложном фоне время поиска объекта, угловые размеры которого близки к его пороговой величине, неограниченно возрастает. Среднее время поиска практически не меняется при масштабных преобразованиях видимого изображения. Кроме того, среднее время поиска является мерой сложности задач зрительного поиска и может быть использовано для ранжирования различных зрительных ситуаций по уровням сложности.

ВЗАИМОДЕЙСТВИЕ МАТЕРИ И РЕБЕНКА: ЛОНГИТУДИНАЛЬНОЕ ИССЛЕДОВАНИЕ ВЗАИМОСВЯЗЕЙ В ПОВЕДЕНИИ (Резюме)

Я.Вальсинер , А. Тамм

В статье приводятся данные о лонгитудинальном обследовании взаимодействия матери и ребенка в возрастах ребенка 2 месяца - 6 месяцев (у I0 диад). С помощью разделения компонентов интеракции по Thomas и Martin (I976) на индивидуально-психологический и интерактивный компоненты было выявлено преобладание индивидуального компонента в процессе интеракции в естественных условиях. С помощью запаздывающих перекрестных корреляций были выявлены гипотетические причинные связи между измеренными компонентами. Данные показали, что система интеракции направлена на создание вариативности в поведении ребенка и константных стратегий в поведении матери.

МАТЕРИНСКАЯ СУБЪЕКТИВНАЯ КУЛЬТУРА - ЭКСПЕРИМЕНТАЛЬНОЕ ИЗУЧЕНИЕ ПОСЛЕРОДОВЫХ КОГНИТИВНЫХ ЯВЛЕНИЙ (Резюме)

Я.Вальсинер, И.Таго, В. Лоолайд, К. Хаук

Обследовались оценки различных объектов (Я, идеал женщины, ребенок, роды) по семантическому дифференциалу, данные женщинами после родов. Факторный анализ выявил две группы шкал в использованном варианте семантического дифференциала: параметры личности (5-мерное пространство) и параметры установок (4-мерное пространство). Группы обследуемых были сравнены между собой, а также с норм-группой. В структурах установок были выявлены различия в группах матерей первого и н-ного ребенка, матерей мальчиков и девочек, и т.д. Результаты указывают на связь когнитивной стороны женщин с различными параметрами их анамнеза.

МЕТОД ДИАГНОСТИКИ ОТНОШЕНИЯ ЧЕЛОВЕКА К ТРЕВОЖНОЙ СИТУАЦИИ (Резюме)

М.Котик

В статье предлагается простой и объективный метод оценки отношения человека к тревожной ситуации. Метод основан на следующем принципе: по слову, которое человек избирает для оценки частоты возникновения подобной ситуации представляется возможным определить его отношение к этой ситуации. В статье дается экспериментальное обоснование предлагаемого метода и иллюстрация его применения для оценки отношения летчиков к различным аварийным ситуациям, возникающим в полете. Предлагаемый метод позволяет оценивать не только общее отношение человека к тревожной ситуации, но и отношение к отдельным обусловливающим ее факторам.

C o n t e n t s

Содержание

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