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The Heuristic Bent *

By Joseph Agassi

Tel-Aviv University and York University, Toronto

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0. Abstract

The logic of questions is still very limited; there is a need for a specification of what is a problem, and what is a problem-situation — or what is an adequate solution to a problem in a given situation. A problem may seek its wording, and so may do the adequacy conditions or desiderata for its solution. For the inarticulate, there is no distinction between theoretical and practical problems. Their problem is a goal, the situation is the available routes to it, and no adequacy conditions.

Wording abstracts problems and requires adequacy conditions for solutions — as constraints on cogency. Yet the inarticulate has solutions too, and even new ones. What is this novelty? Gestaltists view all items and frames as given and novelty as mere recombination. Cognitivists say, innovation is improved discrimination. When verbalized, the new contradicts the old, except for the rare case of strict refinement. This links well with the view of science as increasingly improved approximations to the truth, as it permits placing solutions on one evolutionary scale of improved efficiency: the non-verbal, the preverbal, the pre-scientific and the scientific. Popper has issued a famous slogan: life is problem solving; both the ameba and Einstein are problem-solvers. This is a mere half-baked sketch of a solution, perhaps to

the problem, what is an innovation? It is not a solution, but at best an adequacy criterion.

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1. Problems:

1.1. What is Problem Orientation?

Problem-orientation has become popular these days: viewing one's philosophy as problem-oriented is self-praise. How is the claim for problem-orientation to be examined? It is not enough to admit that people have problems or questions, yet it is already problematic. It is not agreed about what qualified as a question or a problem, not to say, one that is good, interesting, or worth-while.

The logic of questions-and-answers is a young field, and only a small part of it is satisfactory, namely the study of questions to which one may construct complete lists of alternative possible answers, or options, to each question and each alternative answer to the same question excludes all the others. The full dis junction of the possible answers is a tautology. Alternatively, a disjunction may be transformed into a tautology by making it a consequent of a conditional statement, with the weakest statement that entails it as an antecedent, which statement is usually known as the presupposition of the questions. The presupposition is the exclusion, a priori, of some possible alternatives, and thus it renders the disjunction of the alternative solutions into a tautology. (1) Refining the division (in the precise sense in which the refined division admits its coarse predecessor) the set of options may split an alternative excluded by the supposition into excluded and permitted.

So much for the solid part of the logic of questions-and-answers. It took a long time and much effort to achieve, and it is extremely useful when applicable. Yet there is much more about questions which is under study.

The reason some philosophers turn up as problem-oriented is usually that they see (scientific) discovery as a fruit of search. This makes science an extension of common sense. The view of science as extended common sense is very popular: it was endorsed by such diverse authors as Aristotle and Einstein. In accord with commonsense, the usual predicament in which a

researcher is found, a question scarcely has an answer, let alone a set of alternatives. [2] All too often it is the predicament described by Sylvain Bromberger as the puzzling situation where one faces a question with no known answer to it, and yet one can tell whether a new option is an answer or not. [3] What constitutes the most general (non-specific) description of a problem-situation? A candidate may be Sir Karl Popper's idea — perhaps his mere slogan, which in recent years intrigued philosophers: life is problem solving, he said; from the primeval ameba to Einstein we are all problem solvers. Nay, even the primeval DNA molecules on the primeval slime were problem solvers, he said in his second Herbert Spencer Lecture: [4] all life is but conjectures and refutations: living beings regularly meet situations calling for responses, they are problem-situations, if you will; at times these call for some internal changes, for adaptations, for conjectures if you will; adaptation is the alteration of modes of encounter with the environment, and trying new modes is test situations, if you will; the tests happen to be successful or not, they are followed up with refutations or with corroboration, if you will.

1.2. What is a Problem?

Popper's idea is very intriguing, as it is non-specific: it ignores the specific nature of each item of adaptation; it is thus neutral the Lamarck-Darwin dispute. Some adaptations are successful, some of these are inherited, genetically, or traditionally (the human species is the only one for which tradition is central).

Hence, Popper's idea is attractively most encompassing: It allows the celebrated selfish genes to be as informed and intelligent as one may wish, as long as intelligence is trial and error, not what earlier learning theory says that it is. This way Popper has given more substance to his earliest claim (1935) that his learning theory squares best with Darwinian survival of the fittest. It will be here taken for granted that amebas, and even arthropods, are homeostatic to a large degree. It will be here taken for granted that Einstein is not homeostatic, at least not in the same way as an ameba is, and in accord with Popper's diverse writings on the body-mind problem. The simplest homeostatic or near-homeostatic system that is an ameba is the simplest problem solver; Ameba and Einstein serve Popper as points on one evolutionary scale, the scale of adaptation as problem-solving. Albert Einstein's idea that science is but an extension of common sense, Jean Piaget's idea that children are proble m solvers, Wolfgang Köhler's idea that apes are problem solvers too, and Konrad Lorenz's description of the stages which a jackdaw goes through building a nest, and of the traditions of jackdaw flocks, all seem to neatly integrate in Popper's evolutionary scale of problem-solving. Darwin's tree of life transforms into Popper's tree of knowledge. [5]

