# The Search for Models of Clinical Judgment: Fast, Frugal, and Friendly in Paul Meehl's Spirit

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Abstract

Most psychologists have classified Meehl's "disturbing little book" as an attack against the reliability of clinical judgment and as a call for the replacement of clinical judges by actuarial methods. But Meehl had a lot more to say. His book presented three challenges to the study of judgment that have received scant attention. Psychologists have to develop (a) context-specific models of judgment, (b) non-linear process models that take into account the bounded nature of judgment, and (c) clinician-friendly actuarial methods. These challenges have received renewed attention in the ABC research program. Here we show how models of bounded and ecological rationality can be used to describe judgments and improve the accuracy and friendliness of actuarial methods in Paul Meehl's spirit.

## I. Introduction

Paul E. Meehl (1920-2003) does not fall into any ready-made category. In his autobiography, he characterized himself as "a clinical psychologist who also ran rats and knew how to take a partial derivative" (Meehl, 1989, p. 354; Meehl, 1954, p. vii; 1973). Influenced by Karl Menninger's famous book, *The Human Mind*, he went to psychology in order to become a psychotherapist (Meehl, 1986; 1989, p. 339), but graduated from the University of Minnesota, where most psychologists (Hathaway, Paterson, Skinner) were strongly skeptical of psychodynamic theories and where "the scholarly ethos was objective, skeptical, quantitative, and behavioristic" (Meehl, 1989, p. 345). He was a clinician, trained in the Freudian tradition, but open to other methodologies. He was strongly interested in theoretical and philosophical issues (Meehl, 1989, pp. 340, 373). And he was an experimentalist, studying rats in the

behaviorist tradition (McCorquodale & Meehl, 1951; Meehl & McCorquodale, 1953), and human subjects in personality psychology (Meehl & Dahlstrom, 1960).

Meehl is mostly known for his book, *Clinical versus Statistical Prediction: A Theoretical Analysis and a Review of the Evidence* (1954). The influence of this classic can hardly be overestimated. Together with a few seminal papers published in the fifties (Edwards, 1954; Hammond, 1955), it gave a decisive impulse to the study of human judgment (Goldstein & Hogarth, 1997). The book testifies of the diverse interest of its author. Echoing both Meehl's clinical practice and his knowledge of actuarial methods, like the MMPI to which he himself contributed, the book presents a nuanced appraisal of the nature and value of clinical judgments.

Many of his readers failed, however, to pay tribute to the sophistication of Meehl's position. Indeed, in several articles, he complained—somewhat bitterly—about the reading of his 1954 book (Meehl, 1986; 1989, p. 360). Most psychologists have classified Meehl's book as an attack against the reliability of clinical judgment and as a call for the replacement of clinical judges by actuarial methods (e.g., Brehmer, 1994, p.138; Baron, 2000, p. 362). True, in chapter 8, Meehl reviews twenty empirical studies that compare the accuracy of clinical judgments to actuarial methods when a prediction has to be made on the basis of people's given characteristics, or *prognosis*. For example, a prognostic judgment would be to decide whether someone, who is a sixty-five year-old male, and who complains of strong chest pain, will develop ischemic heart disease. Meehl's results have been replicated: whatever their experience, theoretical commitments, feedback opportunities, or information, clinicians are usually outperformed by actuarial methods (for more recent reviews see Dawes et al., 1989; Grove & Meehl, 1996; Swets, Dawes, & Monahan, 2000). But

Meehl had a lot more to say. His book presents three challenges to the study of judgments that have received scant attention.

Context-Specificity First, Meehl emphasizes the distinction between different judgment contexts. Creating a psychological model of the patient—*diagnosis*—is not to be confused with prognosis. In both cases, predictions are made, but the information available to the clinical judge is different. Diagnosis unfolds over time, with an extended interaction between judge and patient. In prognosis, the judge is simultaneously presented with all available information and cannot refine the prediction over time. These differences suggest that the cognitive processes that underlie judgment also differ in these contexts. Most theories of judgment have failed to provide models of context-specific cognitive processes. We discuss some context-specific models in Section III. There, we point out that prognosis may involve different judgmental strategies depending on the information available to the judge.

Non-Linearity Second, Meehl questions the applicability of linear models to judgments (Meehl, 1954, p. 47). Focusing on diagnostic judgments, he favored a notion of diagnostic prediction like the "psychological process which is involved in the creation of scientific theory", with recurrent generation, testing and refinement of hypotheses (Meehl, 1954, p. 65). Meehl, however, does not develop this notion further. The idea that judgments do not result from linear processes applies to prognostic judgments as well. True, non-linear models of prognostic judgment have been developed (Goldberg, 1971; Ganzach, 1995), but they are fairly complex. Instead, we appeal to process models that take the *bounded* nature of our cognition into account. In Section III, we describe recent process models that link non-linearity to the bounded nature of judgment.

