From the perspective of reality, both of these statements are equally indeterminate. Yet (1) reflects the full indeterminacy of the situation (in verbal form), while (2) allows for projection of other comparison conditions (for example, "50 percent chance is higher than 30 percent chance") into the field of reasoning. The latter is an example of semiotic reconstruction of the uncertainty field with the help of signs—quantified probability values—which create an illusion of certainty where there is actually none (that is, even if the claim that 50 percent chance is higher than 30 percent chance, its relevance for the reality of rain tomorrow is only illusory).

Do We Toss a Coin to Live?

The standard starting point of making sense of probability is the ordinary act of betting—tossing a coin. It is usually on the basis of such coin-tossing that the meaning of probability is set forth.

A coin is a thin round piece of metal which, when thrown up and let to land on a hard surface, lands either on one (heads) or the other (tails) side. Assuming the hardness of the landing surface, there are only two possible options for the landing.[2] Thus, by accepted probability calculus, each of the sides ("heads" and "tails") *has the same chance* (0.5, or one in two) to occur.

Note the basic attribution trick in this statement: both sides are an inseparable part of the same coin. Yet, the attribution is made to each of the parts *as if* those could be separated. In reality, neither the "heads" nor "tails" side of the coin "has" the chance (separately from each other) to land on *its* side. It is the coin that—when tossed—lands, not one (or the other) side of the coin. Thus, the coin (as a whole) lands either on one, or another side, but the sides do not land in any state without the coin as the whole.

Three Meanings of Probability

From the same event of tossing a coin, one can proceed to outline the three kinds of probabilities that Western thought has operated with over the past three centuries.

First, there is the *propensity* notion of probability. This probability is based on the set of structural possibilities inherent in the structure of the object and its situation. Thus, the coin—at least a thin one, thrown on hard surface—entails two possible landing options. The probability described above—p "heads" = p "tails" = 0.5—is an example of propensity notion

of probability. The thinker only needs to know the structure of the coin (and its tossing environment) so as to estimate the probabilities. The estimation can change, if the structure of the object changes. Imagine that a coin is made to "grow" in its thickness and reach the same thickness in the third dimension that it has in the other two. The propensity kind of probability is immediately changing from a ½ to ½ split to a ⅓ ("heads"), ⅓ ("tails"), and ⅓ ("on edge") estimate. Note that propensity as the basis of probability estimate is independent of any previous experience with tossing coins, and can be fully deductively calculated prior to the first tossing of the coin.

Second, probabilities can be *frequentist*. The frequentist probability estimation entails full dependence upon the past history—summatively accumulated over time—of the experienced events. Thus, one needs a large number of coin tossings for estimation of the frequentist probability of the "heads" or "tails." In the case of a coin, it is likely that the summarized frequencies of "heads" and "tails" over time coincide with propensity-based probability estimates. After all, the coin remaining two-sided, a very large number of tossings should result in approximately equal options.

Third, there exists the notion of *subjective probability*. The subjective probability is a subjectively quantified *degree of belief* about the outcome of an event. Under conditions where all the information about the properties of the event are known (a coin is a good example), the subjective probability may concur with the propensity version of the probability estimation. Thus, if I know the structure of the coin and its landing surface, I can believe that the chances of "heads" and "tails" on any tossing are equal (0.5), and if I were to try it out on a large number of occasions, my belief may indeed be proven by empirical evidence. Yet, the features of a system are not always known (no or limited access to the propensity conditions), nor is the history of the object known (no frequentistic information). Under such circumstances, the degree of belief can provide the thinker with complicated projective possibilities.

MIXING OF PROBABILITY NOTIONS IN PSYCHOLOGICAL RESEARCH

There is a basic issue at stake in psychology's methodology: the applicability of different notions of probabilistic thinking in its theoretical

discourse. In current practice, there exists constant confusion between the three notions. Of the three models of probability—frequentistic, subjective, and propensity—only the first two are amply utilized by psychologists. It is especially the case with the first—frequentistic probability notion is used widely (as it allows for the use of inductively-accumulated knowledge of frequencies of events), and often translated into *the* probability notion. Yet, such translation need not be applicable, especially when the researcher moves from a population-based data base (for frequentistic probability estimation) into a degree of belief (subjective probability) concerning an individual case (O'Doherty, 2006).

An example of such translation was criticized by Allport in the context of prediction of personality:

> A fatal *non sequitur* occurs in the reasoning that if 80 percent of the delinquents who come from broken homes are recidivists, then *this* delinquent from a broken home has an 80 percent chance of becoming a recidivist.[3] The truth of the matter seems to be that *this* delinquent has either 100 percent certainty of becoming a repeater or 100 percent certainty of going straight (Allport, 1942: 156).