The above presentation is faulty: a stage in the presentation was skipped: Popper's solution was praised there prior to a decision that it is a solution to

the problem at hand. What is the problem at hand? I do not know. What does Popper say it is? Nothing. He deems himself a problem-oriented philosopher, and his early writings do admirably regularly and systematically exhibit this fact since they regularly address problems. Yet neither his First Herbert Spencer Lecture nor his Second poses a problem; nor does he say anywhere what problem his slogan, life is problem solving, is meant to solve. Perhaps it characterizes problems in general. But this is not satisfactory. (Notice that "what is life?" and "what are problems?" are excluded by his a priori staunch rejection of all "What is...?" questions as essentially essentialist.) There may be a great difficulty lurking here: his two slogans, life equals problem solving, and problem solving equals conjectures and refutations, may entail a third: life equals conjectures and refutations; how does this compare with his classical theory, science equals conjectures and refutations? These slogans entail, life equals science. This seems to me too Heideggerian [6] a technique to suit Popper, and it certainly is neither science-oriented nor problem-oriented. The reading of Popper's slogan as a broadening of the domain of application of his theory, so as to offer the honorific title of a scientist to Ameba has to be rejected as Popper denied this honorific title to astrologers, whose level of comprehension and of performance are distinctly higher. Doubtless, science is verbal and homeostasis is not; the central role of language in science was stressed by Popper from the very beginning (1935) — simply because it was questioned. David Hume declared dogs learn by association just like Newton. [7] Is all learning scientific? is all life learning? If not, then Popper's slogan is misleading.

1.3. When is a Problem solved?

There is a view that, whereas matter is inert, living things possess souls and are thus self-propellants. William Gilbert has ascribed this view to Plato and declared that since magnets have forces they have souls. Having forces is not problem solving, as forces persist against great obstacles without causing motion. The same holds for the simplest guided missiles meant to aim at the heat-source of an enemy vehicle. Perhaps this does not hold for clever ones, for those which can dodge obstacles and decoys. Are clever guided missiles problem-solvers akin to problem-solving kamikaze pilots? As the lowest life forms, including amebas and arthropods, are largely or wholly homeostatic, equating life with problem solving is accepting that homeostatic systems solve problems. Popper denies that guided missiles are living things. His slogan is thus not a theory of problem solving, yet perhaps something can be gained from it.

What counts as a problem or a problem-situation for Ameba? Let me approach this question slowly. It is easy to articulate a problem which Einstein has faced: it may be possible to quote him. How does one articulate a problem a baby faces? Not only do babies have problems which they cannot articulate; as Piaget has admirably observed, at a certain stage the inability to articulate causes tremendous frustration; and the frustration

aggravates the problem. Hence, in a sense, the articulation of the baby's problem may distort it, since the frustration due to the inarticulateness is a part of it. More generally, it is possible to conjecture what is the problem of one who is fully cognizant of it, and not of one who is unaware of it, or even of one who is aware of it but unable to articulate it. This includes Einsteins and ordinary scientists and detectives: they are known to experience this situation

In what sense is Ameba on a par with Einstein, though only the latter is articulate? In what sense can a problem be articulated for Ameba, and how will an articulation of Ameba's problem compare with that of Einstein? Clearly, while ascribing to it a problem related to its behavior the distortion of ascribing cognition and language to it should be avoided. The difficulty in doing so is partly exegetic: how should Popper's new slogan square with his classical writings? Pseudo-scientists are problem solvers by Popper's new view; they are problem dodgers by his old view.

This seeming contradiction is easily resolvable. The best way to do so may be this: pseudo-scientists are pretentious problem solvers: they solve problems different from the ones they say they solve, or they claim too much credit for their solutions.

This resolution is objectionable as it refers to intent: objective criteria are needed so as to render it admissible. Popper says, pseudo-scientific solutions are erroneously deemed scientific. Handling Popper's slogan, then, requires desiderata for solutions. What kind of solution is open to Ameba? Can it answer the desiderata?

The move here endorsed is a partial solution to Bromberger's problem. He asks, how is a statement seen as a new solution to a given problem? My answer is, a putative answer to a question is checked against desiderata (articulated or not) for it; there are conditions a statement must meet in order to count as an answer, and to be satisfactory different kind of answers have to satisfy different criteria or to meet different desiderata. Consider the question, is this or that statement true? Evidently only four answers to this question qualify, no matter what the two statements in question are, and no adequacy condition is needed. Yet when a scientific explanation is sought, adequacy conditions are obviously needed. Rules can be worded as to what counts as an answer, as a scientific answer, as one forcing itself on detectives, on journalists, on civil courts, and on judge and jury. Increasingly stringent conditions for initial tenability of a proposition are usually recognized, for it to count as a basis for permissible action; these conditions are often specified by law and by custom.

2. Problem-situations:

2.1. What is a Problem-situation?

It is possible to articulate correctly the situation of a person facing a problem

and unable to articulate it. For this it is necessary to ascribe to that person the right problem and the inability to articulate it. The ascription thus attained, as all ascription here discussed, is merely hypothetical and attained by empathy. There is a limit to this, which at the very least is the limitation on our imagination. This, for a conspicuous example, is true of discoveries of problems: prior to articulation, while struggling to be born, to use the Socratic metaphor, no one around could articulate them, usually not even their discoverers or their discoverers' collaborators.

The same holds for problems babies face, since describing those problems often takes a brilliant discoverer of the stature of Freud, a Piaget, a Melanie Klein or a René Spitz. It is a historical fact that these thinkers brilliantly imagined problems which they ascribed to babies. Their conjectures are problematic, and so we are still in the dark: no baby is as intelligent as Freud and Klein suggest; Piaget's theory of age-dependent levels of comprehension is refuted; as to Spitz' theory, it is not even known what question it answers.

Ascribing a problem t is answering the question, what is the question or problem that someone faces? The most basic difference is between those who can and those who cannot articulate; then comes the difference between those who have articulated their problem and those who have not yet done so. Further comparison is problematic: there is no theory of problems as yet to facilitate general comparison.