Friendliness Third, Meehl emphasizes that prediction can and should be improved. Meehl suggested replacing clinical judgment by actuarial methods *when* the latter are more suited. Clinicians, he argued, should dedicate their time and energy to the tasks, like therapy, that cannot be efficiently accomplished by actuarial methods. Meehl has repeatedly complained about the lack of impact his plea has had on the clinical practice (Meehl, 1989, p. 380). The idea of replacing clinical judgments by actuarial methods is still controversial (Bishop, 2001; Bishop & Trout, 2002; Dawes, 2002). Arguably, this is due to the clinicians' difficulty in understanding and applying actuarial methods like linear regression (Green & Mehr, 1997; Elwyn et al., 2001). The models presented in Section III can be used as actuarial methods that are both *accurate* and *easy* for clinicians to understand and apply.

In this article, we argue that the challenges presented in Meehl's "disturbing little book" have received renewed attention in the ABC research program (Gigerenzer, Todd, & the ABC Research Group, 1999; Todd & Gigerenzer, 2000). Specifically, this program emphasizes the context-specificity of the cognitive processes underlying judgment, offers models of judgment that differ from the linear actuarial methods discussed by Meehl and his followers, and acknowledges the limited time and computational power of the clinical judge. In addition, the proposed models of clinical judgment can be used to construct actuarial methods for quick, effortless and clinician-friendly prognostic prediction that compete well with, or even outperform, more complex actuarial methods. Before we present these models in greater detail, we discuss some of the models for clinical judgment that were proposed in the wake of Meehl's book.

## II. Models of Clinical Judgment after Meehl:

## Linear Man, Configural Man and Biased Man

Not long after the publication of Meehl (1954) various attempts were made to better understand the cognitive processes used by the clinical judge. Ironically, many of the proposed models were based on the notion of a linear combination of various pieces of information (Hoffman, 1960; Hammond, 1955), that is, the type of model that Meehl had used to characterize actuarial methods only.

First, it is important to point out that these early approaches take different stances on whether or not the linear models of judgments describe our cognitive processes (Brehmer, 1994). On the one hand, researchers such as Hoffman (1960) were merely interested in modelling the *relationship* between input variables and output variables in judgment, and simply viewed linear regression as a conventional tool to describe this relationship. In contrast to this "as if"-approach, proponents of the Brunswikian perspective, originally developed in the field of perception but extended to judgment by Hammond (1955), took linear models to describe people's actual cognitive processes. Over the years, however, the distinction between tool and model got lost, and the idea of weighing and integrating was generally accepted as a model of the cognitive process itself.

The main findings of this research on how people use information and why clinical judgment deviates from actuarial methods can be summarized as follows (Brehmer, 1994). Across a wide range of situations, linear models do a very good job at predicting the clinical judgment at a fixed point in time and the inclusion of non-linear elements increases the predictive fit only slightly (Slovic & Lichtenstein, 1971). But if we study the same judge at different points in time, clinical judges seem to

weigh the available cues unreliably and inconsistently. This lack of robustness is ascribed to the human susceptibility to "boredom, fatigue, illness, [and] interpersonal distractions" (Goldberg, 1970, p. 423).

Some researchers took these results as indicating that, essentially, the cognitive process involved in judgment is linear (Brehmer & Brehmer, 1988). Others remained skeptical and developed models based on configural cues (Wiggins & Hoffman, 1968; Goldberg, 1971). Instead of being linear judges, it was hypothesised that people are sensitive to the interactions between cues. Configural cues cannot be broken down into simpler cues, for instance because they involve products of these simple cues. The resulting models are thus even more complex than the linear ones.

At the same time, an alternative account of non-linear cognitive processes was beginning to emerge. Slovic and Lichtenstein (1971) concluded from their extensive review that "subjects are processing information in ways fundamentally different from […] regression models" and call for "more molecular analyses of the heuristic strategies that subjects employ when they integrate information" (p. 729). In the beginning of the seventies, Kahneman and Tversky (1974) broke with the linear-man and the configural-man hypotheses and proposed that judges follow often non-linear and simple mental short cuts. Moreover, these short-cuts may lead to biases. For instance, they proposed that people attend to the representativeness, rather than the predictive power of information (Kahneman & Tversky, 1973). However, they failed to clearly model the underlying processes (Gigerenzer, 1996).