The strict logic of Allport's argument can be followed if we look at his arguments from a strictly defined developmental perspective—that of irreversibility of time in the lives of organisms. "Becoming a delinquent" is not an event similar to tossing coins. It is a process of becoming, taking place within a complex system (such as a particular adolescent). The repetition of the "delinquent act" by a particular adolescent is worked out between the developing person and his/her environment. Hence, the history of similar previous cases (for example, a sample of adolescents who have been found delinquent) has no bearing upon *this particular* young person.

Allport's point is important: habitual transfer of frequentistic probability notions from populations to individuals creates an illusion of knowledge, and stops actual inquiry. A probability estimate carried over to an individual has no explanatory value. In the case of a set of multi-linear possible life-course trajectories, the knowledge of any N previous cases cannot provide the researchers with adequate information about the actual construction of the N+1st case. The actual construction of the person's life experience takes place in irreversible time and concrete life contexts as those emerge during that time period. Each possible next step in this course is predictively equifinal from the vantage point of the present: for example, a person who has committed a delinquent act either does it again—that is, has "100 percent certainty" for that—or does not.

Cognitive Heuristics as Cultural Mediation Complexes

Contemporary cognitive psychology has often demonstrated its normative bias: the process of thinking by ordinary persons has been evaluated to the standpoint of norms of one or another kind of formal logic, rather than studied for the discovery of its own inherent logic. Thus, "errors" of thinking—viewed from the standpoint of either classical two-valent logic, or statistical rules of inference—have been documented and paraded in front of the ever-new cohorts of psychology students. Those students may listen to the stories with awe, and proceed to make the very *same "errors" in their own reasoning. Thus, it is the research on reasoning* that needs to adjust its scope, not the reality of human mental processes *that have served us well since we managed to kill our first predator.*

Example 6.6: Heuristics in Thinking

Consider, for example, the following scenario that has been the basis for subjective probability estimation tasks: "Linda is 31 years old, single, outspoken and very bright. She majored in philosophy. As a student she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations" (Tversky and Kahneman, 1983: 297).

In a forced choice selection—ranking—of interpretations (from a list of eight options), three have made their way into the data base of modern cognitive psychology. The interpreters of the scenario compared judgments that were assumed to be unrepresentative of Linda ("Linda is a bank teller"), another that was considered to be representative of her ("Linda is active in the feminist movement"), and their unified version (conjunction: "Linda is a bank teller who is active in the feminist movement"). The originators of the "heuristics and biases" research in cognitive psychology—Amos Tversky and Daniel Kahneman—have made this judgment task pivotal for demonstrating that ordinary persons (as well as "sophisticated" ones, those who have taken statistics courses at Stanford) all commit the so-called "conjunction fallacy." That "fallacy" consists of systematic believing that the conjunction of the two ("Linda is a bank teller who is active in the feminist movement") is more probable than either of its components taken separately). If the persons—ordinary or sophisticated—had utilized the laws of probability calculus, the conjunction of the two parts should have been viewed as *less* probable than its components. Tversky and Kahneman demonstrated that use of probability calculations was not the case, and that respondents used some other, non-logical and non-probabilistic, ways of deciding about Linda's present status.

The prominence of the "conjunction fallacy" in human reasoning indicates that applicability of probabilistic reasoning in everyday life reasoning is itself a decision (which is not made probabilistically or logically by persons). Calculation is a lengthy process, and is not simply applicable under conditions of limited information and time pressure on the decision maker (see Gigerenzer's claim for alternatives—"fast and frugal heuristics"—below). Probability, in each of its three meanings, is applicable to real-life reasoning only in narrowly circumscribed conditions.

The cognitive "heuristics and biases" tradition in cognitive psychology has emerged from the discovery that ordinary human beings do not follow the canons of frequentistic probability thinking—the base rates of the events thought about. Tversky and Kahneman labeled such base-rate dismissing moves in thinking "heuristics," and used a set of such heuristics to explain human reasoning. Thus, for example, the *representativeness heuristic* entails "... an assessment of the *degree of correspondence* between a sample and a population, an instance and a category, an act and an actor or, more generally, between an outcome and a model" (Tversky and Kahneman, 1983: 295; emphasis added).

The notion of "degree of correspondence" is a subjective phenomenon that is completely delegated to the intra-psychological subjective realm. Tversky and Kahneman—whether consciously or not—have brought modern cognitive science back to the study of introspection. Yet, they assume that human reasoning might, in its subjectivity, be probabilistic.

The mixing of different perspectives described above (population-based frequencies with psychological salience of an instance, or model) is evident in the case of the representativeness heuristic. "Heuristic" is a blanket term for a cognitive complex that a person uses to solve a problem under the present conditions.