Yet even highly articulated problems are problematic. Einstein's work is studied by methodology and his problems are studied by a problem-oriented methodology. This is troublesome, since there is no canonic methodology, much less a canonic problem-oriented methodology. Let us take Popper's theory as canonic. Which variant of it? Let us equate his different variants, as he has repudiated none of them. His view of science as conjectures and refutations should be a part of his view of all living systems as acting by trial and error. Does Ameba act by trial and error? Do guided missiles? Are conjectures trials? (Refutations are, of course, the detection of errors; yet equating facing an error with scientific refutation is an error: Popper says, the activity of science is not the mere bumping into one's error by accident but the active search for refutations. Attempts to refute a theory may fail: trials to refute it may be erroneous. Failed refutations, as we learn from [William Whewell and] Popper, count as scientific corroboration.) Science, then, as conjectures and refutations, is but the pinnacle of trials and errors. This then is the situation: Ameba is a poor searcher and Einstein is a conscious and systematic and good searcher.

Let us examine the case of Ameba first. Are there theories of amebas (or arthropods) as problem solvers? Extant theories describe them as hemostats akin to guided missiles. Do clever guided missiles, then, face problems when in action? How should one go about this question? How can a decision on it be reached? Perhaps problems are set in problem-situations, Ameba-

problem-situations seek solutions but guided-missile-problem-situations do not. If so, we have seen land.

There is no theory of problem-situations. And so, my search seems blocked. Let me try to provide problem-situations some characterizations and then try to generalize. It is very hard to describe a problem Einstein may have, and the same holds for different reasons regarding Ameba; it may be easier to utilize the success which Wolfgang Köhler has had describing a problem which an ape solves when trying to reach a banana hanging too high up, say, by placing a stool beneath the banana. This is not to prefer simian problem-situations to human or amebic ones, but an attempt to use all available resources so as to get unstuck.

2.2. Köhler's Ape's Problem-situation

We may imagine a problem by empathy with the ape we study, and ascribe the problem to it. Köhler himself did so, yet his study belongs to a different context. We have to remember, said Köhler, that simian vision differs from human vision: each species perceives different patterns of objects, or sees objects in conformity to different patterns. Köhler was a Gestalt psychologist who attempted to discover simian perception patterns (= Gestalten), not to study simian problem-situations. Hence, there was much latitude in Köhler's study, since he ascribed to his subjects both problems and patterns of solution: he did the latter intentionally and with empathy; the former he did while barely noticing it. Much more is known about apes now than in Köhler's days. So let us discuss this a bit. To tighten this latitude somewhat we may expand the liberty we took when ascribing questions to apes, and plant them in the framework of the logic of questions-and-answers. This will hopefully offer a link between problem and Gestalt in the following manner.

Consider an organism, its situation and goal. Consider the list all possible routes which an organism can take in that situation which begin in the given situation and end in reaching the given goal; we may delineate these as satisfactory solutions to the problem, how should the organism in the given situation attain the given goal? Some of the successful routes are accessible to the given organism. The ability of the organism to perceive enough of the situation to have access to a route or its ability to hit it at random and then utilize it is one of the factors that make a route accessible. Here perception theory and the logic of questions-and-answers come in. Gestalt theory says, one Gestalt is shared by different routes accessible to an organism seeking a goal. All this is within the logic of questions-and-answers. Clearly, this situation also fits the logic of tasks. The exciting fact is that the problem-situation in any reasonably adequate non-verbal presentation renders parallel the logic of questions-and-answers and the logic of choice, namely the logic of the choice-of-executions-of-tasks, often known as the logic of situations.

For an ape there is no difference between science and technology;

for apes the logic of questions is identical with the logic of situations (of tasks). Köhler used this fact when he tackled simian problem-situations: he tacitly took an ape's problem and task as identical and as immediate. All simian problems are immediate. For humans problem-situations or problematic tasks may involve words but whereas human tasks may be non-verbal, human problems are verbal — even when they are not yet articulated. (This is the difference between the given and the not given to articulation.) For humans tasks may be immediate; for simians they must be so. (Jack London's Jerry of the Islands describes a dog's sense of taboo as it hesitates for a while to save its owner, since this incurs risking its own life.)

Can simians be taught to use human language? Will this change the picture? Here is a criterion to try out: if an allegedly talking ape can use questions not representing immediate tasks, then it definitely does use human language. This criterion is used by Karl Bühler to distinguish the descriptive language of humans from the merely signaling language of other animals. He described expressive language as spontaneous, as not goal-directed, signaling as directed to immediate goals, and descriptive language as able to refer to goals in the abstract. (This refers to an observation that refutes associationism in genera and behaviorism in particular.)

Consider the situations of talking apes who have been successfully taught chunks of communication, whether some simple typing of simple pictographs on some special typewriter or bits of sign-language. Are their communications in the normal simian language different from those in the newly acquired one?

Bühler's theory is very useful here: the claim that human language is conceptual is question-begging; the claim that it is self-reflecting is doubted; the claim that it is accompanied with self-awareness is a most central controversial thesis, and that it is goal-directed is not enough, as animal signaling is goal directed too; Bühler's idea of descriptive language as not necessarily immediate offers a criterion that is not contested, least of all by Popper. To put our question in Bühler's terms, when using the new means of communication, do apes also describe or merely signal? Are their signals necessarily immediate or not?

2.3. The Place of Problems in the World of Research

How much human language is ever open to apes? That an ape will ever be able to comprehend as much as a human is dreamt by no one, except in science fantasy. Yet trained apes are reported to have a clear idea of dirt and of the dirtiness of the dirty: they observe wild simians as dirty even when groomed — presumably on account of their comparatively unruly conduct. Does this mean that the apes reporting this have a rudiment of a descriptive language? Possibly: two readings are available: the communication in question (that certain apes are dirty) is possibly aloof from

any immediate goal, possibly it is an expression of the immediate desire to maintain a distance from them. There is no way of deciding between these two readings short of a crucial experiment consciously utilizing Bühler's criterion.