The models of the linear man, the configural man and the biased man had an enormous impact on research in psychology and other social sciences. However, none of them were constructed to be context-specific. Nor do they provide a friendly way

to improve predictions. True, the configural man and the biased man addressed Meehl's non-linearity challenge. However, the configural man is too complex to be a valid description of the judge and the biased man is not precise enough. As we shall see, there are more plausible ways to give a non-linear account of our cognitive processes.

## III. Meehl Meets the ABC Research Group

If Meehl had constructed process models of the clinical judge, what would they have looked like? As we saw, Meehl (1954) was sensitive to the fact that judgment is context-specific. He also acknowledged that real-life judgment is always constrained by limited time, information and computational power (Meehl, 1957). In this section, we expand on Meehl's views on these issues and we show how the models proposed by the ABC research program flesh them out. We present models of judgment that are context-specific and do not integrate information linearly. Finally, we argue that such models can serve as a basis for *fast*, *frugal* and *friendly* actuarial methods. We argue that clinicians accept these methods more easily than more complex ones.

Context-Specific and Ecologically Rational Already in the preface of his book, Meehl points out that prognostic and diagnostic contexts call for different methods. He writes: "There is no convincing reason to assume that explicitly formalized mathematical rules and the clinician's creativity are equally suited for any given kind of task, or that their comparative effectiveness is the same for different tasks" (Meehl, 1954, p. vi, emphasis added).

At the end of the book (chapter 8), he continues the discussion of the difference between prediction in prognosis and diagnosis. In pure prognosis, "*...all bad ideas tend to subtract from the power of good ones*" (Meehl, 1954, p. 121, original emphasis). The prediction is made at one point in time and with the information available at that point. In diagnosis, however, the role of prediction is different. Here, the clinical judge can operate by trial and error, and interact extensively with the patient, collecting new information in order to test his hypotheses. Bad ideas are not necessarily damaging in this context: "Nobody knows what the payoff rate is for these moment-to-moment guesses that come to therapists; but the over-all success frequency might be considerably less than 50 percent and still justify the guessing [...] even if the to-be discarded hypotheses were pure filler, they would not impede the therapy except as they consumed time" (Meehl, 1954, pp. 120-121; Meehl, 1989, p. 360). On the contrary, they can trigger good hypotheses.

How should we model context-specific cognitive processes in a formal way? The research program recently introduced by Gigerenzer and his research group has the potential to meet Meehl's context-specificity challenge. In this program, a number of context-specific quantitative models of judgment were developed (Gigerenzer, Todd, & the ABC Research Group, 1999; Todd & Gigerenzer, 2000). Here, context specificity is a consequence of *ecological rationality*, i.e., the notion that cognitive processes, including those underlying judgment, are not only sensitive to, but exploit the structure of the contexts in which they operate (see also Brunswik, 1955; Simon, 1956). Since different contexts have different structures, processes vary across contexts.

For example, when German subjects are asked to decide which of two options has a larger value with respect to a criterion, for example, which of San Diego or San Antonio is larger, they use the *recognition heuristic* (Goldstein and Gigerenzer, 2002). This heuristic is a simple rule: If you recognize only one of the two options, infer that this option is larger. The use of the recognition heuristic is ecologically rational when recognition is positively correlated with city population.

Now, take a context in which both cities are recognized. For this context, Gigerenzer and Goldstein (1996) proposed another model, *Take The Best*. In this model, people are assumed to search for *cues* that are related to the criterion, like the presence of an airport, the existence of a football team etc. Cues are inspected in order of decreasing validity, which is the probability of a correct response given that the two options have a different value on the cue. Someone using Take The Best makes a decision based on the first cue that discriminates between the options. Take The Best is ecologically rational in contexts where cues are very differentially important (Martignon & Hoffrage, 2002), or cues validities are highly dispersed (Katsikopoulos & Martignon, 2004)—see also Hogarth & Karelaia (2004). In these contexts, looking for other pieces of information would not improve or could even degrade the judgment.

Take The Best is used in situations with similar constraints as those the judge faces in clinical practice. First, time pressure seems to increase people's use of Take The Best (Rieskamp & Hoffrage, 1999). Second, the cost of information acquisition influences whether people select Take The Best or a compensatory strategy. When cost of memory retrieval (Bröder & Schiffer, 2003) or information search (Bröder, 2000; Newell & Shanks, 2003) is high, people follow Take the Best closely.