The Availability Heuristic

Tversky and Kahneman formulated a whole set of "heuristics" which they labeled in terms of assumed intra-psychological introspective processes. Thus, that of availability is another "shortcut" around the need to become involved in probability calculations:

> A person is said to employ the availability heuristic whenever he estimates frequency or probability *by the ease with which instances or associations could be brought to mind.* To assess availability it is not necessary to perform the actual operations of retrieval or construction. It suffices to assess the ease with which these operations could be performed, much as the difficulty of a puzzle or mathematical problem can be assessed without considering specific solutions (Tversky and Kahneman, 1983: 164; emphasis added).

Again, the frequency of events is assumed to be parallel to subjective probability. The notion of "ease" is a characteristic of the human mental system that is based on the basic processes of associations.

The Simulation Heuristic

This construct was the last ultimate step in the "heuristics and biases" research program to return to the study of processes of introspection. Whereas in the case of representativeness and availability heuristics the processes behind the invented labels remained without emphasis, in case of the simulation heuristic there is a clear effort to bring those processes out to the arena of investigation. The starting point for the simulation heuristic

> ... is a common introspection. There appear to be many situations in which questions about events are answered by an operation that resembles the running of a simulation model... we construe the output of simulation as an assessment of the ease with which the model could produce different outcomes, given its initial conditions and operating parameters... mental simulation yields a measure of the propensity of one's model of the situation to generate various outcomes (Tversky and Kahneman, 1983: 201).

Simulation of events occurring within assumed (constructed) scenarios is the process of problem-solving. The "heuristics and biases" program has reinvented the mental problem-solving processes (under the name of simulation) that were effectively studied in introspection experiments of the "Würzburg School" as well as by its corollary researchers, Otto Selz and Karl Duncker (Simon, 1999). The critical (re)invention is the return to the need to study the processes of decision-making as those are taking place in the real time, rather than make inferences about those processes from their outcomes. The study of such processes qua (as) processes entails the need to consider time limits that exist in various problem-solving tasks.

How Can Human Thinking Proceed at its Regular Speed?

Most of the phenomena captured by "cognitive heuristics" are based on laboratory tasks (such as the ones described above). The actual decision-making in real life takes place as the person detects a problem, and in accordance with the time demands of the solution. There is often the pressure of time on the decision-making process.

The need to act under uncertainty (of the future) and time pressure (of the given problem definition) leads to the need for sturdy mechanisms of

human reflection. Gerd Gigerenzer has labeled such cognitive mechanisms *fast and frugal heuristics* (FFH). These are essentially psychological tools for overlooking some parts of existing information for the sake of efficiency of the decision. Thus,

> Fast and frugal heuristics employ a minimum of time, knowledge, and computation to make adaptive choices in real environments. They can be used to solve problems of sequential search through objects or options, as in satisficing [*sic*]. They can also be used to make choices between simultaneously available objects, where the search for information (in the form of cues, features, consequences, etc.) about the possible options must be limited, rather than the search for the options themselves. Fast and frugal heuristics limit their search of objects or information using easily computable stopping rules, and they may make their choices with easily computable decision rules (Gigerenzer et al., 1999: 14).

In contrast to Tversky and Kahneman's assumption of cognitive forming of the solutions (via heuristics), Gigerenzer advocates a model of thinking that operates upon regulation of the search process for answers. The mental system—faced with an ill-defined problem (for example, "Which city has a bigger population, Munich or Antananarive?")—utilizes the approximate information based on familiarity of the names, and stops the decision process before it enters into long calculations. Most human reasoning is based on ignorance, and yet it works sufficiently well in our life environments.

From FFH to Semiotic Mediation

The human reflected-upon world is inherently ambiguous; despite its present seemingly clear state, it can change at any moment. It is here where Gigerenzer's "fast and frugal heuristics" share grounds with semiotic mediation. The latter reflects the *conditionality* of the states of the world. Thus, cultural heroes, mothers and/or tricksters are employed in myth-stories and discourse in general to reflect the possible (conditional) changes of their conduct from one extreme to another. In this respect, the semiotically-mediated world is a "personally cautious world"—with different possible scenarios for what might happen with a person under different conditions. The decisions about how to solve different kinds of problems, ranging from trivial decisions to those decisions on which human lives may depend (as in medicine), would lead to the use of one or another kind of heuristic process.