Can more be obtained from the known facts by moving from the theory of language to learning theory? Can this help decide in which way simian language is poorer (less developed / less abstract?) than human language? Not without the aid of a proper (evolutionary?) theory of language to help decide, or at least indicate whether decision is at all available.

Things are tricky: since human language is so much more lavish (developed / abstract?) than simian language, humans can easily conjure new concrete states and problem-situations for the poor ape and even teach the ape some concrete solutions to them. Some humans show no faith nor any interest in abstract science: they treat science as super-pragmatists. When new solutions, or new problem-situations plus solutions to them appear, then some super-pragmatists master them as well as anyone, perhaps better, since they waste no effort on trying to comprehend the new abstractions and they devote efforts exclusively to their tasks. Is the difference between the ape and that super-pragmatist smaller than the difference between the same ape and the abstract thinker? How should this be decided? No answer.

Nevertheless, ground has been gained — for those who still relish in theoretical problems, not for super-pragmatists and not for apes: we can now exhibit apes facing new tasks and comprehending them and being instructed in their solutions or inventing solutions or improving known solutions. Hence. Köhler's view of the ape's conduct as the discovery of a solution is possibly an error: an ape may have seen some other being (human or simian) solve a problem and ape the solution. Why did Köhler insist on the resourcefulness of his apes

Perhaps because he found simian resourcefulness more impressive than simian miming ability, perhaps he found the claim that apes truly understand a solution they discover all by themselves more convincing than that they understand a solution they ape, perhaps he was intrigued by the semblance of the human and the simian heuristic process. For, he was intrigued by the question, are human and simian problem-solving techniques comparable? As a Gestalt psychologist he had to admit that children discover the way his apes do: the experiments he made on simians merely aped ones he and his Gestaltist colleagues had earlier made on infants. He was troubled by problem-solving techniques of adults, especially of the Einsteins amongst us. He held firm views regarding scientific method. Scientific method he deemed inductive, and this was problematic for him, as it should be for any Gestaltist (and for any cognitivist). For, as a methodology inductivism depends on associationist perception theory that had been consciously superseded by the (cognitivists, including the) Gestaltists. (8)

Thus, a few questions intertwine: are simians problem solvers? are infants? and, are scientists? To answer these questions, consistency between methodology and psychology regarding perception is required. This was merely so noted by Köhler who declared that since science is inductive, the mentality of the scientist differs from that of the ape. This is funny, since it makes the mentality of the scientist inferior to that of the ape — on the supposition that Gestalt perception is more sophisticated than mere association, a supposition that Gestaltists share with other avant-garde perception psychologists.

Here the study of Berkson and Wettersten of Popper's early researches signifies: they describe his initial problem-situation as rooted in cognitivist psychology and learning theory and as instigated by his realization that these conflict with inductivist methodology. Popper himself is vague in his autobiography about his move from psychology to methodology and ascribes it to a shift in interest. A shift in interest is a change that invites an explanation. Berkson and Wettersten faced the following problem: what problem or problem-situation has shifted Popper's concern from psychology to methodology? (9)

So there was a stalemate here — to be resolved by developing a methodology fitting cognitive psychology, an alternative to inductivism which fits associationism. Generally, no methodology according with Gestalt psychology has ever been developed. In the meantime, however, Gestalt psychology was superseded by the cognitivist or the Würzburg school (both were rooted in the work of Oswald Külpe). Learning theory encompasses questions-and-answers, which are special cases of tasks-and-executions; Popper's shift from perception theory to methodology was the shift from a concern with executions to the concern with answers only: he neglected executions for a while. He then moved o situational logic. Equating Ameba with Einstein closed the gap between the two: amebas only execute and humans conjecture too. Köhler's problem is solved: apes, babes and scientists make endeavors; the difference is in degree and in the ability to articulate

3. Rationality:

3.1. Rationality and Innovation

There are interesting consequences to the previous discussion for the theory of rationality. Rational action is the execution of a given task in a given situation; rational thought is the execution of an intellectual task, such as the search of an answer to a given question. Rational thought can be integrated into rational action, not as pragmatists wanted it, since the move involved adding into the scheme high-level, abstract tasks and executions: thought is not judged by its practical consequences alone, and humans are thus recognized as occupying a level higher than simians. This can be developed into all sorts of highly abstract, interesting and useful, aspects of

technology, including cybernetics, systems analysis, and data processing.

To return to Köhler's ape. Where lies the difference between inventing and emulating? What is the creativity of a new performance? What is the heuristic of Köhler's ape? Does any simian ever really invent

In what sense is the solution which Köhler's ape invents new? What is novelty? (10) The simplest criterion of novelty is that any combination of existing components not previously turned up is new. This criterion is used, for example, by Noam Chomsky, when he proves that grammar is innate. Children can present correctly new word-sequences, new sentences in accord with the rules of grammar: These are ones not previously uttered or heard. In a very distinct sense uttering a previously unheard sentence is an innovation and in a very distinct sense it is not: it is not new in that it is a combination of given words according to a given set of rules, yet it is new in that it has never occurred before. The same goes for Köhler's ape: following Gestalt psychology (rather than the cognitivism of the Würzburg school), Köhler admits that in a sense the ape cannot ever perform an utterly new task: it cannot make use of a Gestalt not inborn. Nevertheless, the ape found the vertical sequence, stool, ape, banana: it made an intellectual effort in order to have it. The joy of this success is perceptible as distinct from the joy of its fruit — in Köhler's simian and in Chomsky's infant alike. Clearly, something innate has contributed to the discovery, as is evident from the fact that it is not available to all creatures. In a sense, then, invention is inborn: in this sense there is no real invention, then.