Moreover, there is accumulating evidence that people learn to use simple strategies when these strategies pay off (Bröder, 2003; Rieskamp & Otto, 2004).

The ABC program proposes context-specific models as a consequence of the notion of ecological rationality. Another key notion of the ABC program, inspired by Simon (1956), is the notion of *bounded rationality*.

Non-Linear and Boundedly Rational Meehl emphasizes that clinical prediction is made under considerable time pressure, with limited information and knowledge, and with a substantial lack of feedback. These constraints are inherent to the bounded resources of the clinician and to the clinical context. As Meehl puts it, "... it is impossible for the clinician to get up in the middle of an interview, saying to the patient, "Leave yourself in suspended animation for 48 hours. Before I respond to your last remark, it is necessary for me to do some work on my calculating machine."" (Meehl, 1954, p. 81). Clinical prediction has to be done on-line.

Meehl did not develop the theme of bounded rationality. Specifically, he did not see how it connects with the non-linearity challenge—developing non-linear models of cognitive processes underlying judgment. As we shall see below, ABC bridges the gap between these two ideas. The program emphasizes that because judgment is bounded, the processes that generate it must be simple. The suggestion is that their simplicity results from a specific *kind* of non-linearity.

The models proposed by ABC, like Take The Best, do *not integrate* cues. For example, as we saw, someone using Take The Best decides on the basis of the first discriminating cue. As a consequence, a decision is mostly made after looking up only a fraction of the cues, and sometimes only one. We say that Take The Best is fast and frugal. Avoiding the integration of cues makes the ABC models non-linear. Thereby,

we meet Meehl's second challenge: The non-linearity of the models proposed by ABC results from the hypothesized simplicity—particularly, the non-integrative nature—of the processes.

The focus on fast and frugal models also makes it possible for ABC to meet Meehl's friendliness challenge. Insisting on simplicity makes it possible to develop friendly actuarial methods that are acceptable by clinicians, but that also retain the accuracy of more integrative actuarial methods.

Simple, Friendly, and Accurate Meehl was frustrated by clinicians' reluctance to use actuarial methods for making predictions. Recently, Dawes (2002; Dawes, Faust, & Meehl, 1989) and Bishop (2001) have called for increased use of actuarial methods. The fact, however, remains that clinicians are reluctant to even consult actuarial methods. We argue that fast and frugal models can be used successfully as actuarial tools in clinical prognosis. We illustrate this claim with a model that is related to Take The Best, but tailored to the clinical context. Furthermore, we point to evidence that physicians are willing to use these methods, plausibly because of their simplicity. We call these methods *friendly heuristics*.

Green and Mehr (1997) tested how likely physicians in a Michigan hospital were to use printed cards that showed how to use the logistic regression of Long et al., (1993). This regression instrument is widely considered to be one of the most accurate methods for judging whether a patient has a high risk of ischemic heart disease. The physicians' judgments about actual patients were monitored and initially, it appeared that the physicians' judgments were affected by the regression instrument. Later, however, it was discovered that physicians disregarded almost all elements of the regression, and considered *only three out of the seven symptoms* that were originally

included. Thus, physicians seem to prefer frugal methods. This has been also been observed by Elwyn et al. (2001), Fischer et al. (2002) and Dhami and Harries (2001). Beyond the medical domain, lay judges have also been found to use simple heuristics in bail decisions (Dhami & Ayton, 2001).

Besides showing that physicians use little information, Green and Mehr also discovered that the physicians were using this information in a way that is computationally much simpler than the regression instrument. This is supported by the match between the physicians' judgments and the predictions made by two simple models. These models were *a tally rule* (Dawes & Corrigan, 1974) and a *fast-and-frugal tree* (see below), which have been also investigated by the ABC group as models of judgment (Martignon, Vitouch, Takezawa, & Forster, 2003; Katsikopoulos & Martignon, 2003). Importantly, these simple models had a success rate comparable to that of the logistic regression, suggesting that simple processes may be as accurate as complex ones. In sum, Green and Mehr found that physicians used a *simpler* approach that relied on little information and that did not compromise accuracy.

So far we have focused on modeling the prognostic judgment. We now argue that the same models can be used to formulate actuarial methods that are friendly and accurate. In this way, meeting Meehl's first two challenges helps facing the third one.

We now describe fast and frugal trees by way of example—for a formal definition, see Katsikopoulos and Martignon (2003). Consider the following problem. Should antibiotic treatment that involves macrolides be prescribed to a young child suffering from community-acquired pneumonia? This is a delicate decision, because pathogens underlying this illness are often resistant to macrolides (Fischer et al., 2002). The decision also needs to be made quickly.