STRATEGIC USES OF REASONING

miotic mediation reflects the desired (goals-oriented) reflection upon world. This may make it possible to ignore the ambiguity of the nditional world, and represent the world in terms of unipolarity of a sired sign. This is where ideologies narrow down human complexity reflection, with a clear purpose. "Dialog" in the case of an ideological sade is not a desired form of interaction; if it is claimed to be of value, s a framework of superimposition of the ideologist's missionary claim gain control over "the other." Political "dialogs," as well as advertise-nts in mass media that manifestly use the notion of "dialog" are aimed disambiguating "the other's" field of conduct. The process is simple: domain of human actions that previously had not been highlighted w becomes singled out as an "area of concern." The concern then comes reflected upon in ambiguous terms (guiding the persons to-rds constructing their personal worries about this). Finally, it becomes ambiguated again, *but now through making the disambiguating agent be in control* of relieving the worries. A domain "X" is made into a roblem," and the solutions to that "problem" are made available as *rvices" by an exclusive set of "professionals" who are "well-trained"* olve precisely these "problems." The professional services of child chology and education specialists need not differ much from advice grandmothers could give, yet the value is produced by the profes-al construction of the "problem" and its "cure."

EDOM OF MAKING "THE RIGHT" CHOICE

disambiguating strategies rely upon semiotically-constructed values would make the external control of the issue acceptable. In many eties of our time, the generalized complex of "freedom of choice" is zed in this process. Some years ago, when telephone companies in United States were "de-monopolized" (and many new companies could pete for the same customers), TV commercials with text like "now *have the 'choice'* for your provider of telephone services . . . we hope to make the '*right*' choice . . . " began to appear. The new ambiguous tion for the clients—who previously had not needed to bother about "right" to "make choices" about telephone companies—was im-diately made into a domain of discursive activity, by goal-oriented agents *fully controlled their version of provision of the given know-how.*

The "right to decide" (between telephone companies) was culturally created within an existing set of possibilities, each of which (if chosen) would gain full control over the given relation with the client who had decided in their favor. The ambiguity of deciding (among options not revealed in full to the prospective "clients") was generated socially; this immediately set the stage for various goal-oriented efforts of disambiguating the situation. The latter operates with signs that exclude their opposites, thus creating certainty and eliminating doubts.

The crucial test of the advertising efforts would be to look for *any signs of doubt* about the advertised product itself, communicated in the advertisement text. This is particularly interesting in the case of products that are necessarily inherently ambiguous—all medical "drugs" carry an inherent ambiguity with them (not different from any other substance usable in human existence, including tobacco and alcohol). Medicines can both cure and kill; which of the two scenarios works in a given case is, in principle, indeterminate.

Thus, the particular "side effects" of a medical drug for a particular person cannot be predicted, and the long-term "safety" of a drug is not testable in principle (for example, which pharmaceutical company would wait for 20 years to test the *lack* of long-term negative effects of a drug that needs to capture the market *now*?). These are inevitable, inherent ambiguities of human life in the "modern world," which are ideologically turned into semiotic unambiguity (for example, "drug X is *safe*"). Thalidomide was "safe" as a drug administered to pregnant women until cases of congenital bodily malformation in their offspring were discovered, albeit in low frequencies compared to the wide use of the drug. Yet, it was sufficient to lead to banning of the drug. Asbestos in the architectural environment was once viewed as "safe"; however, in our present time, examples abound of asbestos-infested buildings that have been abandoned.

CONCLUSIONS: ABDUCTION AS PROCESS OF INNOVATION

Human thinking is simultaneously an intra-mental and inter-mental process. In its basic flow it belongs to the intra-mental domain. Yet, most of its objects are in the domains outside of the human individual psyche. Moreover, the ways of thinking are actively suggested by other people, through different forms of communication. Communication is not a flowery,

utopian process of "sharing" or "communion" of kindred souls. Instead, it carries in it all of the human goal-orientations, tactical action plans, and, most importantly, ever-open possibilities for modification of the communicative messages.

It is in the context of such openness of communicative messages that the intra-mental process of thinking constitutes the force that creates relative stability of the mind in the middle of myriad social suggestions. Yet, there is always the tension with the frameworks in the social world that attempt to guide the thinking process. Thinking is guided both internally—through externalization of the person's understanding of how to frame the here-and-now setting—and externally—some external social agent suggesting and demanding how the person might, should, or must, think. Abduction here takes precedence over induction and deduction. The highly valued "freedom of thought" is a negotiated settlement, rather than a philosophical given.

Notes

1. For full coverage of how concrete persons were set up to belong to this scheme as filling in the minor premise, see *The Tryal of Tituba Indian: Transcripts of the Salem Witchcraft Trials of 1692*, Salem, MA: The New England and Virginia Company, n.d.
2. Under conditions of a different surface, such as soft and embracing, the coin may also land and stay on its edge. This example proves that the probability of the coin's landing depends upon the environment within which the coin-tossing occurs.
3. Recidivist = repeater of crimes.