In a sense the same process is an invention, and in a sense it is not; this has puzzled many a reader of Köhler and of Chomsky[2] particularly because neither has articulated the two senses. (Describing a solution and the solution itself are not the same. Some given problem-and-solution are, thus not always easy to diagnose.) Critics of Köhler or of Chomsky are unjust when they fail to notice that both think no Gestalt is new yet some instance of it is, especially when an organism uses a tricky Gestalt (such a subjunctive conditional) for the first time. This is to present the view of Köhler and of Chomsky not as true but as interesting for students of heuristic

The most obvious objection to it is that it makes novelty too cheap: novelty is reached whenever a Gestalt or a matrix is filled with new items from a given range, even though the items are placed according to given rules. (The matrix, the rules and the items are abstract entities. A word is an abstraction, since two utterances at times are and at times are not utterances of the same word, according to some rules that are fairly sophisticated and not yet satisfactorily articulated.)

3.2. Varieties of Innovation

Do apes comprehend words / sentences? Can they combine words in accord with some rules of some grammar? This is no matter of mere fact, so

rushing to check information will not suffice: when apes answer questions do they signal in sign language? Do they execute immediate tasks? Pupils under examinations exhibit the same problem: they are expected to answer questions; they may cheat and execute the easier task of repeating a response which they had learned by heart: responding to examiners' word-sequences they utter other word-sequence. Suspecting foul play, examiners alter the wording of their questions. Hence, some degree of comprehension is required for noticing that some word recombination does not alter meanings / tasks; yet not much: the cheating student may be programmed to respond in the same manner to a variety of variants.

The ability to create new combinations is thus usually but erroneously deemed indicative of some comprehension and of the ability to use some serviceable rules. Proof. Consider a computer-program with a full list of possible word-combinations that qualify as answers and the list of or a filter for all proper ones, will enable cheating students overcome the obstacles suspicious examiners may place on their way by varying the questions. End of proof.

Something seems to have gone wrong here. When is the ability to manipulate signs evidence of comprehension of their function, and when is this not adequate? A comparison of the ape using sign-language with the student cheating by reproducing by hear a classical proof of a mathematical theorem should reveal that the same process may happen with particularly subtle proofs. Students may feel glimmerings in and out of comprehension of a subtle proof, until they get a firm hold on it. Glimmerings here are metaphorical; glimmerings occurs in the literal sense as images appear and vanish, usually in stereoscopic vision (especially when done with no stereoscope); light appearing in a flash to one eye but not to the other glimmers; a stereo-image appears and vanishes until a firm hold on is acquired, and then it stays put as long as it is observed. The process in different cases of glimmering, in the metaphoric and in the literal sense, is of one having access to a Gestalt, in some metaphoric or generalized sense of access. Now, anyone who follows Köhler, Chomsky or Piaget or Lorenz — I add Piaget and Lorenz here for a good measure only — admits that the Gestalt captured in the process of comprehending a proof is an innate Gestalt. This is known as innatism or nativism.

According to innatism, then, simians can learn to compose sentences only if such knowledge is inborn, yet this learning can be genuine in the same sense that it is genuine in humans; the inborn Gestalt or matrix was not accessible at first yet with effort access to it was gained. Unlike Gestalt theory, the Würzburg cognitive psychology permits the invention of Gestalten or rather improvements on inborn matrices, through attempts to extend their domains of applicability. The material with which these matrices are built need not be new. They can be older matrices or older items rendered matrices. For example, the prevalent theory of sentences is not Gestalt theory but, as it happens, cognitivist or Würzburgian: it is that

matrices of sentences are as old as words; they are not new combinations of older words. Yet the earliest ancient sentences are presumably not given to analysis, that is, they are one-word sentences, which later have evolved into analyzable matrices, as two-word sentences by the split of the initial word leading to the view of it as two words or perhaps as a structured one-word sentence comprising, say, a root plus its declension.

Analyzing an item previously not given to analysis surely is innovation. A new differentiation (diairesis) then is a part of the process of innovation, no less than a new reintegration, and it has place in no nativist theory: Gestalt theory precludes it and is thus empirically refuted.

Differentiation is the improvement of the ability to perceive, the act of creating new matrices which usher in new visions. This is central to the diverse perception studies inaugurated by J. J. Gibson and his disciples. What is missing is the view of the act of differentiation as innovations: new differentiation and vision appear together in some glimmering, shimmering, exciting experiences.

Nevertheless, even for the Würzburgians, Popper included, there is a sense in which a Gestalt is inborn even before it was invented or before access to it was found. For, some Gestalten that cannot be discovered by one animal species is discoverable by a higher one — perhaps with effort and gradual shimmering progress. In this sense the heuristic bent is both innovative and not quite innovative, and with no contradiction: it is innovative from below, not from above, as it were. Moreover, a new Gestalt may then be either of an answer to a question or of an execution of a task, or both.

Consider the pragmatist engineer, trained in science but interested in new tasks — a veritable normal scientific engineer. This image turns out to be one side of the picture — of the upper and non-innovative part — the lower part of which is innovative. This helps make sense of the familiar fact that so many scientific questions so easily turn in the hands of engineers into technological tasks, of the familiar fact that so many technological tasks constitute for researchers terribly interesting questions, and, quite generally, that less abstract, technological tasks or questions give rise to new technological tasks or questions, where at times an interesting / dull question / task may become an interesting / dull task / question. We have here a plethora of new types of activities all familiar from the field but rather new in research, or at least not systematically explored thus far — for want of differentiation, I daresay. The crux of all this is its invitation for and admission to a variety of criteria of novelty. A new answer to a given question logically excludes all older ones; a new question permits only new answers (even if they are familiar sentences: as answers to a new question they are new [11]) and these contradict the old except if the new question is a strict refinement of the old; new metaphysical systems call for both new thought patterns — Thomas S. Kuhn calls the move from one to another a Gestalt-switch so that he should deem a Gestalt any matrix prescribed by a

metaphysics; hence his concept of Gestalt or Gestalt-switch is a mere metaphor. (This is what he initially called a paradigm, before his terminology was derided. [12]) A new technology similarly renders accessible a hitherto inaccessible execution; a new theory of technology usually conflicts with old ones, and a new technological question is the wish to render an inaccessible execution accessible. When tasks subject to question are added and questions are seen as tasks of sorts, then a stupendous set of typologies becomes available that cannot but excite the theoretical and practical imagination and stimulate heuristic in the philosophy of technology. [13]