For these reasons, the classical decision analysis approach is inappropriate, because it would require gathering a large quantity of information that is difficult to get a hold of, like the probability and the cost of pathogen resistance. Instead, Fischer et al. (2002) simply assumed that two binary cues are known for each child. The first cue is whether the child had fever for more than two days, and the second cue is whether the child is older than three years. The rule is as follows: "*Prescribe macrolides only if the child has had fever for more than two days and the child is older than three years*". This rule can be easily memorized and can be quickly applied. It is a friendly heuristic. When the rule was evaluated on real data, it was found to lead to a 68% reduction of incorrect prescriptions, which is not significantly different from the reduction achieved by a scoring system based on logistic regression (Fischer et al., 2002). The fast and frugal tree is both friendly and accurate.

This verbal rule can also be represented graphically as a fast and frugal tree—see Figure 1. At the top level of the tree, it is asked whether the child had had fever for more than two days. If the answer to this is "no", it is immediately concluded that macrolides should not be prescribed. Only if the answer to the first question is "yes", is it asked in the second level of the tree whether the child is older than three years. If the answer to the second question is "no", it is concluded that macrolides should not be prescribed and if the answer is "yes", it is concluded that macrolides should be prescribed.

Insert Figure 1

This tree does not require the evaluation and combination of all possible outcomes for both options of prescribing and not prescribing macrolides. It only uses easily available cues about the patient in a simple sequential fashion. This tree is

frugal, because it uses only one cue at a time and because it uses at most two cues, and it is fast, since it processes each cue separately, by just asking and answering one question.

There is also evidence that fast and frugal trees are in fact easy to memorize (Katsikopoulos et al., 2003). In this study, participants were unexpectedly asked to draw various types of classification trees that they had used the previous day. It was found that the match between the predictions of the remembered and original trees was maximized when the original trees were fast and frugal. Further research is needed to discover under which conditions fast and frugal trees are easily applied and learned.

In this section, we have shown that fast and frugal trees can be used as friendly and accurate actuarial methods. The same is true of other fast and frugal models of our cognitive processes. For example, there is evidence that the recognition heuristic can be used as an actuarial method to predict performance of the stock market (Borges et al. 1999). In general, frugal methods are successful because they avoid the statistical problem of over-fitting (Czerlinski, Goldstein, & Gigerenzer, 1999).

## IV. Conclusions

Meehl's *Clinical versus Statistical Prediction* is mostly well known for presenting the first systematic survey of how well the prediction of clinical judges compares to actuarial methods. It might come as a surprise to the first-time reader that this comparison does not surface in the book until the end. The rest of the book is filled with important reflections on the clinical and actuarial judgment. In particular,

Meehl presents judgment research with three challenges that have more or less been ignored. In this article, we have tried to expand on them all.

Judgment is context-specific: in diagnosis, prediction can develop over time and bad ideas are not necessarily harmful; in prognosis, the judge only has one shot at making a correct prediction on the basis of the available information. The cognitive processes underlying judgment may also vary across prognostic contexts. For example, both Take The Best and the recognition heuristic can be used in prognosis, depending on the information available to the judge.

Human judgment differs from the linear actuarial methods Meehl compared it to. Human judges cannot always afford to integrate information. To understand the clinical judge, we have to remember that judgment is normally made with limited time and information. Instead of looking for complex non-linear models, we presented simple non-linear ones. The fact that human judgment is not linear does not mean that it fails. We argued that human judgment is fast and frugal and it efficiently uses time and other available resources.

In order to improve clinical judgment, more is needed than studies that compare it to actuarial methods. We have to find accurate actuarial methods that clinical judges are willing to use, like the fast and frugal trees. These methods are less information-greedy. This is crucial in the clinical setting, where information, like results of medical tests, is costly. Fast and frugal actuarial methods often mirror the cognitive processes underlying judgment. Therefore, they are friendly, that is, easy to use and transparent enough for the clinical judge to still feel in control. In sum, fast and frugal methods can provide us with valuable actuarial tools.

In the future, we hope that research concerning clinical judgment continues to develop the complexity of Meehl's position. We need to understand clinical judgment in the actual context in which it is made. We need to understand when clinical judgment can match actuarial methods and when it has to be supplemented. And we need to develop additional actuarial methods that are used in clinical settings. We need fast, frugal and friendly actuarial methods.


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Figure 1

The fast and frugal tree proposed by Fischer et al (2004) for making macrolide prescription decisions.