3.3. Evolutionary Rationalism

Stoic logicians have observed that a dog may sniff at alternative routes at a forking path and, having excluded all paths but one, the dog might conclude that the remaining path is the right one, as evidenced from its choosing that last alternative with no sniffing. Things are much more diverse than that. Just like humans, dogs at times do jump to conclusions — they may bark up the wrong tree, as the apt expression goes — and these erroneous conclusions may have verbal analogues that may be logically valid; they may be invalid and rendered valid by adding as premises some suppositions which are presumably taken for granted; especially in non-verbal cases, the question of the validity of such inferences depends on such interpretations. Also, like humans, at times dogs do check their suppositions / conclusions and try to correct them. Also, each animal may exhibit errors it cannot correct, like following some scent in a circle till exhaustion stops the futile search. Whatever else this illustrates, it illustrates the fact that dogs do have problems in some generalized sense of the word.

Does Ameba have problems? Suppose it is a mere automaton. Are rationality and automatism exclusive or are they united in Ameba? Popper's claim that Ameba and Einstein are both problem solvers is problematic for him as long as he refuses life to servo-mechanisms and equates problem solving with life. One has to read his idea of problem solving as that of an innovative process in a sense in which servo-mechanisms are not innovative. Assuming this to be so, then the present discussion is stuck until more is known about problems and about innovation.

Norbert Wiener has made a tempting suggestion: automata are not rational, he suggested (God and Golem Inc.), as they are still unable to learn to articulate problems. If this is the criterion for high-level rationality, then only humans possess it, even thought apes and dogs do attack problems. Otherwise, also simple computers and servo-mechanisms may be at least as rational as apes and dogs.

What then is innovation? Let me try to apply some theory of verbal innovations to (verbal and non-verbal) tasks, so as to find how can Ameba be innovative.

There are some desiderata for a theory of verbal innovation: it must satisfy

some criteria of adequacy: for one thing, it should not put pseudo-science on a pedestal. Does pseudo-science solve (innovative or not) problems? The difficulty is dual. In a sense, any statement can serve as a solution to many problems and it also may serve as a part to many solutions.

In a sense, most statements taken as solutions by some people or traditions, do not pass the most obvious criteria of adequacy. Moreover, adequacy is not the same as goodness: any hungry animal solves adequately its urgent problem when it enters a death-trap enticed by food — especially if it then successfully escapes. In a sense no animal ever opts for inadequate solutions. When we are guided by rules of adequacy we ascribe to an animal a problem and even some very simple criteria of adequacy. (Brain damages create various deviations from the supposed adequacy.) Humans are often characterized by an ability to try solutions which are quite inadequate. Possibly the regular exercise of inadequate solutions is an unavoidable step towards the discovery of the questions which they are supposed to answer.

It was Bromberger, we remember, who has puzzled over the fact that it is possible to apply a criterion even without the ability to articulate it, as evidenced from our ability to recognize an answer to a question when we meet one. I have ventured to split his question to two: what makes a statement an answer? and what makes an answer adequate? We do know when a statement does answer a question, when not; we do know when an answer is adequate, though with less ease.

The evolutionary approach, says Popper, is the problem-solving one: evolutionism is a view of life as problem-orientated. Now this fits Lamarckism better than Darwinism, since the acquired characteristics that it postulates to be inherited, we may surmise, are solutions to problems posed by changed but rather stable environments. It is hard to view neo-Darwinist evolutionism, on its natural selection of blind mutations, as problem-oriented in more than a metaphoric sense. Not so its view of selection as error-elimination: error is a failure-to-fit-the-environment, and elimination of error is here extinction. Intuitively, amebas and arthropods are less adaptable than higher animals in that their specimens learn almost nothing: they are almost fully fixed at birth and innovate nothing. Does this not open the way to a theory of degrees of adaptability with scientific rationality as the peak of adaptability? This, clearly, is what Popper suggests, and it would be a synthesis of neo-Darwinism with neo-Lamarckism, which he wishes to effect (and which Barbara McClintock's studies of jumping genes require anyway). The way to an evolutionary answer to his quest may be cleared if a theory were available of the growth of rationality from the earliest appearance of humanity on earth. In the absence of this, it may be easier to glance at the earliest forms of human thoughts that are easily available.

This invites Popper's idea that science has evolved out of myth. The technological counterpart to the story should be, rational technology has grown out of magic. Do myths answer questions adequately? Are magic acts

adequate to their tasks? The question regarding magic seek an answer in an adequate theory of rationality (and I. C. Jarvie and I have ventured to offer one). (14) The explanation of the fact that myth and magic are no match to science is one of Popper's breakthroughs. He has argued that myths are not vulnerable enough. Species are to be invulnerable if they are to survive; thoughts are to be vulnerable, to die for us, as he has put it. The counterparts are the survival of the ameba or its mutant offspring and the survival of a theory or its successor. Where do myth and magic stand? Are they so rigid that they perish only with their carriers or are they able to die for us? If the former, then how did science at all emerge? If the latter, how does myth ever die?

Popper has offered no answer. His slogan is thus rather disappointing — even if it turns out later to have been of heuristic value. It is, to repeat, hard to judge before the problem it comes to solve is stated. Still worse, not all cases of trial-and-error are adequate conjectures and refutations, not even all entirely verbal trials-and-errors. Only those verbal trials are adequate conjectures, which answer the adequacy criteria for a scientific explanation, whatever these may be. Refutations, then, are attempts to find those facts which hopefully will help us answer the question, is the conjecture at hand true? Likewise, not all actions are conjectures, not all attempts to get some bananas are conjectures: as conjectures are adequate answers to questions, so trials are adequate attempts to perform tasks: going in circles endlessly is neither.

Popper's late attempts to develop his philosophy may obscure the significance of his early achievements, of his obviously adequate and most significant classical (true or false) solutions to some classical problems — because he is insensitive to his own view that new and subtler observations usually contradict older ones. (15)

Before coming to a conclusion let me offer two final paragraphs, on Popper's late theory of science as approximations to the truth. Does this theory include his early theory of science as trial-and-error? Do these two conform to his theory of life as problem solving?

The view of science as approximations to the truth is central to Popper's later philosophy of science. It is a great improvement on, and in contradiction with, his theory of science as trials-and-errors, since some trials-and-errors are not only approximations but more often they are futile trials to find needles in haystacks. At the very least in the latter case, common in technology, a task not completed is scarcely an advancement, yet science is advanced with every new clear step, be it a success or a failure, be the scientific venture capable of completion or not. Otherwise it would not advance at all until extra-scientific information would be available as to when a scientific task is complete. Popper's slogan, Ameba and Einstein are both problem-solvers, thus translates his view of scientific theories as increasingly improved approximations to the truth into the view

of them as solutions on one evolutionary scale of improved efficiency from the non-verbal through the preverbal and the pre-scientific to the scientific. This, however, is a mere half-baked sketch, no solution to a problem — an adequacy criterion at best.

Finally, as to approximationism and life as problem solving; solutions have to be approximate: precise solutions are hardly ever useful. (16) The problem remains, what is the role of increasingly better approximations? They are essential in the world of basic experiences. An example may be useful. That binocular vision is conducive to survival is clear. It is effected by considering the images received from the two eyes once as approximately the same picture in both eyes and then, in a better approximation, as somewhat different. (17) (This is best illustrated in Bela Julesz' justly famous dots experiments.) More generally, a comprehensive view of the world is indispensable for the conscious selection of details to observe: most observable details are ignored so as to make sense of the rest; in perception of animals and infants this is done unawares, but this is not so for thinking processes, especially science. The great achievement of contemporary, ecological, perception theory of the Gibson style lies precisely in this lesson and its amplifications to diverse psychological fields, such as the study of memory. The theory of science as inductive makes no sense of these developments, and this is precisely why all philosophers who endorse that theory ignore Gibson: they take the old defunct associationist theory of perception as sacrosanct. Already Descartes attempted to create a framework for science on the understanding that without a framework sensations make no sense. But he wanted certitude for his framework. The available alternative is either the view of science as choosing its frameworks irrationally, as Thomas S. Kuhn seemingly suggests at times (and seemingly denies at times) or the theory of scientific theories as approximations to the truth. This latter theory is very problematic but also very exciting, no less because it is a door to evolutionary theories. One major problematic item in it is the need to have an inarticulate filter of perception: whereas Jakob von Uexküll and his followers, such as Konrad Lorenz, stress that the world-picture of an animal depends on its ability to perceive (18), as a result of Popper's views, as well as of Sir John Eccles' neurological studies, it may be suggested that an essential part of the adjustment mechanism of an organism is its ability to discriminate, i.e., attend to some items at times and discard the same items at other times. Do amebas discard? This is an important open question that should be answered favorably if Popper's ameba is to remain a mini-scientist. This is what remains of Popper's parable of Ameba and Einstein.

4. Conclusions

The slogan, all life is problem solving, from Ameba to Einstein, is very tempting in that it presents an evolutionary scale of sorts. The very idea of an evolutionary scale is risky, as it is the thin edge of the wedge of cosmic evolutionism of the sort sought by many of Darwin's followers (though

presumably not Darwin himself), which Popper has splendidly attacked in his celebrated The Poverty of Historicism and The Open Society and Its Enemies. Of course, to characterize all life as sharing one characteristic is not yet an evolutionary scale, though it possibly may serve in that capacity. As Popper deems problem solving basic, it suggests that a possible evolutionary scale is the levels or degrees of problem-solving or of its efficiency. My counter-proposal is to assume that there are more than one dimension of rationality, and the degrees of efficiency of any problem-solving may differ in different dimensions. This, of course, will abolish the idea of one evolutionary scale and will be more in tune with the pluralist approach, which is the lasting heritage of Darwin's teachings. If so, then the only real gain from Popper's slogan is the colorful declaration of the demise of associationism and of other, slightly more sophisticated learning theories, that forbid innovation proper, including Gestalt psychology, Chomsky's innatism, Piaget's "evolutionary epistemology" as well as of the imprinting theory of Lorenz.

Popper's idea of the survival value of rationality is all too obvious for words. This would have been generally admitted were it not coupled with his rubber-stamp idea of science as conjectures and refutations. Here is the reason for the significance of his slogan: already in the last century thinkers have sought a theory of science that tallies better with Darwinism, yet they recoiled from the suggestion that scientific truths may be false statements. This is the coup of Popper's theory of science: error elimination is parallel to extinction. Pluralism is the opposite of the demand for quick extinction. Popper's view of science demanding swift and quick criticism seems more vicious than Darwin's nature. Query: the assertion that Popper's theory of science is Darwinian, what part of it is it metaphoric, what part is literal?

The problem, then, pertains not only to Popper's slogan. A theory of science is wished for, with two desiderata: first, that it present science as rational and as such to be also conducive to survival, yet without thereby implying cosmic evolutionism; second, that it present the survival of a theory without this being merely metaphorical. Perhaps then a theory survives in the sense of being taught and applied so that it seems to possess a high degree of verisimilitude or some other virtue (so that pace Popper, a refuted theory need not be considered extinct). Doubtless, Popper has scored in the sense that his theory of science answers these desiderata best, yet they also show the need for further improvements. Perhaps the most promising avenue is the study of science and scientific technology as parts of human ecology and as the sources of the current global risks to survival, hopefully also as the source of the solution to this plight [19].

NOTES

* This is a revised version of the paper published in Philosophy and Rhetorics, 26, 1993, 9-31

(1) The part of the logic of questions-and-answers outlined here is also known in other contexts as state-descriptions: each state-description is a finitely long statement comprising a conjunction of singular statements. At times this is deemed the proper basis for the theory of probability (Ludwig Wittgenstein, Tractatus Logico-Philosophicus), yet this is insufficient as the different states may have unequal a priori probabilities. Its simplest embodiment is a simple program for booking a limited number of tickets for a finite list of events. This was extended to infinite lists and was given a fancy name: "possible-worlds semantics". As a semantic theory proper this theory raises an insoluble problem of renaming which is really irrelevant to it: even the theory of probability, where state-descriptions and questions meet, has no place for renaming, as noted in K. R. Popper, "On Carnap's Version of Laplace's Rule of Succession," Mind, 71, 1962. See also my "The secret of Carnap", reprinted in my The Gentle Art of Philosophical Polemics: selected reviews and comments, La Salle, IL: Open Court, 1988.

(2) The famous canons of induction in John Stuart Mill's Logic seem to suggest that scientific research is commonsense as it is exclusively eliminative. That some but not all research is eliminative is an observed fact. The principle that all research is eliminative is perhaps equivalent to the principle of limited variety announced by J. M. Keynes in his A Treatise on Probability, 1921. Possibly the defenders of this principle, such as G. H. von Wright in his The Logical Problem of Induction, 1957, will not take the word "eliminative" in the sense here understood: no one has a complete list of alternative theories. In any case, surely, since science is not confined to operating within a commonly received framework, it is not mere commonsense. It is a matter of bold conjectures, as Popper stressed, or of "crazy" ones, as Bohr stressed.

(3) See my Science in Flux, Dordrecht and Boston: Kluwer, 1975, Chapter 10, Questions of Science and Metaphysics, pp. 240-69.

(4) Rom Harré ed., Problems of Scientific Revolution; Progress and Obstacles to Progress in the Sciences (the Herbert Spencer Lectures, 1973). Oxford: Clarendon Press, 1975

(5) See my review of Popper's Objective knowledge, reprinted in my The Gentle Art of Philosophical Polemics, Chapter 27.

(6) In Heidegger's What is Metaphysics? the questions, what is truth? and what is freedom? are given the same answer: it is the let-be-of-the-what-is. A brilliant conclusion from this is then presented: truth and freedom are identical. Taken literally this is hilarious; taken metaphorically, however, it is a trite sermon.

(7) See my Towards a Rational Philosophical Anthropology. Dordrecht and Boston: Kluwer, 1977, Chapter Two: Man as Animal.

(8) See Max Wertheimer, Productive Thinking, Enlarged Edition, Harper

Torchbook, 1959, p. 12, on the contribution of the Würzburg school to task-oriented studies and their significance. The important fact is that Gestalt psychology seems to be consistent with inductive logic that is endorsed as in no need for discussion (pp. 7 -8). See also there, Chapter Two, The Bridge Problem. Chapter Nine, on Galileo's discovery, raises the question right off the bat: did Galileo use induction? I do not know Wertheimer's answer. Wertheimer stresses that science is problem-oriented and that there are different modes of thinking (p. 245 ff.), some more inductive than others. Yet Wertheimer's principle of Prägnanz throws everything into confusion, as it says that we all always optimize the simplicity and clarity of the organization of our perception.

(9) See W. K. Berkson and J. R. Wettersten, Lernen aus dem Irrtum: Karl Poppers Lerntheorie, Hamburg: Hoffmann und Kampe, 1982. English translation, Learning from Error, Karl Popper's Learning Theory. La Salle, IL: Open Court, 1984. See also J. R. Wettersten, The Roots of Critical rationalism, Amsterdam and Atlanta GA: Rodopi, 1992, especially his review of Popper's Die Beiden Grundprobleme, "From Vienna Via Heidelberg and Würzburg", reissued there.

(10) See my "Criteria of Novelty", reprinted in my Science in Flux, 1975, esp. pp. 55-7, 72.

(11) See my essay referred to in note 3.

(12) See my review of Kuhn's book, reprinted in my The Gentle Art of Philosophical Polemics, 1988, Chapter 9.

(13) See for details my Technology: Philosophical and Social Aspects. Dordrecht and Boston: Kluwer, 1986.

(14) See J. Agassi and I. C. Jarvie, eds., Rationality: The Critical View: Dordrecht and Boston: Kluwer, 1987, our final essays, where rational thought is subsumed under the category of rational action.

(15) See my essay on novelty, referred to in note 10 above, and my review of Popper's Objective Knowledge, referred to in note 5 above.

(16) See my Science in Flux, 1975.

(17) See my "The Wisdom of the Eye", on David Marr's Vision, in J. Social and Biological Studies, 10, 1987, 408-13. See my The Gentle Art of Philosophical Polemics, 1988, Chapter 27.

(18) See reference in note 7 above.

(19) See my works referred to in notes 3 and 12 above.